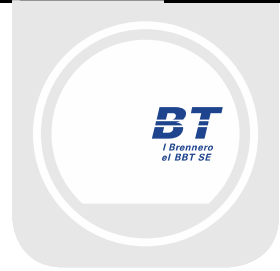




Mit Beteiligung der Europäischen Union aus dem Haushalt der Transeuropäischen Verkehrsnetze finanziertes Vorhaben

Opera finanziata con la partecipazione dell'Unione Europea attraverso il bilancio delle reti di trasporto transeuropee



Ausbau Eisenbahnachse München-Verona

# BRENNER BASISTUNNEL

Ausführungsplanung

Potenziamiento asse ferroviario Monaco-Verona

## GALLERIA DI BASE DEL BRENNERO

Progettazione esecutiva

**D0700: Baulos Mauls 2-3**

**D0700: Lotto Mules 2-3**

**Projekteinheit**

Nothaltestelle

**WBS**

Fermata di Emergenza

**Dokumentenart**

Statische Berechnung

**Tipo Documento**

Calcolo statico

**Titel**

Statische Berechnung FdE-V-IN-FdE-CcTa

**Titolo**

Relazione di calcolo FdE-V-IN-FdE-CcTa



Raggruppamento Temporaneo di Imprese 4P

ch. Pro.ter S.r.l., Via G.B. Sommarini 5, 20125 Milano, Tel: +39 026779711, Fax: +39 0267152612

Generalplaner / Responsabile integrazioni prestazioni specialistiche

Ing. Enrico Maria Pizzarotti

Ord. Ingg. Milano N° A 29470

Mandataria



Progetto  
Infrastrutture  
Territorio s.r.l.

Mandante



Mandante



Mandante



Fachplaner / il progettista specialista

Ing. Davide Merlini

Ord. Ingg. Como N° 2354 A

Datum / Data

Name / Nome

Gesellschaft / Società

Bearbeitet / Elaborato

30.01.2015

A. Battaglia / M. Falanesca

Pini Swiss

Geprüft / Verificato

30.01.2015

D. Merlini

Pini Swiss



Galleria di Base del Brennero  
Brenner Basistunnel BBT SE

Name / Nome

R. Zurlo

Name / Nome

K. Bergmeister

Projekt-  
kilometer /  
Chilometro  
progetto

von / da 32.0+88  
bis / a 54.0+15  
bei / al

Projekt-  
kilometer /  
Chilometro  
opera

von / da 44.5+55  
bis / a 45.0+25  
bei / al

Status  
Dokument /  
Stato  
documento

Massstab /  
Scala

-

Staat  
Stato

Los  
Lotto

Einheit  
Unità

Nummer  
Numero

Dokumentenart  
Tipo Documento

Vertrag  
Contratto

Nummer  
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## 1 EINLEITUNG

Das vorliegende Dokument beinhaltet die Bemessung der Außen- und Innenschalen des Anschlussbereichs zwischen Abluftquerstollen Nothaltestelle (FdE-V) und Mittelstollen Trens (FdE-CcT) im Bereich der Nothaltestelle.

Der Nothaltestelle entwickelt sich vorwiegend innerhalb des Bündnerschieferkomplexes (geomechanische Homogenzonen 11 – 13 [2]) mit variablen Überdeckungen von 1025m bis 1125m Abbildung 1.

Die für den Vortrieb des Anschlussbereiches Ausbruchsquerschnitte des Mittelstollens Trens sind mit den Abkürzungen CcTa-T2 ([4]) e FdE-CcTa-T3 ([5]) bezeichnet. Die Ausbruchsquerschnitte für den Abluftquerstollen hingen werden wie folgt abgekürzt: FdE-Va-T3 [6] e FdE-Va-T4 [7].

Diese Ausbruchsquerschnitte wurden auf Grund der gesammelten Erfahrung in der Ausführung von vergleichbaren Tiefbauprojekten entworfen. Dabei wurden konstruktive Verstärkungen der Standardprofile des Mittelstollens Trens (FdE-CcT-T) und des Abluftquerstollen (FdE-V-T) (siehe Berichte [8] e [9]) vorgesehen.

Der vorliegende Bericht behandelt die Bemessung der Innenschale im Anschlussbereich FdE-Va-IN-FdE-CcTa, unter Berücksichtigung der Übergangsbereiche FdE-V-IN-FdE-Va und FdE-CcT-IN-FdE-CcTa.

Die Innenschale ist bewehrt und wird aus Beton C30/37 ausgeführt. Die Mindeststärken, welche die Bautoleranzen berücksichtigen, variieren zwischen 60cm in Bereich der Kalotte und 90 cm im Bereich des Sohlgewölbes. Die einzelnen Betonierabschnitte des Anschlussbereichs sind durch Anschlusseisen miteinander verbunden.

## 1 INTRODUZIONE

La seguente relazione riporta il dimensionamento dei rivestimenti della zona di innesto tra i cunicoli di ventilazione (FdE-V) e il cunicolo centrale di Trens (FdE-CcT) all'interno della Fermata di Emergenza.

La Fermata di Emergenza si sviluppa prevalentemente all'interno del complesso dei calcescisti (zone geomeccaniche omogenee 11 - 13 [2]) con coperture variabili da 1025 m a 1115 Figura 1.

Le sezioni di scavo previste per affrontare lo scavo nella zona di innesto per il cunicolo centrale di Trens sono denominate FdE-CcTa-T2 ([4]) e FdE-CcTa-T3 ([5]) mentre per lo scavo del cunicolo di ventilazione sono denominate FdE-Va-T3 [6] e FdE-Va-T4 [7].

Queste sezioni di scavo sono state progettate sulla base dell'esperienza costruttiva in analoghi lavori sotterranei, considerando appositi rinforzi costruttivi rispetto ai profili standard del cunicolo centrale di Trens (FdE-CcT-T) e del cunicolo di ventilazione (FdE-V-T) per i quali si rimanda rispettivamente ai rapporti [8] e [9].

Nel presente rapporto si riporta il dimensionamento del rivestimento definitivo dell'innesto FdE-Va-IN-FdE-CcTa, prendendo in considerazione anche le transizioni tra la sezioni FdE-V-IN-FdE-Va e FdE-CcT-IN-FdE-CcTa.

Il rivestimento definitivo è completamente armato ed è costituito da calcestruzzo C30/37 con spessori minimi, che tengono conto delle tolleranze in fase di costruzione, pari a 60 e 90 cm rispettivamente in calotta ed in arco rovescio. Tra i vari conci che compongono l'innesto è presente armatura passante.

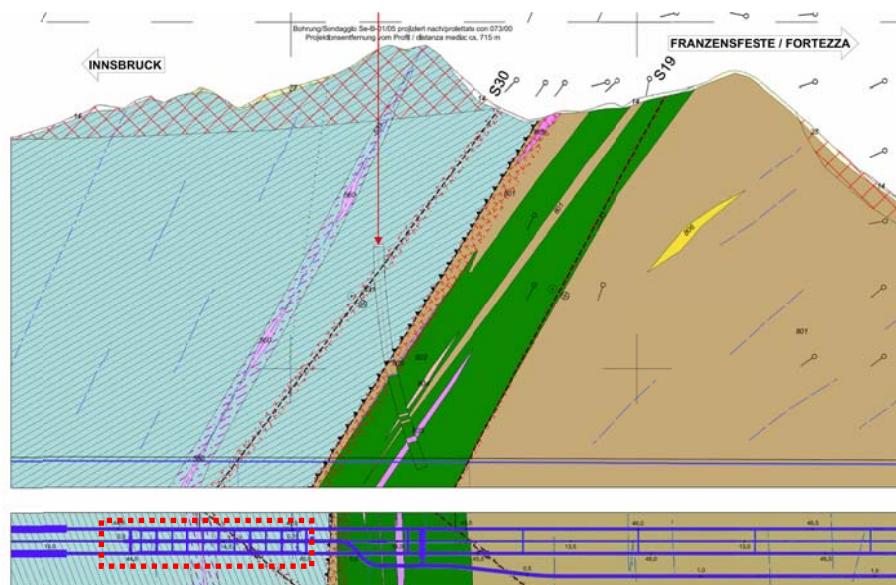


Abbildung 1: Auszug aus dem geomechanischen Längsschnitt und aus dem geologischen Lageplan [3] mit Angabe des untersuchten Bereichs.

Figura 1: Estratto del profilo geomeccanico longitudinale e della planimetria geologica [3] con indicazione dell'area di studio.

## 2 MATERIALKENNWERTE

### 2.2 BETON

Für die Bemessung der Innenschale ist in der Regel ein Beton der Festigkeitsklasse C28/35 mit folgenden Eigenschaften zu berücksichtigen:

$$E_{cm} = 32000 \text{ MPa}$$

$$f_{ck} = 30 \text{ MPa}$$

Hierbei sind:

- $E_{cm}$  = Mittelwert Sekantenmodul
- $f_{ck}$  = charakteristische Druckfestigkeit des Betons nach 28 Tagen

### 2.3 BEWEHRUNGSSTAHL

Folgende Betonstähle sind für die Bemessung der Außenschale heranzuziehen:

$$E_s = 210000 \text{ MPa}$$

$$f_{yk} = 450 \text{ MN/m}^2$$

Hierbei ist:

- $E_s$  = Sekantenmodul
- $f_{yk}$  = charakteristischer Wert der Streckgrenze des Betonstahls

## 2 MATERIALI

### 2.1 CALCESTRUZZO

Per il dimensionamento del rivestimento definitivo si considera un calcestruzzo con classe di resistenza C30/37 con le seguenti caratteristiche:

Dove:

- $E_{cm}$  è il valore medio del modulo elastico
- $f_{ck}$  è la resistenza a compressione caratteristica del calcestruzzo dopo 28 giorni

### 2.2 ACCIAIO D'ARMATURA

Per il dimensionamento dell'anello si utilizza l'acciaio tipo B450C:

dove:

- $E_s$  = modulo elastico
- $f_{yk}$  = tensione caratteristica di snervamento acciaio per cemento armato



### 3 AUßENSCHALE

Die für den Vortrieb des Anschlussbereiches Ausbruchsquerschnitte des Mittelstollens Trens sind mit den Abkürzungen CcTa-T2 ([4]) e FdE-CcTa-T3 ([5]) bezeichnet. Die Ausbruchsquerschnitte für den Abluftquerstollen hingen werden wie folgt abgekürzt: FdE-Va-T3 [6] e FdE-Va-T4 [7].

Diese Ausbruchsquerschnitte wurden auf Grund der gesammelten Erfahrung in der Ausführung von vergleichbaren Tiefbauprojekten entworfen. Dabei wurden konstruktive Verstärkungen der Standardprofile des Mittelstollens Trens (FdE-CcT-T) und des Abluftquerstollen (FdE-V-T) (siehe Berichte [8] e [9]) vorgesehen.

Analog dazu wird für detailliertere Informationen zum Gebirgsverhalten auf die Dokumente [8] und [9] verwiesen.

Im vorliegenden Bericht wurde die Möglichkeit, dass die Anschlussbereiche im extrem druckhaften Gebirge (Gebirgstyp GA-BST-KPH-8f, GA-T-R-8f und Bruchsystem S30 und TWS [1]) liegen ausgeschlossen. In diesem Fall wird auf den Bericht *Risikomanagement* verwiesen (02\_H61\_EG\_991\_KTB\_D0700\_15005).

### 3 RIVESTIMENTO DI PRIMA FASE

Le sezioni di scavo previste per affrontare lo scavo nella zona di innesto per il cunicolo centrale di Trens sono denominate FdE-CcTa-T2 ([4]) e FdE-CcTa-T3 ([5]) mentre per lo scavo del cunicolo di ventilazione sono denominate FdE-Va-T3 [6] e FdE-Va-T4 [7].

Queste sezioni di scavo sono state progettate sulla base dell'esperienza costruttiva in analoghi lavori sotterranei, considerando appositi rinforzi costruttivi rispetto ai profili standard del cunicolo centrale di Trens (FdE-CcT-T) e del cunicolo di ventilazione (FdE-V-T) per i quali si rimanda rispettivamente ai rapporti [8] e [9].

Analogamente per le informazioni sul comportamento dell'ammasso roccioso si rimanda ai rapporti [8] e [9].

In particolare nel presente rapporto, non sono state analizzate le zone di innesto che possano ricadere nelle formazioni incoerenti con comportamento estremamente spingente (ammassi GA-BST-KPH-8f, GA-T-R-8f e sistemi di faglie S30 e TWS [1]) per le quali si rimanda al rapporto *Procedura di gestione del rischio* (02\_H61\_EG\_991\_KTB\_D0700\_15005).

## 4 INNENSCHALE

### 4.1 STABWERKSMODELLE

Die Beanspruchungen der Innenschale sind durch das informatische Rechenprogramm MIDAS Gen2013, das auf die Finite-Elementen-Methode (FEM) basiert, berechnet worden.

Für die Berechnung wurde die dreidimensionale Geometrie des Kreuzungsbereiches herangezogen, wobei die Struktur aus Plattenelemente (plates) besteht. Die Tunnelinnenschale wurde mit drei- und viereckigen Plattenelementen modelliert mit einer Seitenlänge kleiner 0.4m und einer Dicke, welche der realen Innenschalendicke (Kalotte, Widerlager, Sohlgewölbe) entspricht.

Die strukturelle Steifigkeit der Plates Elemente wird als  $E'_c \times I_y$  des nicht gerissenen Schnitts berechnet. Das Trägheitsmoment  $I_g$  wird im Verhältnis zur Schnittachse aus Beton berechnet, wobei der Stahl, wo vorhanden, ausgelassen wird. Das elastische Modul  $E'_c$ , im Falle von ebener Verformung, beträgt

$$E'_c = \frac{E_c}{1 - \nu^2}$$

mit:

- $E_c$  = Modul der Betonelastizität;
- $\nu$  = Poissonsahl (0.2);

Zur Modellierung des unbewehrten Betons wird ein elastisch-lineares Materialmodell verwendet.

### 4.2 MODELLIERUNG DER BETTUNG

Die Zusammenwirkung Boden-Struktur wird mit dem Einsatz von Point Support Elementen simuliert, die an die Modellknoten gesetzt werden. Nur bei Komprimierung übertragen diese Elemente den Knoten eine Reaktion, die dem Kontaktdruck Boden-Struktur entspricht. Die Steifigkeit der genannten Elemente wird unter Berücksichtigung des Reaktionsmoduls des Bodens  $k$  und der Schnittstelle, welche sich aus dem Paket der Abdichtung - Drainageschicht ergibt, bestimmt. Die erste wird laut den nachfolgend angeführten Relationen bestimmt und zwar jeweils für gekrümmte und gradlinige Oberflächen (Abs. 4.2.1 und 4.2.2). Die zweite wurde mit 60'000 kN/m<sup>3</sup> aufgrund der Eigenschaften des Abdichtungsstreifens angenommen. Letztere zählt für Verschiebungen von weniger als 0.5 cm. Werden diese Verschiebungen überschritten, entspricht die Schnittstellensteifigkeit der des Gebirges.

Die tangenziale Steifigkeit wurde aufgrund des Vorhandenseins des Abdichtungsbahn an der Schnittstelle Boden-Struktur vernachlässigt.

## 4 RIVESTIMENTO DEFINITIVO

### 4.1 METODO DELLE REAZIONI IPERSTATICHE

Le sollecitazioni nel rivestimento definitivo sono state calcolate mediante il programma di calcolo informatico MIDAS Gen2013, basato sul Metodo degli Elementi Finiti (FEM).

Per il calcolo si considera la geometria tridimensionale dell'intero incrocio e si definisce un modello della struttura mediante elementi finiti piani di tipo plate. Il rivestimento della galleria è schematizzato con elementi plates di forma triangolare e quadrata aventi lati con lunghezza inferiore a 0.4 m e caratterizzati da spessori che simulano quelli reali dell'elemento strutturale considerato (calotta, piedritto, arco rovescio).

La rigidità strutturale degli elementi plates è calcolata come  $E'_c \times I_y$  della sezione non fessurata. Il momento d'inerzia  $I_y$  è calcolato rispetto all'asse della sezione in calcestruzzo, trascurando la presenza dell'acciaio ove presente. Il modulo elastico  $E'_c$ , in condizioni di deformazioni piane, vale:

dove:

- $E_c$  = modulo di elasticità del calcestruzzo;
- $\nu$  = rapporto di Poisson (0.2);

Per la modellazione del calcestruzzo si utilizza un modello costitutivo del materiale elastico-lineare.

### 4.2 INTERAZIONE TERRENO-STRUTTURA

L'interazione terreno-struttura viene simulata mediante l'utilizzo di elementi distributed spring support posti sulla superficie dei plates del modello. Tali elementi trasmettono ai plates, solo se compressi, una reazione pari alla pressione di contatto terreno-struttura. La rigidità degli elementi citati è determinata tenendo conto del modulo di reazione del terreno  $k$  e dell'interfaccia data dal pacchetto impermeabilizzazione-strato drenante. La prima è definita secondo le relazioni di seguito descritte (paragrafo 4.2.1 e 4.2.2), rispettivamente per superfici curve e rettilinee. La seconda è stata assunta pari a 60'000 kN/m<sup>3</sup> in virtù delle caratteristiche del pacchetto d'impermeabilizzazione. Quest'ultima ha valenza per spostamenti inferiori a 0.5 cm. Superati tali spostamenti, la rigidità dell'interfaccia diventa quella dell'ammasso.

La rigidità tangenziale è stata trascurata in virtù della presenza del manto di impermeabilizzazione nell'interfaccia terreno-struttura.

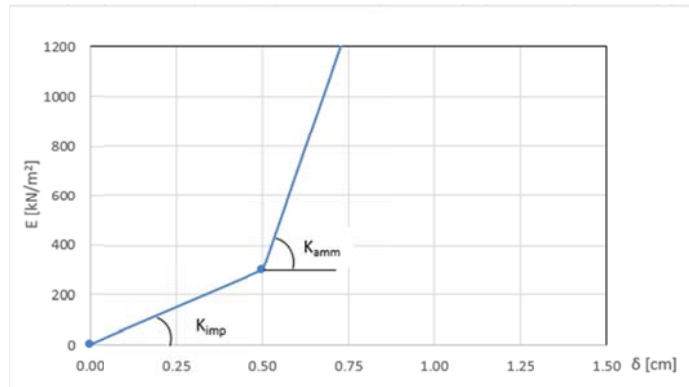


Abbildung 2: Schematisierung der Schnittstelle

Figura 2: Schematizzazione dell'interfaccia

#### 4.2.1 Modellierung der Bettung

Die radiale Bettung der Innenschale im Gebirge/Boden ermittelt sich in der Regel unter Berücksichtigung des Elastizitätsmoduls  $E$  und der Querdehnzahl  $\nu$  des Gebirges/Bodens sowie der Systemlinie des entsprechenden Innenschalenradius  $R$  wie folgt:

$$K_R = E \times \frac{(1 - \nu)}{(1 + \nu)(1 - 2 \times \nu) \times R} = \frac{E_S}{R}$$

Hierbei ist:

- $K_R$  = radiale Bettung Innenschale – Gebirge [ $\text{MN}/\text{m}^3$ ]
- $E$  = Elastizitätsmodul des umliegenden Bodens/Gebirges
- $E_S$  = Steifemodul des umliegenden Bodens/Gebirges
- $\nu$  = Querdehnzahl des Bodens/Gebirges
- $R$  = Tunnelradius Systemlinie

#### 4.2.1 Rigidezza radiale

Per la definizione della rigidezza del letto di molle radiali in materiale sciolto, si tiene conto del modulo elastico  $E$ , del coefficiente di Poisson  $\nu$  dell'ammasso roccioso e del raggio interno  $R$  della galleria.

Dove:

- $K_R$  = rigidezza del letto di molle radiali a contatto con l'anello interno [ $\text{MN}/\text{m}^3$ ]
- $E$  = modulo elastico dell'ammasso roccioso
- $E_S$  = modulo edometrico dell'ammasso roccioso
- $\nu$  = coeff. di Poisson dell'ammasso roccioso
- $R$  = raggio della galleria – linea di riferimento

#### 4.2.2 Federkonstanten Auflagerbereich/Sohle

Das Widerlager der Konstruktion mit Sohlplatte bzw. offener Sohle (Querschläge) wird durch Federn mit zugehöriger Steifigkeit in Abhängigkeit der dazugehörigen Einflussbreite „ $b$ “ modelliert. Die Federkonstanten sind wie folgt zu ermitteln:

Federkonstante  $c_v$  – vertikal

- $c_v = E_{\text{Geb.}} \cdot 0,5 \cdot b$

Federkonstante  $c_h$  – horizontal

- $c_h = 0,5 \cdot c_v$

#### 4.2.2 Costante della molla nelle zone di appoggio / fondo

L'appoggio della costruzione con arco rovescio viene modellato con molla distribuita sulla superficie di contatto dei plates interessati. La costante della molla si calcola come segue:

Costante della molla  $c_v$  – verticale

- $c_v = E_{\text{Geb.}} \cdot 0,5$

Costante della molla  $c_h$  – orizzontale

- $c_h = 0,5 \cdot c_v$

### 4.3 EINWIRKUNGEN

Im Folgenden werden folgende Kürzel für die Einwirkungen herangezogen:

- G = ständige Einwirkungen
- Q = vorübergehende Einwirkungen
- A = außergewöhnliche Einwirkungen (z.B. Brand, Anprall, Explosion)
- E = Erdbeben

#### 4.3.1 Eigengewicht G1

Die für die Berechnung des Eigengewichts verwendete Querschnittsfläche pro Tunnelmeter basiert auf den Planmaßen der Konstruktion.

Das spezifische Eigengewicht des Stahlbetons ist mit  $\gamma = 25 \text{ kN/m}^3$  zu berücksichtigen.

#### 4.3.2 Oberleitung G2

Die Oberleitungslasten werden laut Abbildung auf der sicheren Seite liegend für eine maximale Spannweite von 50 m angesetzt. Aus diesen Lasten ergeben sich die am Aufhängepunkt anzusetzenden Lasten:

- Moment von 3,80 kNm
- Horizontallast von 0,70 kN
- Vertikallast von 2,50kN

### 4.3 ANALISI DEI CARICHI

Per le azioni si utilizzano le seguenti abbreviazioni:

- G = Azioni permanenti
- Q = Azioni variabili
- A = Azioni eccezionali (per es. incendio, urto, esplosione)
- E = Azioni sismiche

#### 4.3.1 Peso proprio G1

Il volume utilizzato per il calcolo del peso proprio si basa sulle dimensioni effettive della struttura.

Il peso specifico del calcestruzzo viene assunto pari  $\gamma = 25 \text{ kN/m}^3$ .

#### 4.3.2 Catenaria G2

Le catenarie vengono applicate per sicurezza su una distanza massima di 50 m, come nella Illustrazione. Da questi carichi derivano quelli da applicare al punto di sospensione:

- Momento di 3,80 kNm
- Carico orizzontale di 0,70 kN
- Carico verticale di 2,50kN

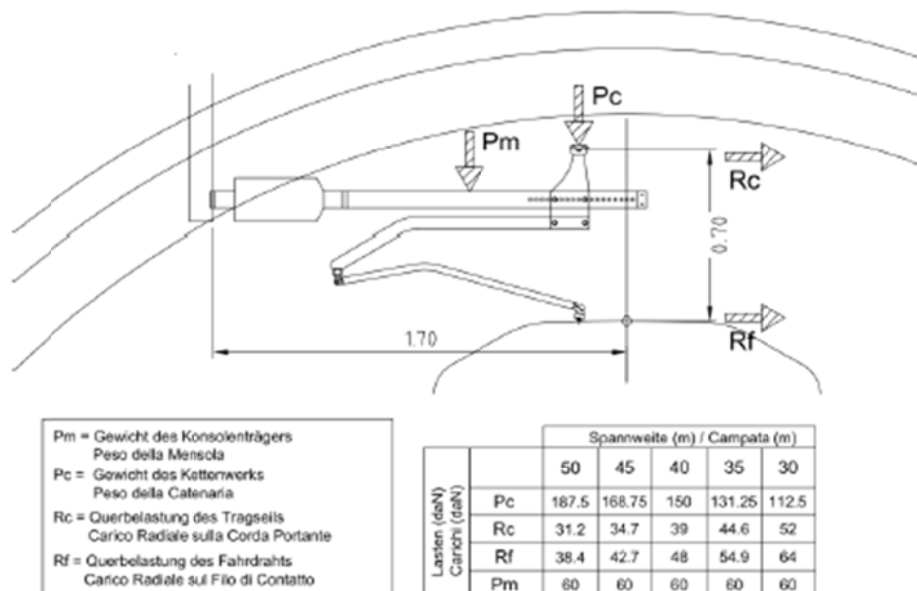


Abbildung 3: Lasten der Oberleitung

Figura 3: Carichi della catenaria

#### 4.3.3 Oberleitung G3

Das für die Berechnung des Eigengewichts verwendete Volumen basiert auf dem Planmaß der Konstruktion.

Das spezifische Gewicht des unbewehrten Betons wird mit  $\gamma_{c,na} = 24 \text{ kN/m}^3$  angenommen.

Das spezifische Gewicht des Stahlbetons wird mit  $\gamma_{c,ar} = 25 \text{ kN/m}^3$  angenommen.

#### 4.3.4 Wasserdruck G4

Für druckentlastete (drainierte) Tunnel wird der Wasserdruck, bei Regelquerschnitten mit Sohlgewölbe, nur bis in Höhe der Ulmenlängsdrainage berücksichtigt. Die Wasserlasten sind dann wie folgt anzusetzen:

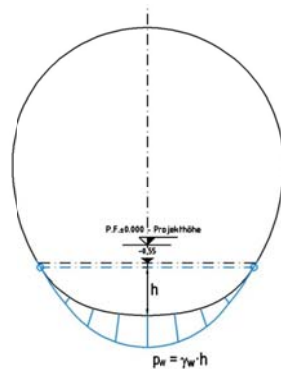


Abbildung 4: Lastbild Wasserdruck – drainierter Regelquerschnitt

#### 4.3.5 Gebirgslast G5

Die Gebirgslast entspricht der aus der FEM-Berechnung resultierenden Last nach vollständigem Verfall der fiktiven Aushubkräfte (letzte Stufe der FEM-Analyse).

Die Gebirgslast wurde aus der Bemessung des Ausbruchquerschnitts FdE-CcT T5 (siehe Dokument [8]) herangezogen. Falls in der Vortriebsphase extrem druckhaftes Gebirge angetroffen werden sollte wird auf Kapitel 3 verwiesen.

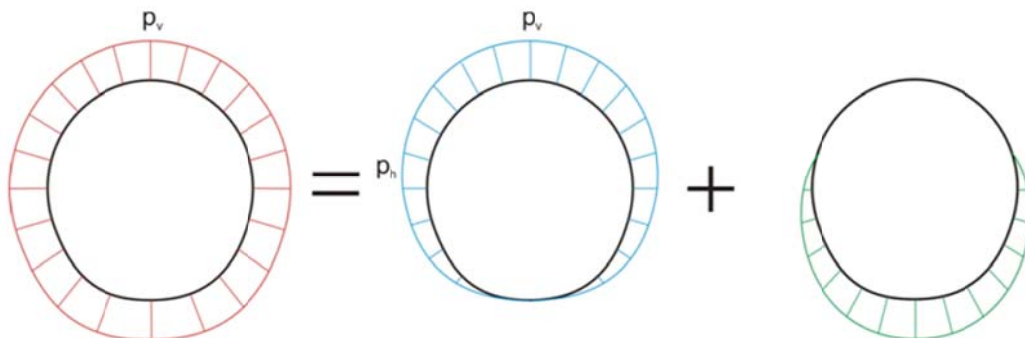


Abbildung 5: Qualitative Darstellung der numerisch ermittelten Normalspannungen (rot), der aktiven Gebirgslast (blau) und der passiven Bettungsreaktion (grün)

#### 4.3.3 Riempimento in cls al di sopra dell'arco rovescio G3

Il volume utilizzato per il calcolo del peso proprio si basa sulle dimensioni effettive della struttura.

Il peso specifico del calcestruzzo non armato viene assunto pari a  $\gamma_{c,na} = 24 \text{ kN/m}^3$ .

Il peso specifico del calcestruzzo armato viene assunto pari a  $\gamma_{c,ar} = 25 \text{ kN/m}^3$ .

#### 4.3.4 Pressione idraulica G4

Per il caso di galleria drenata (senza pressione) nelle sezioni tipo con arco rovescio, il carico idraulico viene considerato solo dal vertice inferiore al di sotto dell'arco rovescio fino all'altezza del drenaggio sul piedritto. Il carico idraulico viene applicato secondo il seguente schema:

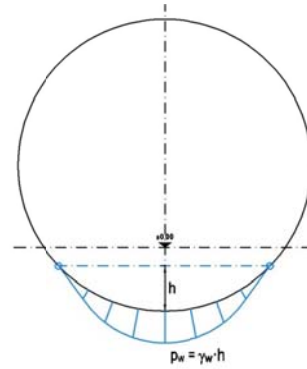


Figura 4: Pressione idrostatica - Sezione tipo drenata

#### 4.3.5 Carico dell'ammasso G5

Il carico d'ammasso è pari al carico che agisce sul rivestimento definitivo emerso dalle analisi agli elementi finiti, al completo decadimento delle forze fittizie di scavo (ultimo step delle analisi FEM).

Il carico d'ammasso è stato ripreso dal valore fornito per il dimensionamento della sezione di scavo FdE-CcT T5 riportato nel documento [8]. Nel caso vengano incontrate durante lo scavo formazioni estremamente spingenti si rimanda a quanto indicato nel Cap. 3.

Figura 5: Rappresentazione qualitativa delle tensioni normali (rosso), ottenute dal calcolo numerico, del carico attivo dell'ammasso (blu) e della reazione assestamento del terreno (verde)

#### 4.3.6 Kriechen und Schwinden des Betons G6

Das Schwindmaß des Betons wird gemäß NTC 2008 Kap. 11.2.10.6 ermittelt.

Die Kriechzahl  $\phi$  wird gemäß dem NTC 2008 Kap. 11.2.10.7 unter Berücksichtigung des Spannungszustandes aus einer Einwirkungskombination ständiger Lasten ermittelt.

Kriechen und Schwinden des Betons bewirken eine Längenänderung  $\Delta l$  (Endschwindmaß), auf welche die Berechnung in Form einer gleichmäßigen Temperaturabkühlung gründet.

Für alle Abschnitte die höher als 25 cm und aus Beton C30/37 sind ergibt sich eine Durchschnittsverformung per autogenes zeitlich unendliches Schwinden von 0.27‰. Bei der Dimensionierung ist, gemäß Vorschrift, 50% des Schwindens übernommen worden, was durch eine gleichmäßige Temperaturabkühlung von -13.4 °C simulierbar ist. Diese Abkühlung muss, z.B., mittels Einsatz eines funktionstüchtigen Superverflüssigungsmittels (Typ MasterGlenium von BASF), nicht-kalkhaltigen Zuschlagstoffen und Zugabe eines Expansionsmittels (Typ MasterLife SRA100 von BASF) bewirkt werden. Das angewendete System muss auf der Baustelle mit präventiven Proben geprüft werden.

Bei der Modellierung der Innenschale, insbesondere bezüglich Absatz 4.1.1.1 des NTC08, verfährt man mit einer gleichmäßigen Temperaturabkühlung von -6.7° C an den GZT und von -8.9°C a den GZG.

#### 4.3.7 Temperatur Q1

Die Dimensionierung der Innenschale hat unter Berücksichtigung der Temperatureinwirkung gemäß der nachfolgenden Tabelle entsprechend dem Abstand zum Portal zu erfolgen.

Abstand Portal / Distanza dall'imbocco [km]	3,0 - 10,0	
Temperaturgradient / gradiente della temperatura $\Delta T$ / [°C]	2	
$\Delta T_{eff}$ [°C]	Winter / Inverno	Sommer / Estate
	-10	10

Tabelle 1: Temperatureinwirkung Innenschale

Der Temperaturgradient  $\Delta T$  gibt die Temperaturdifferenz zwischen Innen- und Außenkante der Innenschale wieder.

Temperaturbeanspruchungen während des Baus der Innenschale werden vernachlässigt.

Die Einwirkungen im Brandfall werden im Kapitel 4.3.11 behandelt.

#### 4.3.6 Viscosità e ritiro del calcestruzzo G6

La deformazione dovuta al ritiro del calcestruzzo si calcola in base al paragrafo 11.2.10.6 delle NTC 2008.

Il coefficiente di viscosità  $\phi$  si calcola ai sensi delle NTC 2008 par. 11.2.10.7, considerando la condizione tensionale derivante dalla combinazione di azioni permanenti.

Viscosità e ritiro del calcestruzzo comportano un cambiamento in lunghezza  $\Delta l$  (valore finale del ritiro), su cui deve essere basato il calcolo, in forma di diminuzione uniforme della temperatura.

Per tutte le sezioni con altezza maggiore di 25 cm e calcestruzzo con classe di resistenza C30/37 risulta una deformazione media per ritiro autogeno a tempo infinito pari a 0.27‰. Nel dimensionamento si è assunto il 50% del ritiro imposto dalla Normativa, simulabile mediante l'applicazione di un abbassamento uniforme della temperatura di -13.4 °C. Tale riduzione dovrà essere ottenuta, ad esempio, mediante l'utilizzo di un superfluidificante performante (tipo MasterGlenium della BASF), di inerti non calcarei e tramite l'aggiunta di un espansivo (tipo MasterLife SRA100 della BASF). Il sistema adottato dovrà essere verificato con prove preventive in cantiere.

Nella modellazione delle strutture interne, con particolare riferimento al paragrafo 4.1.1.1 dell'NTC08, si procede applicando un abbassamento uniforme della temperatura di -6.7° C agli SLU e di -8.9°C agli SLE.

#### 4.3.7 Temperatura Q1

Per il dimensionamento dei rivestimenti definitivi si considerano azioni termiche, in conformità alla seguente tabella, secondo la distanza dall'imbocco.

Tabella 1: Variazione termica

Il gradiente della temperatura  $\Delta T$  indica la differenza di temperatura tra le superfici interna ed esterna del rivestimento in conci.

Le sollecitazioni derivanti dalla temperatura durante la costruzione dell'anello vengono trascurate.

Le azioni derivanti dalle alte temperatura a seguito di incendio

sono oggetto del paragrafo 4.3.11.

#### 4.3.8 Erdbebeneinwirkung E1

Die Einwirkungen, welche aus einem eventuellen Erdbeben resultieren, fallen gegenüber den restlichen Einwirkungen nicht ins Gewicht und werden aus diesem Grund vernachlässigt.

#### 4.3.9 Druck / Sog infolge Zugfahrt A1

Die Be- und Entlastungsvorgänge, welche aus der Zugverkehr resultieren sind in Dokument D0118-064 „Aerodynamik – Klima – Lüftung“ festgelegt. Dem Dokument kann entnommen werden, dass im Extremfall (außergewöhnliche Einwirkung) im Tunnel aerodynamische Einwirkungen von  $\Delta_p \text{ Druck} = + 11 \text{ kN/m}^2$  und  $\Delta_p \text{ sog} = - 9 \text{ kN/m}^2$  entstehen. Unter Berücksichtigung der entsprechend Teilsicherheitsfaktoren handelt es sich bei den aerodynamischen Einwirkungen um maßgebende Einwirkungen, welche nur mit Einwirkungen in außergewöhnlicher Bemessungssituation kombiniert werden.

#### 4.3.10 Anpralllast A2

Die Einwirkung „Anprall“ der Schienenfahrzeuge ist nur im Bereich der Verzweigungsbauwerken und Portale zu berücksichtigen.

#### 4.3.11 Brand A3

Die Dimensionierung im Brandfall wird gemäß den Vorschriften der EN 1992-1-2 ausgeführt.

Gemäß den Vorschriften des MD 28/10/2005 Sicherheit in den Eisenbahntunnels, wird die Stabilität aller Bauwerke in Hinblick auf die Temperatur-Zeit Kurve laut UNI 11076 gemäß D0118-04326 "Sicherheit gegen die Brandexplosionen" gewährleistet.

Die bewehrten und unbewehrten Abschnitte sind hinsichtlich eines Brandes gemäß den Kriterien des spezifischen Berichts [10] geprüft worden. Hier beschränkt man sich darauf hinzuweisen, dass, einvernehmlich mit der Tabelle D.6.3 del D.M. 16.02.2007 "Klassifizierung der Feuerbeständigkeit der Bauprodukte und -elemente für Bauwerke", folgende Bedingungen ausreichend zur Gewährleistung der REI 120 Klasse sind:

- Stärke 's' der Strukturelemente größer als 160 mm;
- Betondeckung 'a' (Achsenabstand der Bewehrung von der ausgesetzten Oberfläche) größer als 35 mm.

Beide Voraussetzungen sind erfüllt.

#### 4.3.8 Azione sismica E1

Il carico sismico rappresenta una condizione poco influente rispetto alle altre combinazioni di carico e pertanto non viene considerata.

#### 4.3.9 Pressione aerodinamica A1

I processi di carico e scarico tensionale a seguito del passaggio dei treni sono definiti nel documento D0118-064 „Aerodynamica – clima – ventilazione“. Dal documento si deduce che in casi estremi (azioni eccezionali) si presentano in galleria azioni aerodinamiche di  $\Delta_p \text{ pressione} = + 11 \text{ kN/m}^2$  e  $\Delta_p \text{ aspirazione} = - 9 \text{ kN/m}^2$ . Poiché si tratta di azioni rilevanti, anche in considerazione dei relativi coefficienti parziali di sicurezza adottati, le azioni aerodinamiche si considerano solo associate in combinazione con le azioni derivanti dalla situazione di dimensionamento eccezionale.

#### 4.3.10 Urto A2

Il carico da urto è da considerare solo nelle caverne di diramazione e ai portali. Nella zona in oggetto non è pertanto considerato.

#### 4.3.11 Incendio A3

Il dimensionamento in caso di incendio si esegue in conformità alle prescrizioni della EN 1992-1-2.

In accordo con le prescrizioni del DM 28/10/2005 Sicurezza gallerie ferroviarie viene garantita la stabilità di tutte le opere in considerazione della curva temperatura-tempo secondo la UNI 11076 in conformità a D0118-04326 "Sicurezza contro le esplosioni di incendio".

Le sezioni, armate e non, sono state verificate nei confronti dell'incendio secondo i criteri esposti nella relazione specifica [10]. In questa sede ci si limita ad osservare che in accordo alla tabella D.6.3 del D.M. 16.02.2007 "Classificazione di resistenza al fuoco di prodotti ed elementi costruttivi di opere da costruzione" condizioni sufficienti affinché la classe di resistenza REI 120 sia garantita sono:

- spessore 's' degli elementi strutturali maggiore di 160mm;
- copriferro 'a' (distanza dell'asse delle armature dalla superficie esposta) maggiore di 35mm.

Entrambi i requisiti sono soddisfatti.

#### 4.4 EINWIRKUNGSKOMBINATIONEN

Die zu untersuchenden Einwirkungskombinationen sind gemäß NTC 2008 mit den entsprechenden Kombinationsbeiwerten  $\psi$  zu berücksichtigen.

Die für die Dimensionierung der Innenschale entsprechenden maßgebenden Einwirkungskombinationen sind in Tabelle 2 aufgeführt:

Lastfall / Caso di carico Einwirkung sks mbination /Combinazi oni	ständig / permanenti						vorübergehend / variabili			außergewöhnlich / eccezionali			
	Eigengewicht	Oberleitung	Sohlbeton	Wasserdruck	Gebirgslast ohne Auftrieb	Kriechen und Schwinden	Quell-druck	Temperatur (Sommer)	Temperatur (Winter)	Verkehrslast (Zugfahrt)	Brand	Druck infolge Zugfahrt	Sog infolge Zugfahrt
	Peso proprio	Catenaria	Carichi permanent sull'arco rovescio	Carico idraulico	Carichi della roccia in condizioni asciutte	Ritiro e rilassamento	Swelling- Squeezing	Temperatura (Estate)	Temperatura (inverno)	Carico ferroviario	Fuoco	Carico aerodinamico (pressione)	Carico aerodinamico (aspirazione)
	G1	G2	G3	G4	G5	G6	G7	Q1	Q1	Q2	A3	A1	A1
druckentlastet / sistema drenato	1	1.35						1.50					
		1.00						1.00					
	2	1.35					1.00		1.50				
		1.00					1.00		1.00				
	3	1.35	1.35	1.00					1.50				
		1.00	1.00	1.00					1.00				
	4	1.35	1.35	1.00			1.00		1.50				
		1.00	1.00	1.00			1.00		1.00				
	5	1.35	1.35	1.00	1.35	1.35			1.50				
		1.00	1.00	1.00	1.00	1.00			1.00				
	6	1.35	1.35	1.00	1.35	1.35	1.00		1.50				
		1.00	1.00	1.00	1.00	1.00	1.00		1.00				
11	1.00	1.00	1.00					0.60				1.00	
12	1.00	1.00	1.00			1.00		0.60				1.00	
21	1.00	1.00	1.00	1.00	1.00			0.60			1.00		
22	1.00	1.00	1.00	1.00	1.00	1.00					1.00		

Tabelle 2: Einwirkungskombinationen

#### 4.4 COMBINAZIONE DI CARICO

Le combinazioni delle azioni da analizzare devono essere considerate in conformità alle NTC 2008, con i relativi coefficienti di combinazione  $\psi$ .

Le combinazioni delle azioni rilevanti per il dimensionamento dell'anello interno sono di seguito riportate nella Tabella 2:

Tabella 2: Combinazioni di carico

#### 4.5 NACHWEISVERFAHREN

Für den Nachweis des Grenzzustandes der Trag- und Gebrauchstauglichkeit der Innenschale wurden die Einwirkungskombinationen gemäß den Vorgaben im NTC2008, Abs. 2.5.3 berücksichtigt.

##### 4.5.1 Grenzzustand der Tragfähigkeit (GZT)

###### 4.5.1.1 Teilsicherheitsfaktoren Einwirkungen

Die zu berücksichtigenden Teilsicherheitsfaktoren variieren in Abhängigkeit der Kombinationsregeln bzw. der Art der Einwirkung. Folgende Teilsicherheitsfaktoren sind gemäß NTC2008 für ständige, vorübergehende und außergewöhnliche Bemessungssituationen zu berücksichtigen:

$$\begin{aligned} \gamma_{Gj,inf} \text{ günstig/favorevole} &= 1,00 / 1,00 / 1,00 \\ \gamma_{Gj,sup} \text{ ungünstig/sfavorevole} &= 1,35 / 1,20 / 1,00 \\ \gamma_{Q,1,sup} / \gamma_{Q,i,sup} \text{ günstig/favorevole} &= 0,00 / 0,00 / 0,00 \\ \gamma_{Q,1,sup} / \gamma_{Q,i,sup} \text{ ungünstig/sfavorevole} &= 1,50 / 1,30 / 1,00 \end{aligned}$$

Werden die Einwirkungen aus dem Schwinden für den Nachweis im Grenzzustand der Tragfähigkeit berücksichtigt, ist gemäß EC2, Teil 1, Abs. 2.4.2.1 der Teilsicherheitsbeiwert  $\gamma_{SH} = 1,0$  zu berücksichtigen.

###### 4.5.1.2 Kombinationsbeiwerte Einwirkungen

Folgende Kombinationsbeiwerte sind gemäß EN 1990 bzw.

#### 4.5 VERIFICHE

Per la verifica allo stato limite ultimo ed allo stato limite di esercizio dell'anello interno sono state considerate le combinazioni delle azioni in conformità delle prescrizioni del paragrafo 2.5.3 delle NTC2008.

##### 4.5.1 Stati Limite Ultimi (SLU)

###### 4.5.1.1 Coefficienti parziali di sicurezza per le azioni

I coefficienti parziali di sicurezza da considerare variano in funzione delle combinazioni e del tipo di azioni. In conformità alle NTC2008, per le situazioni di dimensionamento standard, temporanee ed eccezionali sono da considerarsi i seguenti coefficienti parziali di sicurezza:

Considerando le azioni derivanti dal ritiro, per la verifica allo stato limite ultimo, si è considerato, in conformità all'EC2, parte 1, paragrafo 2.4.2.1 il coefficiente parziale di sicurezza  $\gamma_{SH} = 1,0$ .

###### 4.5.1.2 Coefficienti di combinazione delle azioni

In conformità alla EN 1990 ovvero alla NTC2008 devono



NTC2008 zu berücksichtigen:

essere utilizzati i seguenti coefficienti di combinazione:

Einwirkung /	$\Psi_0$	$\Psi_1$	$\Psi_2$
Druck / Sog infolge Zufahrt A1 / Pressione aerodinamica A1	0,8	0,5	0,0
Temperatur Q1 / Forze termiche Q1	0,6	0,6	0,5

Tabelle 3: Kombinationsbeiwerte

Tabella 3: Coefficienti di combinazione

#### 4.5.1.3 Einwirkungskombinationen

Die zu untersuchenden Einwirkungskombinationen sind gemäß NTC 2008 mit den entsprechenden Kombinationsbeiwerten  $\psi$  zu berücksichtigen.

Die für die Dimensionierung der Innenschale entsprechenden maßgebenden Einwirkungskombinationen sind in Abhängigkeit von den in-situ vorherrschenden Randbedingungen auszuwählen.

#### 4.5.1.4 Teilsicherheitsfaktoren Widerstand

Die Teilsicherheitsfaktoren der Widerstände bei ständigen und vorübergehenden Bemessungssituation sind, wie mit BBT SE vereinbart, wie folgt unter Berücksichtigung einer Lebensdauer des Bauwerkes von 200 Jahren zu berücksichtigen:

##### Stahlbeton

- Teilsicherheitskoeffizient für den Betonwiderstand  $\gamma_c = 1,60$
- Abminderungsbeiwert zur Berücksichtigung der Langzeitwirkung der Betondruckfestigkeit:  $\alpha_{cc} = 0,85$
- Teilsicherheitskoeffizient für Stahlwiderstand  $\gamma_s = 1,20$

##### Unbewehrter Beton

- Teilsicherheitskoeffizient für den Betonwiderstand  $\gamma_c = 1,60$
- Abminderungsbeiwert zur Berücksichtigung der Langzeitwirkung der Betondruck- bzw. -zugfestigkeit:  $\alpha_{cc,pl.} / \alpha_{ct,pl.} = 0,80$

Für den Nachweis der außergewöhnlichen Bemessungssituation sind die Teilsicherheitsfaktoren mit  $\gamma_c = 1,20$  und  $\gamma_s = 1,00$  zu berücksichtigen. Der Abminderungsbeiwert der Betondruckfestigkeit  $\alpha_{cc}$  bleibt unverändert.

#### 4.5.1.5 Bemessung auf Biegung und Längskraft

Die Bemessung des Stahlbetons erfolgt gemäß den Vorgaben des NTC2008, Abs. 4.1.2.1.2.

Der Nachweis des unbewehrten Betons erfolgt gemäß dem NTC2008, Kapitel 4.1.11.1.

#### 4.5.1.3 Combinazione delle azioni

Le combinazioni delle azioni da analizzare devono essere considerate in conformità alle NTC 2008, con i relativi coefficienti di combinazione  $\psi$ .

Le combinazioni delle azioni rilevanti per il dimensionamento dell'anello devono essere scelte in funzione delle effettive condizioni al contorno in situ.

#### 4.5.1.4 Coefficienti parziali di sicurezza per le resistenze

I coefficienti parziali di sicurezza per le resistenze in fase permanente e temporanea vanno considerati, come concordato con BBT SE, come segue tenendo conto della vita utile dell'opera di 200 anni:

##### Calcestruzzo armato

- Coefficiente parziale di sicurezza per la resistenza del calcestruzzo  $\gamma_c = 1,60$
- Coefficiente riduttivo della resistenza a compressione del calcestruzzo di lunga durata:  $\alpha_{cc} = 0,85$
- Coefficiente parziale di sicurezza  $\gamma_s$  per la resistenza dell'acciaio  $\gamma_s = 1,20$

##### Calcestruzzo non armato

- Coefficiente parziale di sicurezza per la resistenza del calcestruzzo  $\gamma_c = 1,60$
- Coefficiente riduttivo della resistenza a compressione e a trazione del calcestruzzo di lunga durata:  $\alpha_{cc,pl.} / \alpha_{ct,pl.} = 0,80$

Per le verifiche nella situazione di dimensionamento eccezionale i fattori parziali di sicurezza devono essere considerati con  $\gamma_c = 1,20$  e  $\gamma_s = 1,00$ . Il coefficiente di riduzione della resistenza a compressione del calcestruzzo  $\alpha_{cc}$  resta invariato.

#### 4.5.1.5 Verifica a pressoflessione

Per il calcestruzzo armato il calcolo segue le indicazioni delle NTC2008, par. 4.1.2.1.2.

Per il calcestruzzo non armato si seguono le NTC 2008, par. 4.1.11.1.

Für unbewehrte Querschnitte mit großer Exzentrizität wird, gemäß EC2 (§12.3.1), die Betonzugfestigkeit bis zum Erreichen des Designwertes  $f_{ctd}$  berücksichtigt. Der Nachweis ist erfüllt wenn:

Nelle sezioni non armate con un'elevata eccentricità, in accordo con l'EC2 (§12.3.1) si considera la resistenza a trazione del calcestruzzo fino al valore di progetto  $f_{ctd}$ . La verifica risulta soddisfatta se:

$$\sigma_{1,2} = \frac{N_{Ed}}{A} \pm \frac{M_{Ed}}{J} \cdot (h/2) \leq \begin{cases} f_{cd} \\ f_{ctd} \end{cases} \alpha$$

#### 4.5.1.6 Bemessung Querkraft

Die Bemessung des Stahlbetons erfolgt gemäß den Vorgaben des NTC2008, Abs. 4.1.2.1.2.4.

Der Nachweis bei der unbewehrten Innenschale erfolgt gemäß Kapitel 4.1.11.1 des NTC2008.

#### 4.5.1.6 Verifica a taglio

Per il calcestruzzo armato il calcolo segue le indicazioni delle NTC2008, par. 4.1.2.1.3.

Per il rivestimento interno non armato si seguono le NTC 2008, verificando la seguente disuguaglianza:

$$V_{Ed} \leq V_{Rd} = f_{cvd} \cdot \frac{b \cdot x}{1.5}$$

$$f_{cvd} = \sqrt{f_{ctd}^2 + \sigma_c \cdot f_{ctd}} \quad \text{per } \sigma_c \leq \sigma_{clim}$$

$$f_{cvd} = \sqrt{f_{ctd}^2 + \sigma_c \cdot f_{ctd} - \delta^2/4} \quad \text{per } \sigma_c > \sigma_{clim}$$

$$\delta = \sigma_c - \sigma_{clim}$$

$$\sigma_{clim} = f_{cd} - 2 \cdot \sqrt{f_{ctd}^2 + f_{cd} \cdot f_{ctd}}$$

Bei den überwiegend komprimierten Abschnitten wird die Durchschnittsbelastung der Druckspannung  $\sigma_c$  als Durchschnitt der Komprimierungen im reagierenden Abschnittteil 'x' ermittelt:

Nelle sezioni prevalentemente compresse, lo sforzo medio di compressione  $\sigma_c$  è calcolato come media delle compressioni nella porzione di sezione reagente 'x':

$$\sigma_c = \frac{N_{Ed}}{x} = \frac{N_{Ed}}{h - 2 \cdot e}$$

In den Abschnitten mit hoher Exzentrizität, bei Annahme der Betonzugfestigkeit bis  $f_{ctd}$ , wird der Querkraftwiderstand des Abschnitts ausgewertet, indem der ganze Abschnitt als reagierend ( $x=h$ ) betrachtet wird und die Spannung  $\sigma_c$  als Durchschnittsspannung des ganzen Abschnitts, sowohl komprimiert als auch gespannt gewertet wird.

Nelle sezioni con un'elevata eccentricità, coerentemente con l'assunzione di considerare la resistenza a trazione del calcestruzzo fino al valore di  $f_{ctd}$ , la resistenza a taglio della sezione viene valutata considerando reagente l'intera sezione ( $x=h$ ) e valutando la tensione  $\sigma_c$  come tensione media nell'intera sezione, sia compressa che tesa.

$$\sigma_c = \frac{\sigma_1 + \sigma_2}{2}$$

#### 4.5.2 Grenzzustände der Gebrauchstauglichkeit (GZG)

##### 4.5.2.1 Teilsicherheitsfaktoren Einwirkungen

Im Nachweis der Gebrauchstauglichkeit sind gemäß den Kombinationsregeln die charakteristischen Einwirkungen zu berücksichtigen.

##### 4.5.2.2 Kombinationsbeiwerte Einwirkungen

Die in den Einwirkungskombinationen zu berücksichtigen Beiwerte sind aus Tabelle 2 aufgeführt. Die Kombinationsbeiwerte sind gemäß Tabelle 3 zu berücksichtigen.

##### 4.5.2.3 Einwirkungskombinationen

Die zu untersuchenden Einwirkungskombinationen sind gemäß NTC 2008 mit den entsprechenden Kombinationsbeiwerten  $\psi$  zu berücksichtigen.

##### 4.5.2.4 Teilsicherheitsfaktoren Widerstand

Für den Nachweis der Gebrauchstauglichkeit sind die charakteristischen Werte der Widerstände zu berücksichtigen.

##### 4.5.2.5 Ermittlung der Schnittgrößen und Verformungen

Die Ermittlung der Systemverformung erfolgt im Grenzzustand der Gebrauchstauglichkeit (GZG) unter Berücksichtigung der Kombinationsregeln mit den charakteristischen Einwirkungen sowie den entsprechenden Kombinationsbeiwerten.

##### 4.5.2.6 Begrenzung der Rissbreiten

Im Grenzzustand der Gebrauchstauglichkeit ist für die maßgebenden Einwirkungskombinationen unter Berücksichtigung der Teilsicherheitsfaktoren und Abminderungsfaktoren  $\psi$  laut Tabelle 2 die maximale Rissweite  $w_{kal}$  unter Berücksichtigung NTC2008 nachzuweisen. Die zulässige Rissbreite für Normalbeton ohne besondere Anforderung der Dichtigkeit oder bei Existenz einer Abdichtung ist auf  $w_{kal} \leq 0,3$  mm zu begrenzen.

Bei besonderer Anforderung an die Dichtigkeit der Betoninnenschale oder bei aggressiven oder sehr aggressiven Umgebungsbedingungen ist die maximale Rissweite auf  $w_{kal} \leq 0,2$  mm zu begrenzen.

#### 4.5.2 Stati Limite Esercizio (SLE)

##### 4.5.2.1 Coefficienti parziali di sicurezza delle azioni

Nella verifica agli stati limite di esercizio devono essere considerate le azioni caratteristiche con le loro combinazioni.

##### 4.5.2.2 Coefficienti di combinazione delle azioni

In Tabella 2 si trovano i coefficienti da considerare nelle combinazioni delle azioni. I coefficienti di combinazione sono da considerare come in Tabella 3.

##### 4.5.2.3 Combinazioni delle azioni

Le combinazioni delle azioni da analizzare devono essere considerate in conformità alle NTC 2008, con i relativi coefficienti di combinazione  $\psi$ .

##### 4.5.2.4 Coefficienti parziali di sicurezza per le resistenze

Per la verifica agli stati limite di esercizio si devono considerare i valori caratteristici delle resistenze.

##### 4.5.2.5 Calcolo delle deformazioni

Il calcolo delle deformazioni del sistema si esegue allo SLE in considerazione delle regole di combinazione con i carichi caratteristici e dei relativi coefficienti di combinazione.

##### 4.5.2.6 Limitazione dello spessore delle fessure

In considerazione delle NTC2008, si controlla allo SLE lo spessore massimo delle fessure  $w_{kal}$  per le combinazioni di carico rilevanti, in considerazione dei fattori parziali di sicurezza e dei coefficienti di riduzione  $\psi$  secondo Tabella 2. La larghezza delle fessure ammessa per il cls normale senza particolari requisiti di spessore o in presenza di impermeabilizzazione è limitata a  $w_{kal} \leq 0,3$  mm.

In caso di particolari requisiti di spessore del rivestimento interno o di condizioni ambientali aggressive o molto aggressive la larghezza massima è limitata a  $w_{kal} \leq 0,2$  mm.

#### 4.6 BAULICHE DURCHBILDUNG

##### 4.6.1 Expositionsklasse und minimale Betondeckung

Gemäß UNI 11104 ist bei der Expositionsklasse XC3 die Verwendung von Beton C28/35, bei der Expositionsklasse XC4 Beton C32/40 vorgesehen.

Die Berechnung der Mindestbetondeckung zur Gewährleistung der Bauwerklebensdauer >100 Jahren erfolgt laut NTC2008:

	XC3	XC4
Festigkeitsklasse	30/37	32/40
Umweltbedingungen	Normal	Aggressiv
C <sub>min</sub> [mm]	20	30
Nutzbare Lebenszeit > 100 Jahre [mm]	+10	+10
Bauliche Tolleranz [mm]	+10	+10

C <sub>nom</sub> [mm]	<b>40</b>	<b>50</b>
-----------------------	-----------	-----------

Tabelle 4: Mindestbetondeckung

Um die Stärke zu vereinheitlichen, ist eine Betonbedeckung entlang des ganzen Tunnels von 5 cm vorgesehen.

##### 4.6.2 Mindestbewehrung

Ist eine bewehrte Innenschale vorgesehen, wird die Mindestbewehrung gemäß NTC 2008, Punkt 4.1.6.1.1.

Die Querschnittsfläche der Längszugbewehrung darf nicht geringer sein als:

$$A_{S,\min} = 0,26 \frac{f_{ctm}}{f_{yk}} \times b \times d$$

und jedenfalls nicht geringer als  $0,0013 \times b \times d$ ,

wobei:

- b die mittlerer Breite der Zugzone;
- d die Nutzhöhe des Querschnitts;
- $f_{ctm}$  der Mittelwert der Zugfestigkeit des Betons;
- $f_{yk}$  der charakteristische Wert der Streckengrenze des Betonstahls ist.

#### 4.6 STRUTTURA COSTRUTTIVA

##### 4.6.1 Classe di esposizione e copriferro minimo

In accordo alle UNI 11104, in classe di esposizione XC3 è previsto l'utilizzo di calcestruzzo C28/35 mentre in classe di esposizione XC4 è previsto l'utilizzo di calcestruzzo C32/40.

Il calcolo del copriferro minimo al fine di garantire una vita utile dell'opera >100anni è condotto in accordo alle N.T.C. 2008:

	XC3	XC4
Classe di resistenza	30/37	32/40
Cond. ambientali	Normali	Aggressive
C <sub>min</sub> [mm]	20	30
Vita utile > 100anni [mm]	+10	+10
Tolleranza costruttiva [mm]	+10	+10

C <sub>nom</sub> [mm]	<b>40</b>	<b>50</b>
-----------------------	-----------	-----------

Tabella 4: Copriferro minimo.

Per omogeneità si prevede un copriferro netto di 5 cm lungo tutto lo sviluppo delle gallerie.

##### 4.6.2 Armatura minima

In caso il rivestimento necessiti di armatura il quantitativo minimo di armatura da inserire viene definito al punto 4.1.6.1.1 delle NTC 2008.

L'area dell'armatura longitudinale in zona tesa non deve essere inferiore a:

e comunque non minore di  $0,0013 \times b \times d$ ,

dove:

- b rappresenta la larghezza media della zona tesa;
- d è l'altezza utile della sezione;
- $f_{ctm}$  è il valore medio della resistenza a trazione del calcestruzzo;
- $f_{yk}$  è il valore caratteristico della resistenza a trazione dell'armatura ordinaria.

#### 4.7 ERGEBNISSE

Die in Anhang 1 aufgezeigten Analysen zeigen, dass für die FEM-Modelle zur Simulation des Auflockerungsdrucks eine Biegebewehrung erforderlich ist.

Der Übergangsbereich FdE-CcT-IN-FdE-CcTa ist mit  $\phi$  18 mm alle 15 cm im Bereich der Kalotte,  $\phi$  22 mm alle 15 cm im Bereich der Widerlager und  $\phi$  20 mm alle 15 cm im Parament und Sohlgewölbe bewehrt. Die Lastverteilungseisen sind  $\phi$  12 mm alle 15 cm.

Der Übergangsbereich FdE-V-IN-FdE-Va ist mit  $\phi$  18 mm alle 15 cm im Bereich der Kalotte und  $\phi$  20 mm alle 15 cm im Bereich der Paramente und des Sohlgewölbes bewehrt. Die Lastverteilungseisen sind  $\phi$  12 mm alle 15 cm. Im Anschlussbereich zwischen Widerlager und Sohlgewölbe sind drei Bügel  $\phi$  12 mm alle 15 cm pro Laufmeter Tunnel erforderlich.

Das Kreuzgewölbe im zentralen Bereich des Anschlusses ist in beide Richtung mit  $\phi$  20 mm alle 15 cm bewehrt.

Im Parament des FdE-CcTa ist im Bereich unter dem Anschluss mit dem FdE-Va eine Zusatzbewehrung von  $\phi$  26 mm alle 10 cm in vierfacher Lage vorgesehen um die resultierenden Belastungen aufnehmen zu können.

Die Innenschalen weisen einen Bewehrungsgehalt von ca. 70 kg/m<sup>3</sup> und die Zwischenplatte von ca. 150 kg/m<sup>3</sup> auf.

#### 4.7 RISULTATI

Le analisi riportate in Appendice 1 mostrano che i modelli FEM per la simulazione degli effetti indotti dal carico d'allentamento dell'ammasso necessitano l'impiego di armatura flessionale.

Il concio di transizione FdE-CcT-IN-FdE-CcTa è armato con armatura  $\phi$  18 mm a passo 15 cm in calotta,  $\phi$  22 mm a passo 15 cm in muretta e  $\phi$  20 mm a passo 15 cm lungo i paramenti e nell'arco rovescio. I ripartitori sono  $\phi$  12 mm a passo 15 cm.

Il concio di transizione FdE-V-IN-FdE-Va è armato con armatura  $\phi$  18 mm a passo 15 cm in calotta e  $\phi$  20 mm a passo 15 cm lungo i paramenti e nell'arco rovescio. I ripartitori sono  $\phi$  12 mm a passo 15 cm. È necessario predisporre tre staffe  $\phi$  12 mm a passo 15 cm per metro di galleria nella zona di connessione tra la muretta e l'arco rovescio.

La volta a crociare situata nella parte centrale dell'incrocio è armata con armatura  $\phi$  20 mm a passo 15 cm in ambo le direzioni.

Nella parte sottostante l'innesto dell' FdE-Va è stata predisposta all'interno del paramento dell' FdE-CcTa dell'armatura supplementare  $\phi$  26 mm a passo 10 cm su quattro maglie per riprendere le sollecitazioni derivate dal comportamento a puntone-tirante della struttura.

L'incidenza d'armatura è di circa 70 kg/m<sup>3</sup> di calcestruzzo per il rivestimento e di 150 kg/m<sup>3</sup> per le solette intermedie.

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## 5.4 BIBLIOGRAFIE UND QUELLEN

### 5.4.1 Dokumente der Ausschreibungsplanung

#### 5.4.1.1 Regelplanung

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- [2] 02\_H61\_GD\_040\_GTB\_D0700\_22001 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Gesamtbauwerke Teil 2 - Geomechanischer Detailbericht
- [3] 02\_H61\_GD\_040\_GLS\_D0700\_22004 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Gesamtbauwerke Teil 2 - Geomechanischer und Planungsvorprofil - GA-T, FdE-CCT-T
- [4] 02\_H61\_VS\_060\_KRQ\_D0700\_22513 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Ausbruchsquerschnitt FdE-CcTa-T2
- [5] 02\_H61\_VS\_060\_KRQ\_D0700\_22515 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Ausbruchsquerschnitt FdE-CcTa-T3
- [6] 02\_H61\_QS\_060\_KRQ\_D0700\_22715 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Ausbruchsquerschnitt FdE-V(01-06)-T3 / FdE-Va(01-06)-T3
- [7] 02\_H61\_QS\_060\_KRQ\_D0700\_22716 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Ausbruchsquerschnitt FdE-V(01-06)-T4 / FdE-Va(01-06)-T4
- [8] 02\_H61\_OP\_060\_KST\_D0700\_22910 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Statische Berechnung FdE-CcT-T4/T6 (da km 44.5+15.0 a 45.3+ 75.0)
- [9] 02\_H61\_OP\_060\_KST\_D0700\_22911 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 - Statische Berechnung FdE-V(01-06)-T1/T4
- [10] 02\_H61\_EG\_995\_KTB\_D0700\_15003 - Brenner Basistunnel - Ausführungsplanung - D0700: Baulos Mauls 2-3 – Sicherheit bzgl. Feuerexposition

## 5.4 BIBLIOGRAFIA E FONTI

### 5.4.1 Documenti in ingresso

#### 5.4.1.1 Progetto Esecutivo Lotto Mules 2-3

- [1] 02\_H61\_GD\_992\_GTB\_D0700\_13018 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali - Relazione tecnica - Relazione geomeccanica generale
- [2] 02\_H61\_GD\_040\_GTB\_D0700\_22001 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Relazione geomeccanica di dettaglio
- [3] 02\_H61\_GD\_040\_GLS\_D0700\_22004 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Profilo geomeccanico e progettuale di previsione - GA-T, FdE-CCT-T
- [4] 02\_H61\_VS\_060\_KRQ\_D0700\_22513 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Sezione di scavo FdE-CcTa-T2
- [5] 02\_H61\_VS\_060\_KRQ\_D0700\_22515 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Sezione di scavo FdE-CcTa-T3
- [6] 02\_H61\_QS\_060\_KRQ\_D0700\_22715 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Sezione di scavo FdE-V(01-06)-T3 / FdE-Va(01-06)-T3
- [7] 02\_H61\_QS\_060\_KRQ\_D0700\_22716 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Sezione di scavo FdE-V(01-06)-T4 / FdE-Va(01-06)-T4
- [8] 02\_H61\_OP\_060\_KST\_D0700\_22910 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Relazione di calcolo FdE-CcT-T4/T6 (da km 44.5+15.0 a 45.3+ 75.0)
- [9] 02\_H61\_OP\_060\_KST\_D0700\_22911 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Opere generali Parte 2 - Relazione di calcolo FdE-V(01-06)-T1/T4
- [10] 02\_H61\_EG\_995\_KTB\_D0700\_15003 - Galleria di Base del Brennero - Progettazione esecutiva - D0700: Lotto Mules 2-3 - Sicurezza nei riguardi di

#### 5.4.2 Normen und Richtlinien

- [11] Technische Konstruktionsnormen 2008 – NTC 2008;
- [12] Leitfaden N.617, Vorgehensweise für technische Konstruktionsnormen, Ausgabe Januar 2008
- [13] DM 28/10/2005 Sicherheit für Bahntunnel
- [14] UNI EN1990:2006 - Eurocodice 0 – Grundlage für Konstruktion und Dokumentation zur nationalen Umsetzung ;
- [15] UNI EN 1991-1; Eurocode 1 – Actions on structures – 2010/2011
- [16] UNI EN 1992:2005 - Eurocode 2 – Planung von für Stahlbetonbauwerke und Dokumente zur nationalen Umsetzung;
- [17] UNI EN 1997:2005 - Eurocode 7 – Geotechnik und Dokumente zur nationalen Umsetzung
- [18] UNI EN 1992-1-2:2005 - Planung von Stahlbetonbauwerke Teil 1-2: Allgemeinregelung – Brandschutz Strukturplanung
- [19] UNI 11076: 2003 - Testmodalitäten zur Bewertung des Benehmens der an den Decken von Untertagebauten angebrachten Schutzmaßnahmen in Brandfall
- [20] D.M. 16.02.2007 - Feuerwiderstandsklassifizierung von Erzeugnisse und Bauelemente für Bauwerke

#### 5.4.3 Literatur

- [21] Wang, J., 1993 - Seismic Design of Tunnels - A Simple State-of-the-Art Design
- [22] Hashash, Y., et al., 2001, - Seismic design and analysis of underground structures, Tunnelling and underground space technology 16, (247-293)
- [23] Pöttler, R. Die unbewehrte Innenschale im Felstunnelbau - Standsicherheit und Verformung im Reißbereich, Beton und Stahlbetonbau Heft 6, 1993
- [24] Pöttler, R. Standsicherheitsnachweis unbewehrter Innenschalen, Bautechnik 67, 1990

#### 5.4.2 Normativa

- [11] Norme Tecniche delle Costruzioni 2008 – NTC 2008;
- [12] Circolare n.617, Istruzioni per l'applicazione delle "Nuove norme tecniche per le costruzioni" di cui al DM 14 gennaio 2008
- [13] DM 28/10/2005 , Sicurezza nelle gallerie ferroviarie.
- [14] UNI EN1990:2006 - Eurocodice 0 – Basi per la progettazione strutturale e documento di applicazione nazionale
- [15] UNI EN 1991-1; Eurocode 1 – Actions on structures – 2010/2011
- [16] UNI EN 1992:2005 - Eurocodice 2 – Progettazione delle strutture in calcestruzzo e documento di applicazione nazionale
- [17] UNI EN 1997:2005 - Eurocodice 7 – Progettazione geotecnica e documento di applicazione nazionale
- [18] UNI EN 1992-1-2:2005 "Progettazione delle strutture in calcestruzzo Parte 1-2: Regole generali - Progettazione strutturale contro l'incendio"
- [19] UNI 11076 del 1 luglio 2003, "Modalità di prova per la valutazione del comportamento di protettivi applicati a soffitti di opere sotterranee, in condizioni di incendi".
- [20] D.M. 16.02.2007 "Classificazione di resistenza al fuoco di prodotti ed elementi costruttivi di opere da costruzione"

#### 5.4.3 Letteratura

- [21] Wang, J., 1993 - Seismic Design of Tunnels - A Simple State-of-the-Art Design
- [22] Hashash, Y., et al., 2001, - Seismic design and analysis of underground structures, Tunnelling and underground space technology 16, (247-293)
- [23] Pöttler, R. Die unbewehrte Innenschale im Felstunnelbau - Standsicherheit und Verformung im Reißbereich, Beton und Stahlbetonbau Heft 6, 1993
- [24] Pöttler, R. Standsicherheitsnachweis unbewehrter Innenschalen, Bautechnik 67, 1990



## **ANHANG 1 - FEM-ANALYSEN DER INNENSCHALE**

Die Anlage 1 führt die grafischen Darstellungen der wichtigsten Inputs- und Outputs der FEM-Analysen für die Innenschale an, die mit dem Rechenprogramm MIDAS Gen. durchgeführt wurden, sowie die Nachweisverfahren GZT und GZG.

## **APPENDICE 1 - ANALISI FEM DEL RIVESTIMENTO DEFINITIVO**

L'appendice 1 contiene le rappresentazioni grafiche dei principali input e output dell'analisi del rivestimento definitivo condotte con il programma MIDAS Gen, oltre alle opportune verifiche sezionali allo SLU e SLE.

A.5.1. General parameters of structure

A.5.1.1. Model

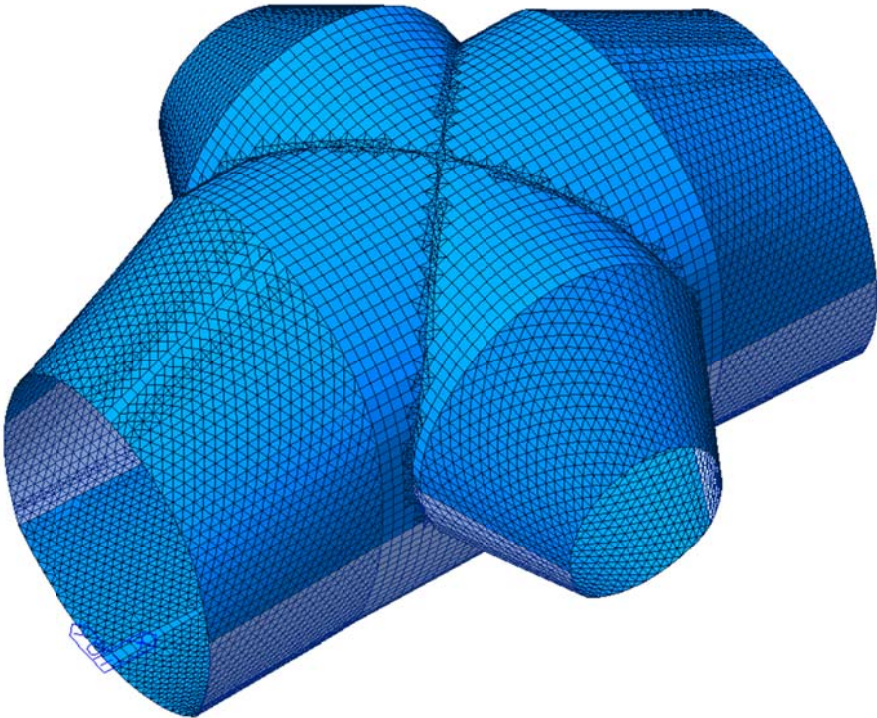


Figure 1 FdE-Va-T4-IN-FdE-CcTa T3 cross section

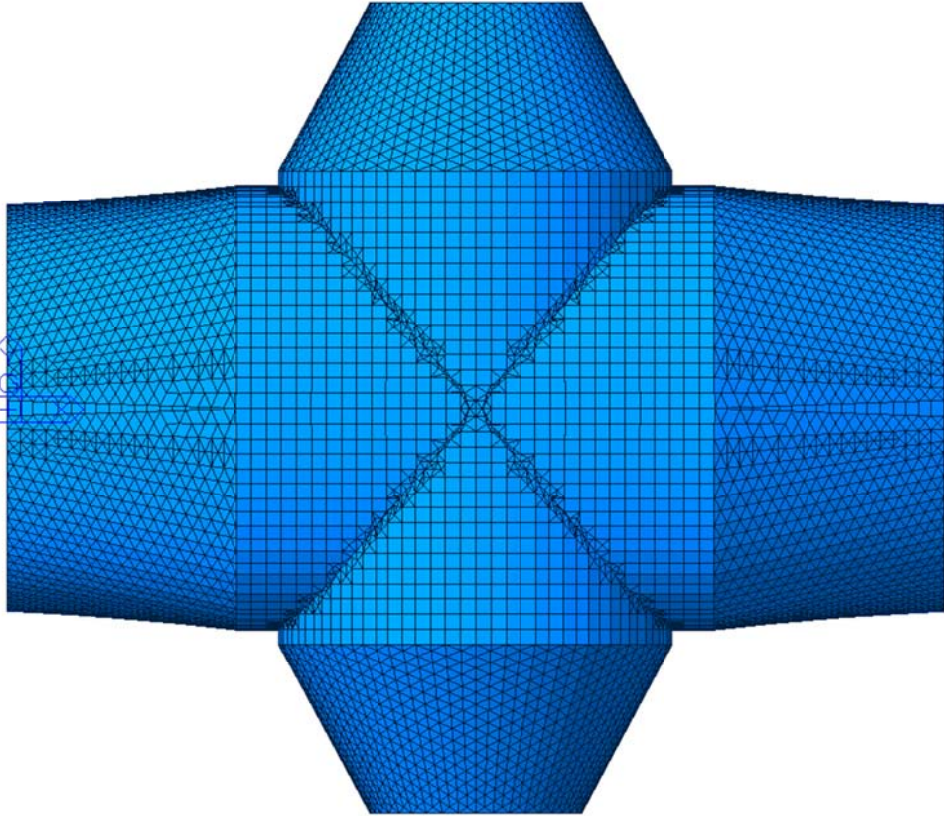


Figure 2 FdE-Va-T4-IN-FdE-CcTa T3 cross section

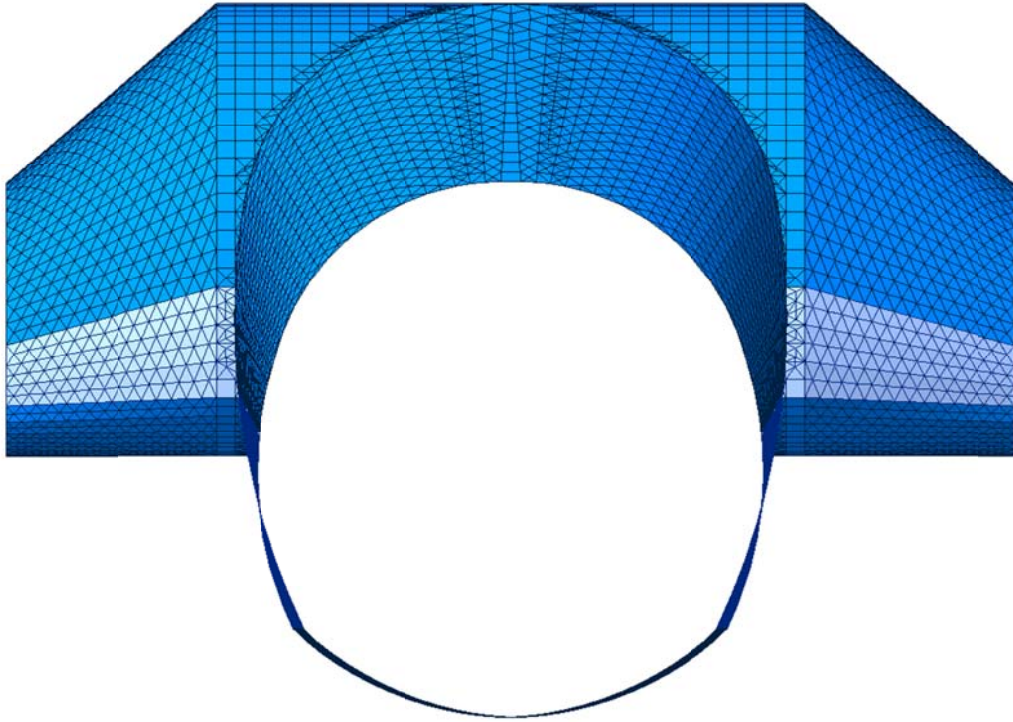


Figure 3 FdE-Va-T4-IN-FdE-CcTa T3 cross section

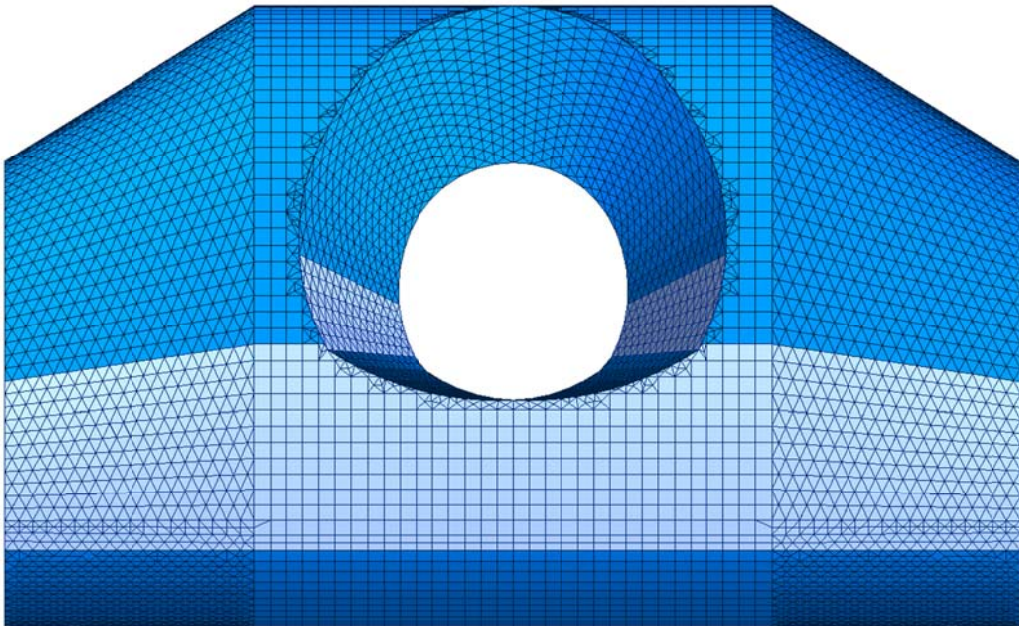


Figure 4 FdE-Va-T4-IN-FdE-CcTa T3 cross section

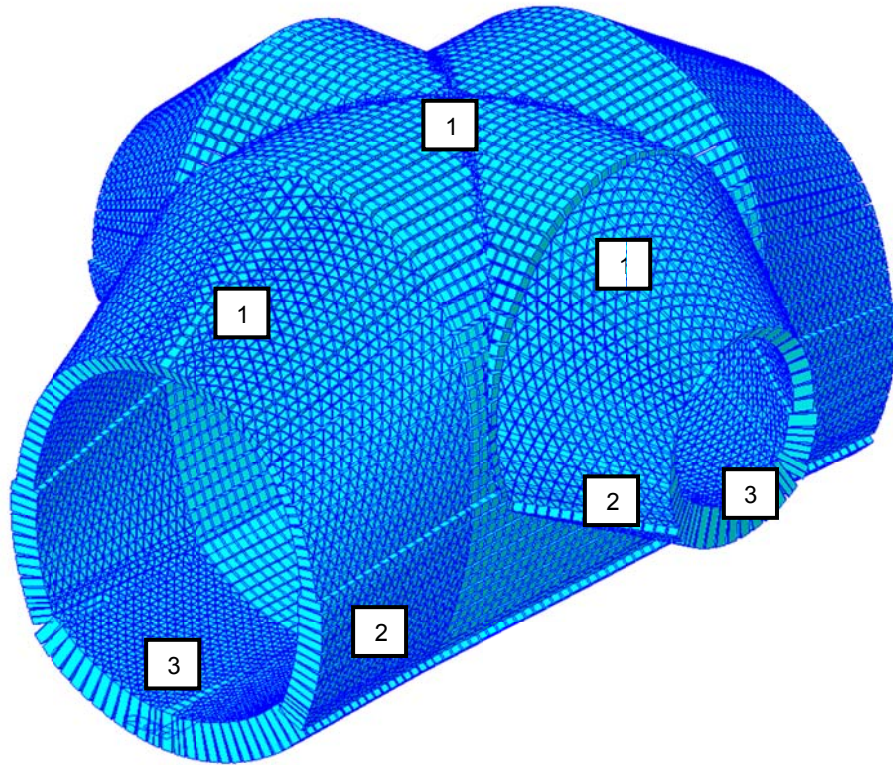


Figure 5 Element section property

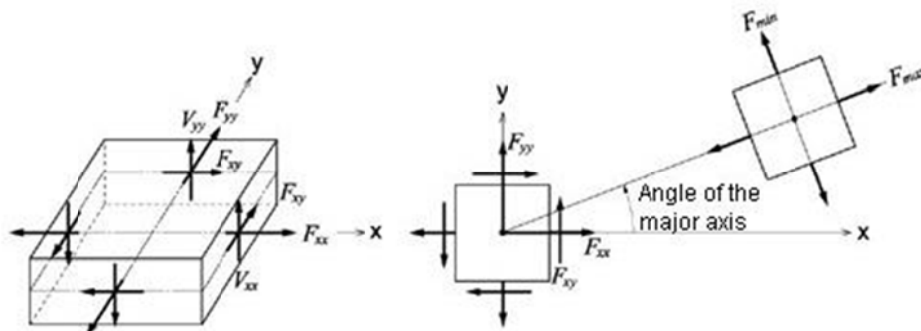
Table 1 Section characteristic

ID	Type	In=Out	Thick-In(m)	Thick-Out(m)	Offset	Offset Type	Offset Ratio	Offset Value(m)
1	Value	Yes	0.6000	0.0000	No	Ratio	0.0000	0.0000
2	Value	Yes	0.9000	0.0000	No	Ratio	0.0000	0.0000
3	Value	Yes	1.2000	0.0000	No	Ratio	0.0000	0.0000

Table 2 Material parameters

ID	Name	Type	Code	Elasticity (kN/m <sup>2</sup> )	Poisson	Thermal (1/[F])	Density (kN/m <sup>3</sup> )	Mass Density (kN/m <sup>3</sup> /g)
1	C30/37	Concrete	NTC2008	3.30e+007	0.2	1e-005	2.50e+001	2.5493e+0
2	B450C	Rebar steel	NTC2008	21.0e+007	0.2	0	7.85e+001	7.850 e+0

A.5.1.2. Results conventions



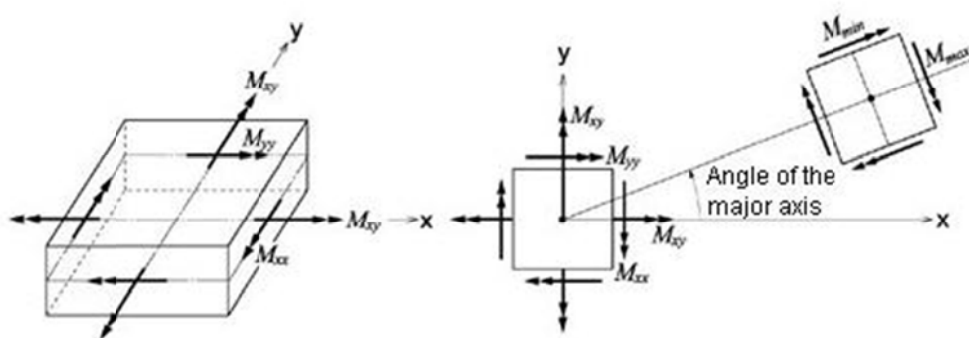
**Fxx:** Axial force per unit width in the element's local or UCS x-direction (Perpendicular to local y-z plane)

**Fyy:** Axial force per unit width in the element's local or UCS y-direction (Perpendicular to local x-z plane)

**Fxy:** Shear force per unit width in the element's local or UCS x-y direction (In-plane shear)

**Vxx:** Shear force per unit width in the thickness direction along the element's local or UCS y-z plane

**Vyy:** Shear force per unit width in the thickness direction along the element's local or UCS x-z plane



**Mxx:** Bending moment per unit width in the direction of the element's local or UCS x-axis (Out-of-plane moment about local y-axis)

**Myy:** Bending moment per unit width in the direction of the element's local or UCS y-axis (Out-of-plane moment about local x-axis)

**Mxy:** Torsional moment per unit width about the element's local or UCS x-y plane

## A.5.2. Load combinations

### LIST OF LOAD COMBINATIONS

NUM	NAME	ACTIVE LOADCASE(FACTOR) +	TYPE LOADCASE(FACTOR) +	LOADCASE(FACTOR)
1	1	Inactive G1( 1.350) +	Add Q1 - E( 1.500)	
2	2	Inactive G1( 1.350) +	Add G6 - SLU( 1.000) +	Q1 - I( 1.500)
3	3	Inactive G1( 1.350) +	Add G3( 1.000) +	Q1 - E( 1.500)
4	4	Inactive G1( 1.350) + + Q1 - I( 1.500)	Add G3( 1.000) +	G6 - SLU( 1.000)
5	5	Inactive G1( 1.350) + + G5( 1.350) +	Add G3( 1.000) + Q1 - E( 1.500)	G4( 1.350)
6	6	Inactive G1( 1.350) + + G5( 1.350) +	Add G3( 1.000) + G6 - SLU( 1.000) +	G4( 1.350) Q1 - I( 1.500)
7	11	Inactive G1( 1.000) + + A1 - P (paramenti)( 1.000) +	Add G3( 1.000) + A1 - A (volta)( 1.000)	Q1 - E( 0.600)
8	12	Inactive G1( 1.000) + + Q1 - I( 0.600) +	Add G3( 1.000) + A1 - A (paramenti)( 1.000) +	G6 - SLU( 1.000) A1 - P (volta)( 1.000)
9	21	Inactive G1( 1.000) + + G5( 1.000) +	Add G3( 1.000) + Q1 - E( 0.600)	G4( 1.000)
10	22	Inactive G1( 1.000) + + G5( 1.000) +	Add G3( 1.000) + G6 - SLU( 1.000)	G4( 1.000)
11	SLE - 1	Inactive G1( 1.000) +	Add Q1 - E( 1.000)	
12	SLE - 2	Inactive G1( 1.000) +	Add G6 - SLS( 1.000) +	Q1 - I( 1.000)
13	SLE - 3	Inactive G1( 1.000) +	Add G3( 1.000) +	Q1 - E( 1.000)
14	SLE - 4	Inactive G1( 1.000) + + Q1 - I( 1.000)	Add G3( 1.000) +	G6 - SLS( 1.000)
15	SLE - 5	Inactive G1( 1.000) + + G5( 1.000) +	Add G3( 1.000) + Q1 - E( 1.000)	G4( 1.000)
16	SLE - 6	Inactive G1( 1.000) + + G5( 1.000) +	Add G3( 1.000) + G6 - SLS( 1.000) +	G4( 1.000) Q1 - I( 1.000)

### A.5.3. Output and check result for cross section FdE-CcT-T5/FdE-CcTa-T3

#### A.5.3.1. Load combination SLU 1

Plate force\_Fxx / ST\_N1

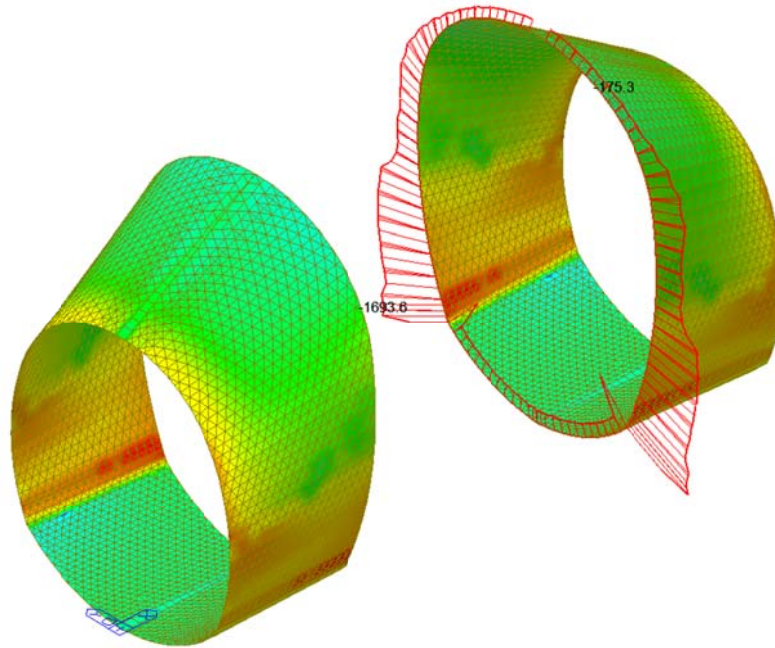


Plate force\_Fyy / ST\_N1

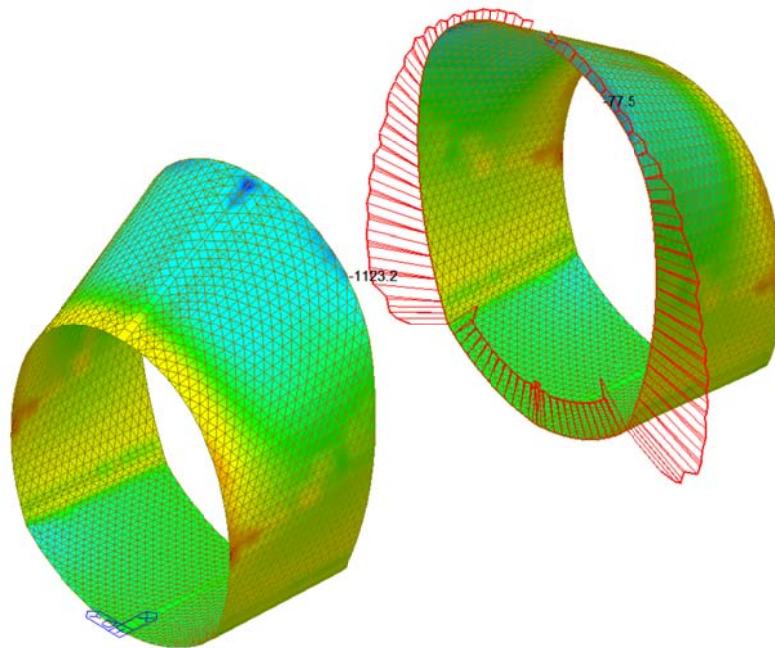
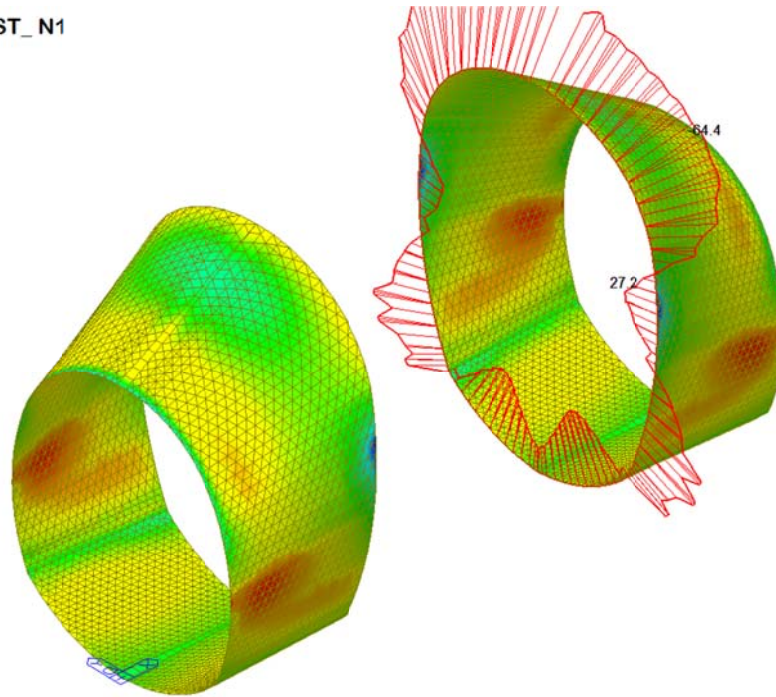


Plate force\_Mxx / ST\_N1



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

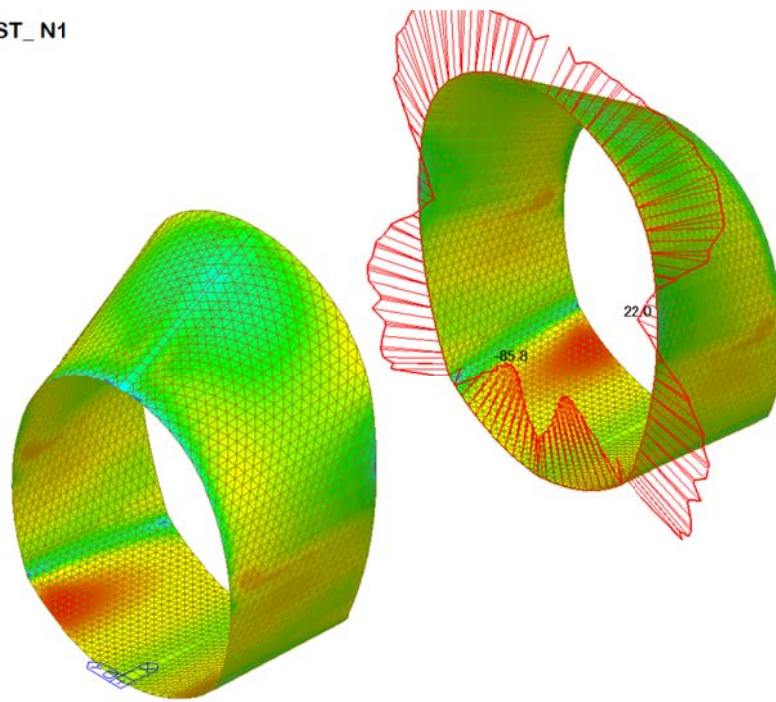
27.49
13.39
0.00
-14.81
-28.91
-43.01
-57.11
-71.21
-85.31
-99.41
-113.51
-127.61

ST: N1  
Avg Nodal Active-  
MAX : 2748  
MIN : 4979

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Myy / ST\_N1



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

26.02
9.05
0.00
-24.89
-41.87
-58.84
-75.81
-92.78
-109.76
-126.73
-143.70
-160.67

ST: N1  
Avg Nodal Active-  
MAX : 10090  
MIN : 1772

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
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Y: -0.622  
Z: 0.537



Plate force\_Vxx / ST\_N1

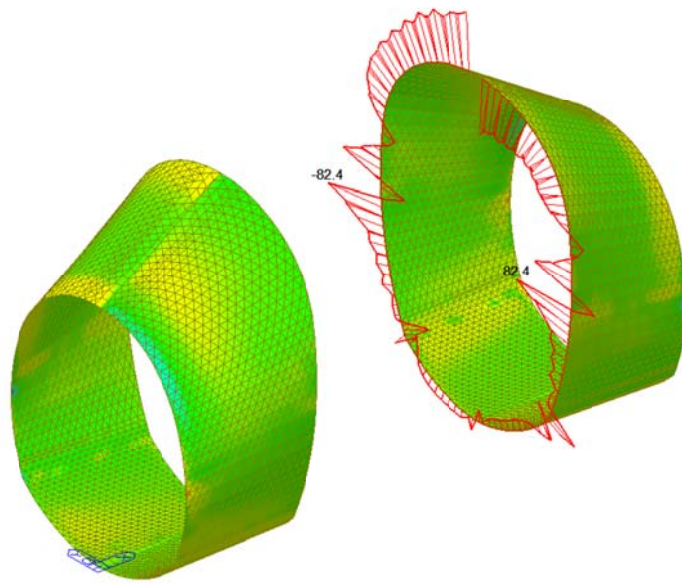
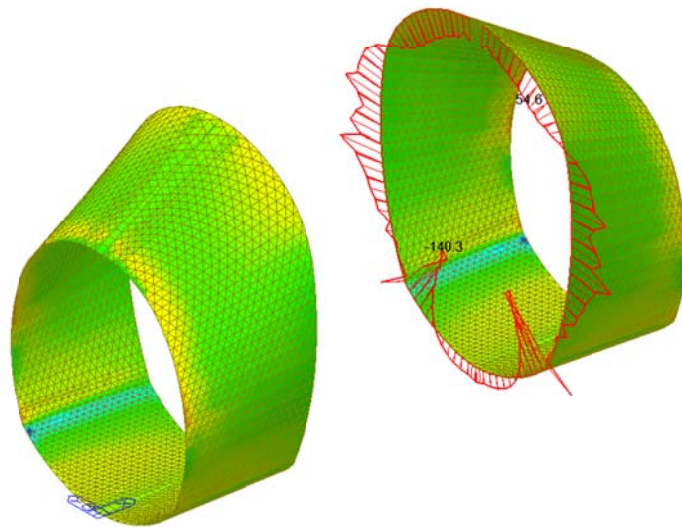


Plate force\_Vyy / ST\_N1



A.5.3.2. Load combination SLU 2

Plate force\_Fxx / ST\_N2

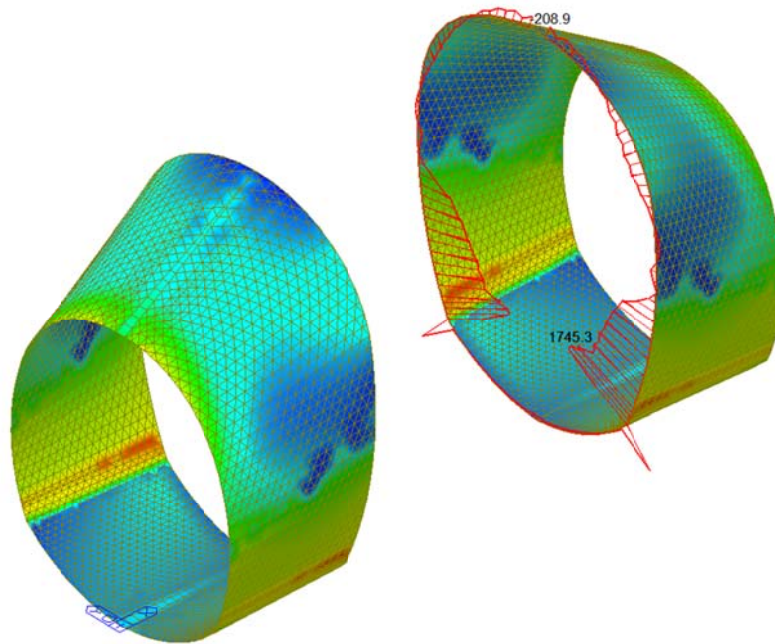


Plate force\_Fyy / ST\_N2

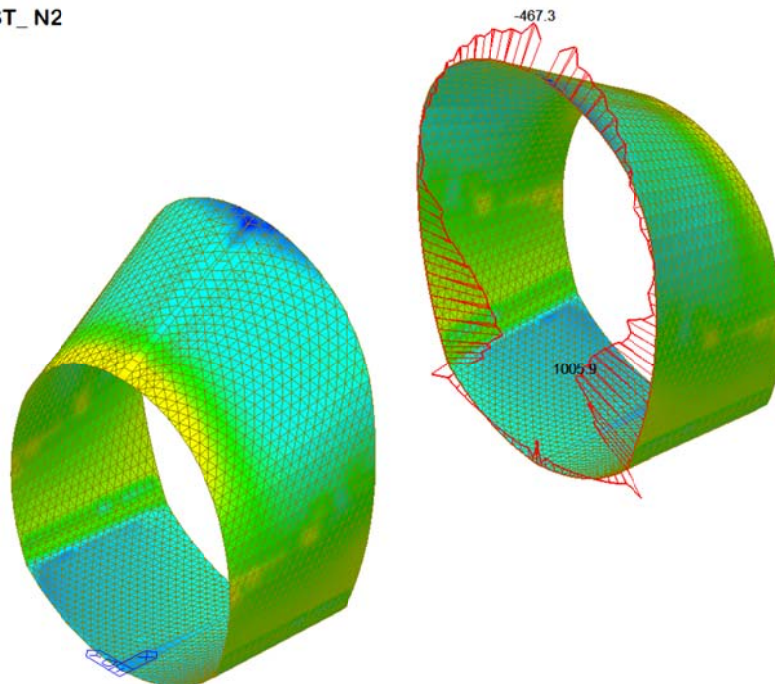
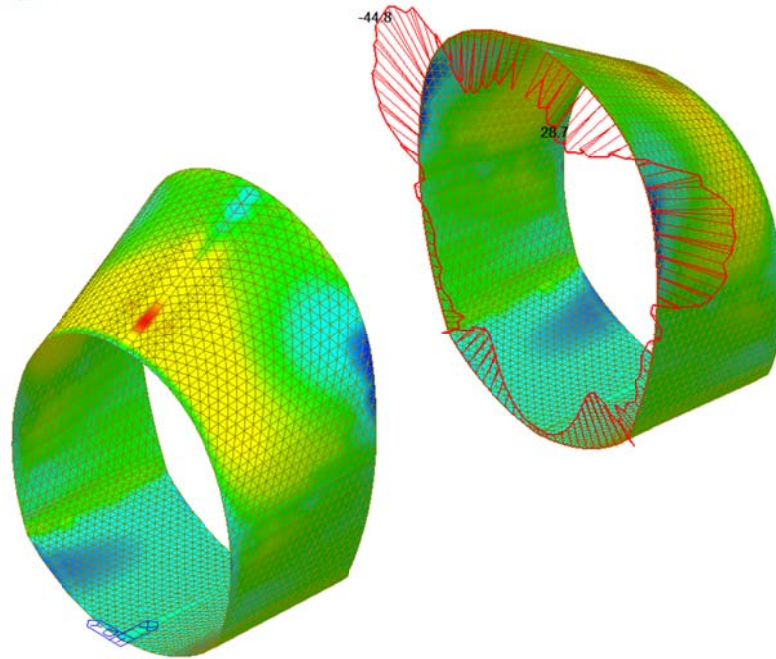


Plate force\_Mxx / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

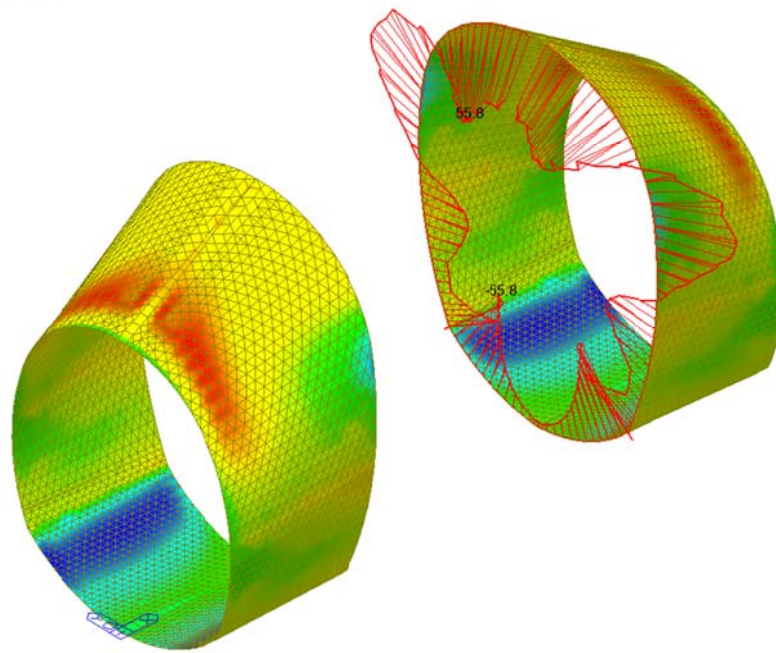
106.42
92.65
78.88
65.10
51.33
37.55
23.78
10.01
0.00
-17.54
-31.31
-45.09

ST: N2  
Avg Nodal Active-  
MAX : 11463  
MIN : 2896

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Myy / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

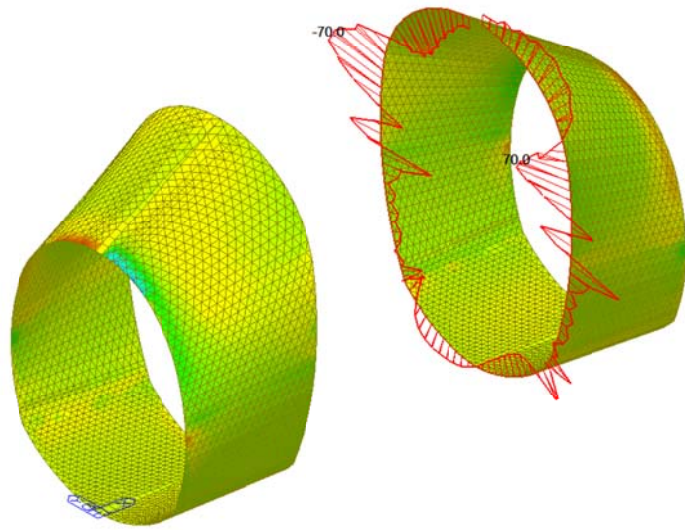
74.83
61.39
47.96
34.52
21.08
7.65
0.00
-19.23
-32.66
-46.10
-59.54
-72.97

ST: N2  
Avg Nodal Active-  
MAX : 11287  
MIN : 1747

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UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Vxx / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vxx

206.98
169.35
131.72
94.08
56.45
0.00
-18.82
-56.45
-94.08
-131.72
-169.35
-206.99

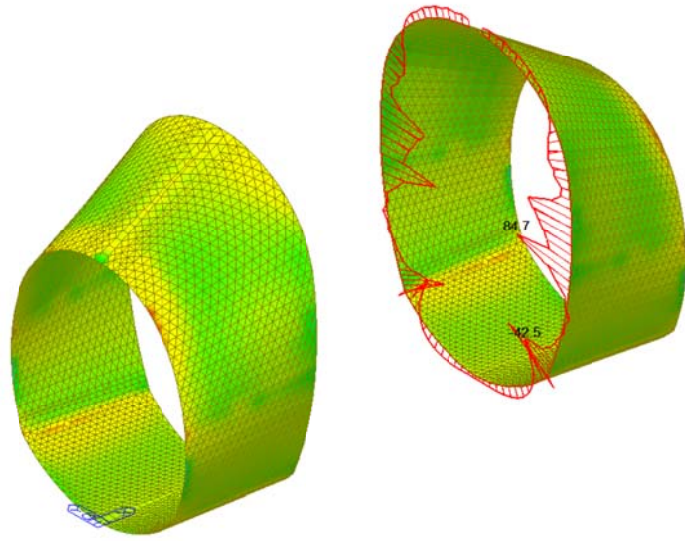
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Avg Nodal Active-

MAX : 11374  
MIN : 3337

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UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

Plate force\_Vyy / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vyy

128.40
101.25
74.10
46.95
19.80
0.00
-34.50
-61.66
-88.81
-115.96
-143.11
-170.26

ST: N2  
Avg Nodal Active-

MAX : 4976  
MIN : 3188

FILE: F02-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

A.5.3.3. Load combination SLU 3

Plate force\_Fxx / ST\_N3

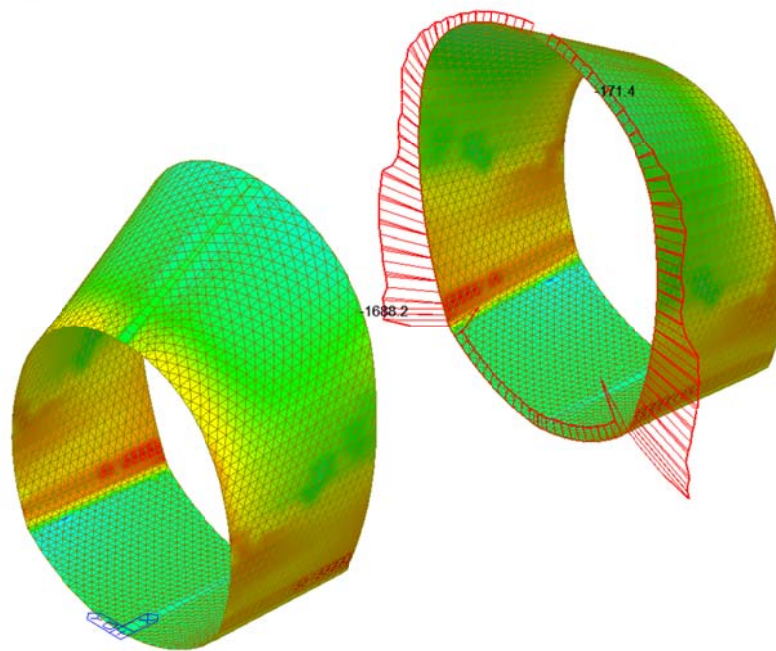


Plate force\_Fyy / ST\_N3

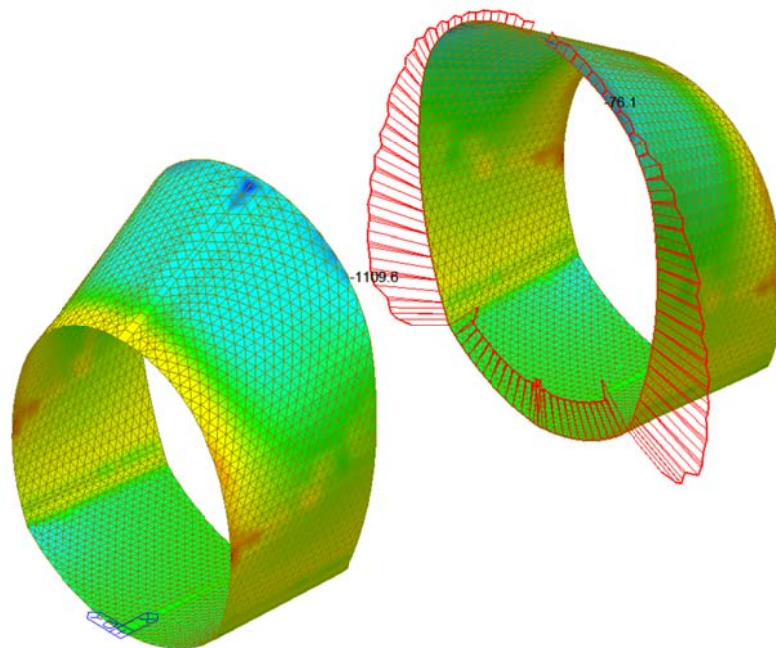


Plate force\_Mxx / ST\_N3

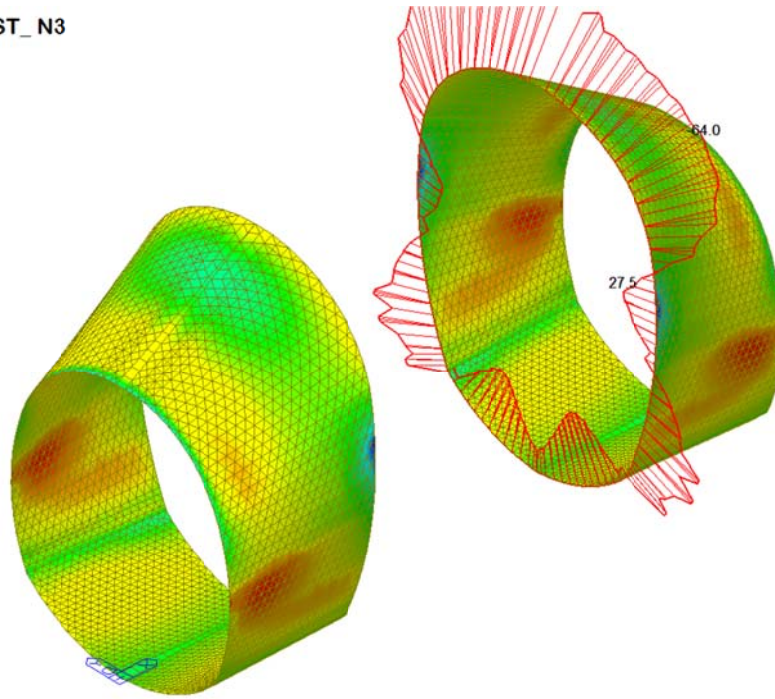


Plate force\_Myy / ST\_N3

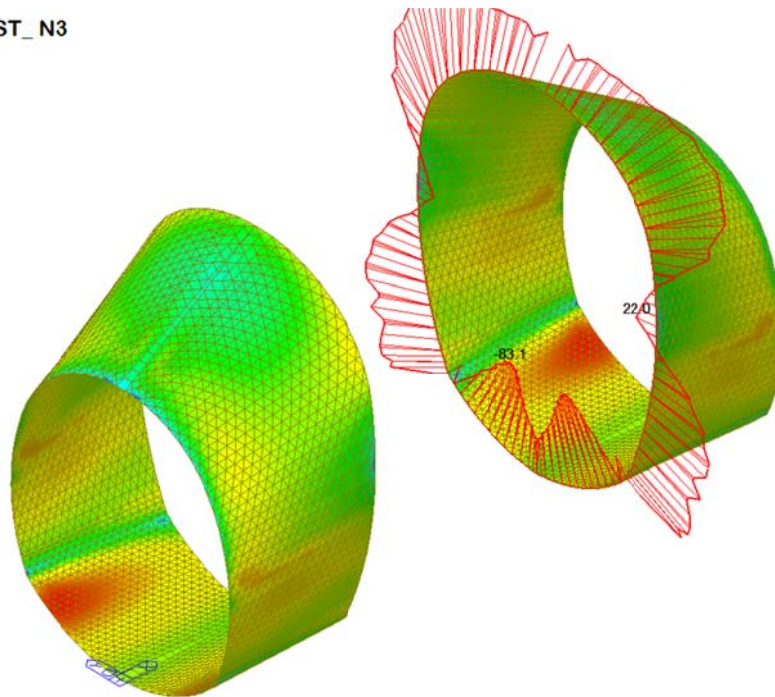


Plate force\_Vxx / ST\_N3

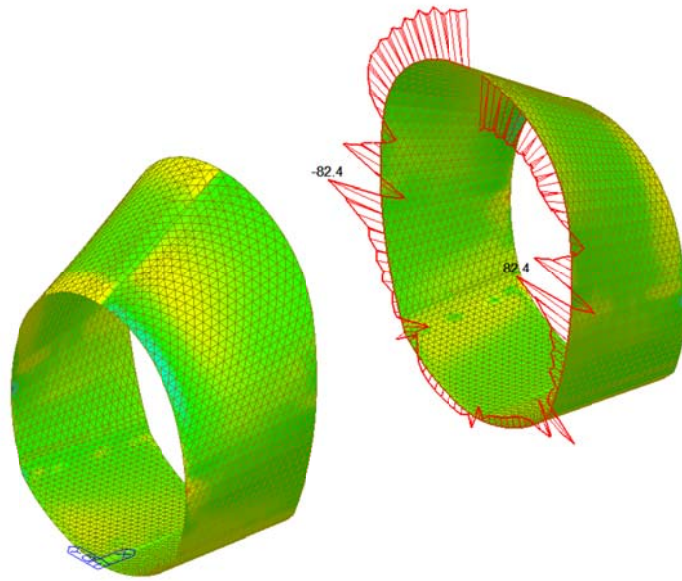
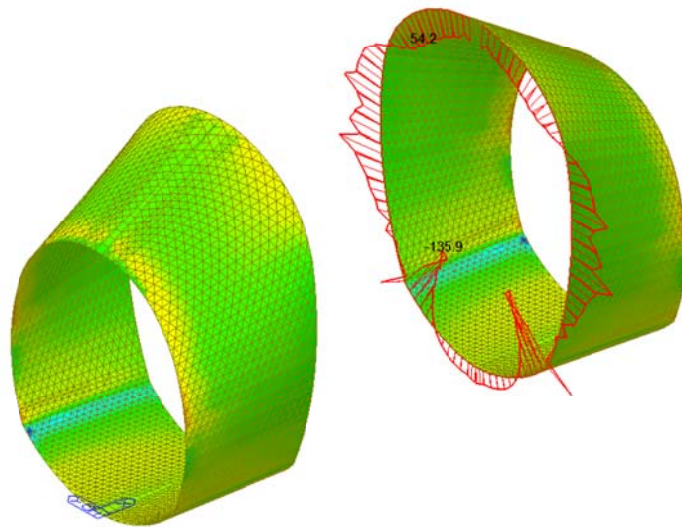


Plate force\_Vyy / ST\_N3



A.5.3.4. Load combination SLU 4

Plate force\_Fxx / ST\_N4

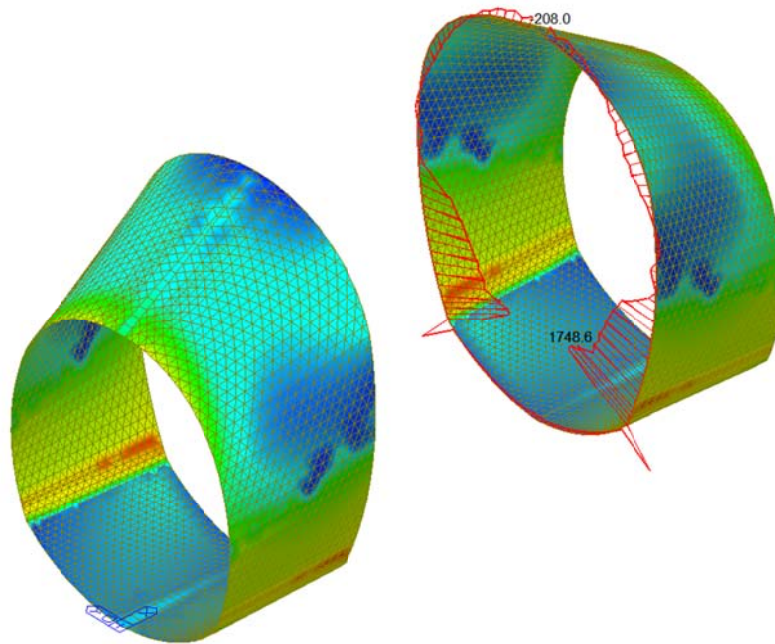


Plate force\_Fyy / ST\_N4

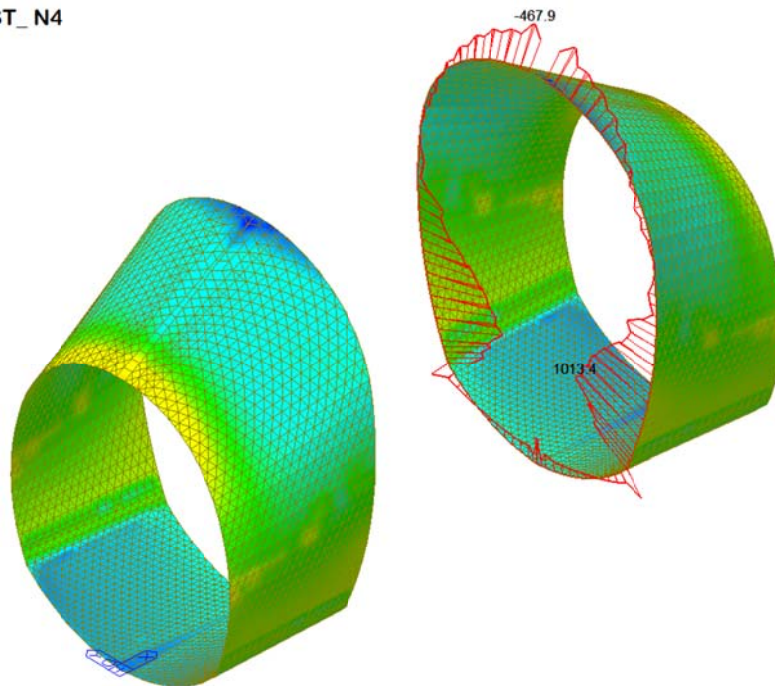
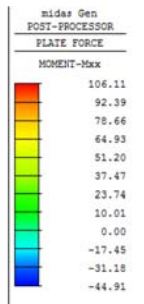
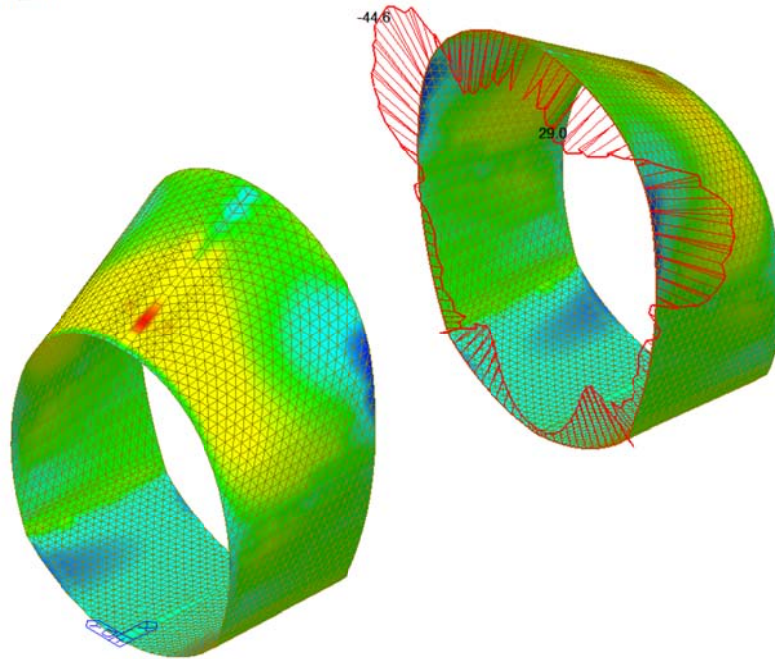


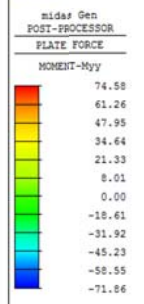
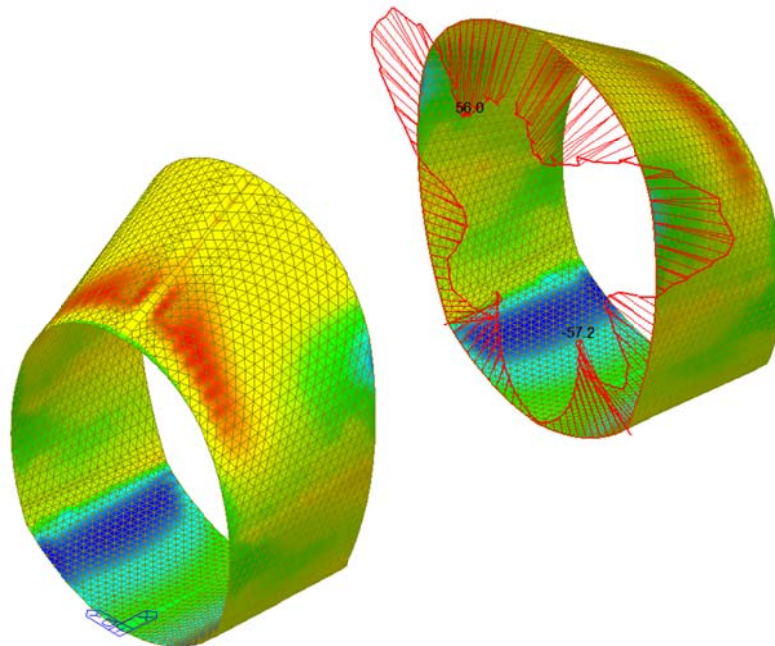


Plate force\_Mxx / ST\_N4



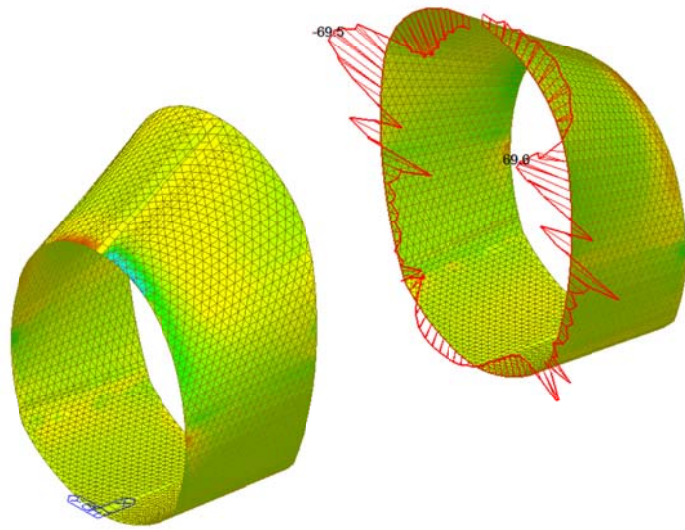
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 Avg Nodal Active-  
 MAX : 11463  
 MIN : 2896  
 FILE: FdE-V-IN-F-  
 UNIT: kN\*m/m  
 DATE: 10/04/2014  
 VIEW-DIRECTION  
 X: 0.570  
 Y: 0.622  
 Z: 0.537

Plate force\_Myy / ST\_N4



ST: N4  
 Avg Nodal Active-  
 MAX : 11287  
 MIN : 1747  
 FILE: FdE-V-IN-F-  
 UNIT: kN\*m/m  
 DATE: 10/04/2014  
 VIEW-DIRECTION  
 X: 0.570  
 Y: 0.622  
 Z: 0.537

Plate force\_Vxx / ST\_N4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vxx

206.22
168.73
131.23
93.74
56.24
0.00
-18.75
-56.24
-93.74
-131.23
-168.73
-206.22

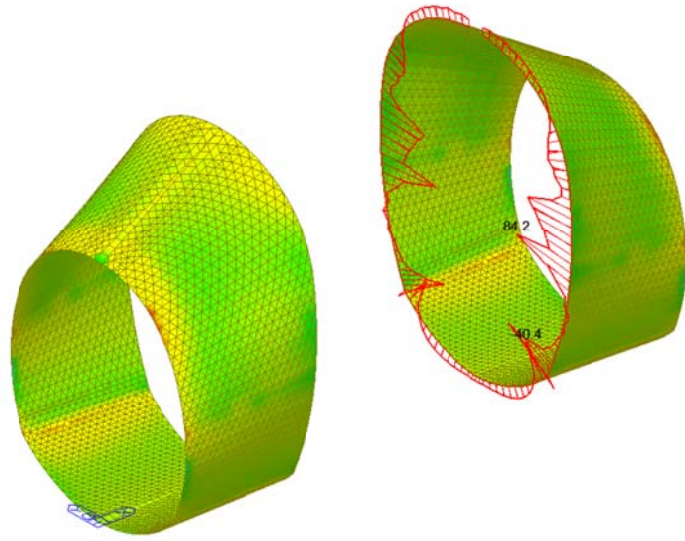
ST: N4  
Avg Nodal Active-

MAX : 11374  
MIN : 3337

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

Plate force\_Vyy / ST\_N4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vyy

130.33
103.09
75.84
48.59
0.00
-33.15
-60.40
-87.64
-114.89
-142.14
-169.39

ST: N4  
Avg Nodal Active-

MAX : 4976  
MIN : 3188

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

A.5.3.5. Load combination SLU 5

Plate force\_Fxx / ST\_N5

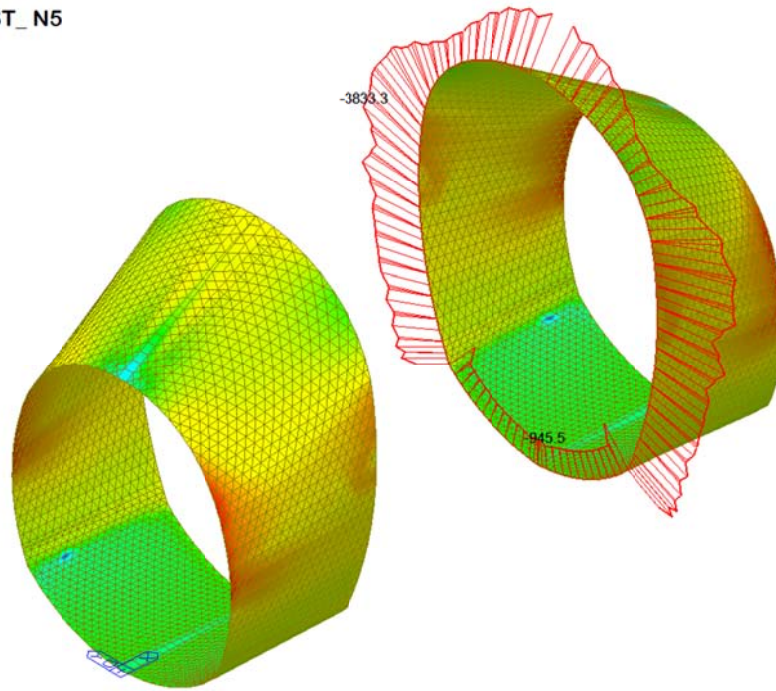


Plate force\_Fyy / ST\_N5

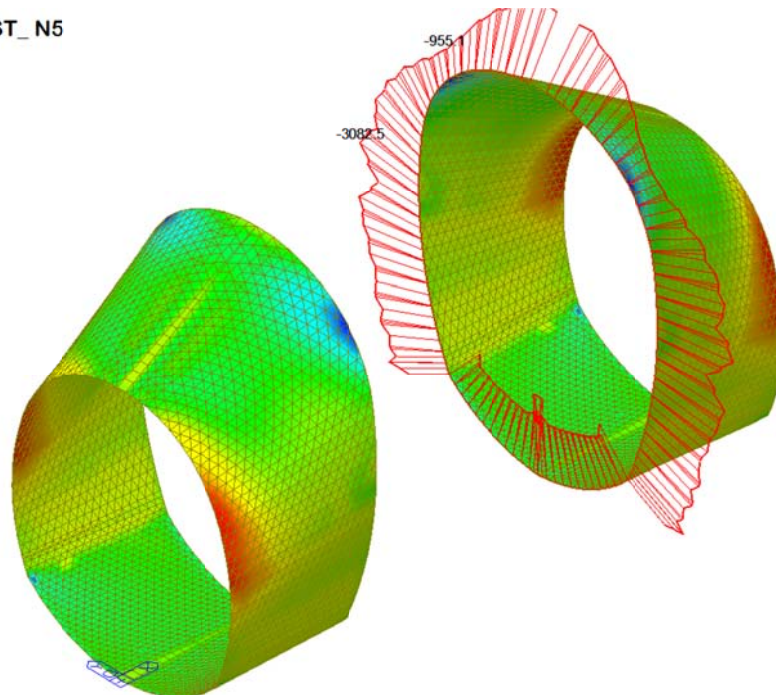


Plate force\_Mxx / ST\_N5

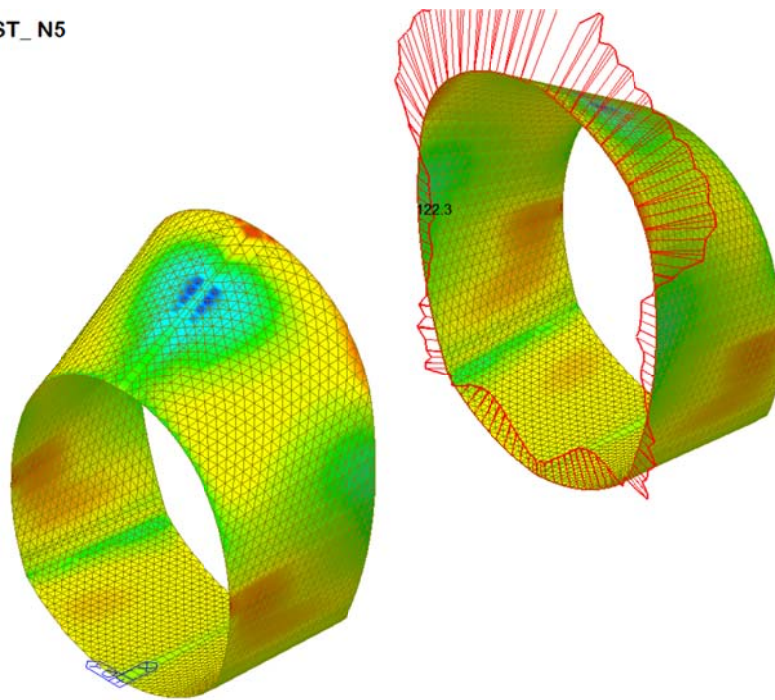


Plate force\_Myy / ST\_N5

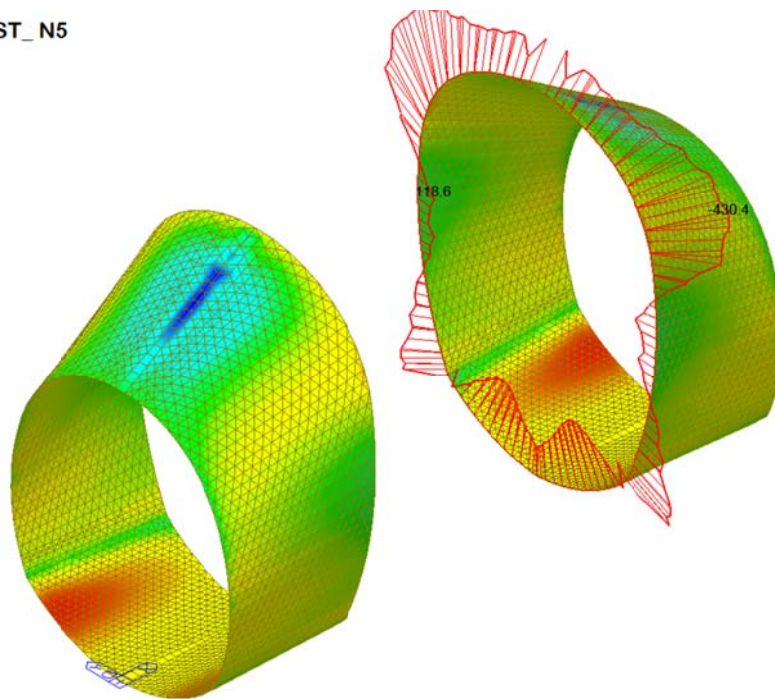


Plate force\_Vxx / ST\_N5

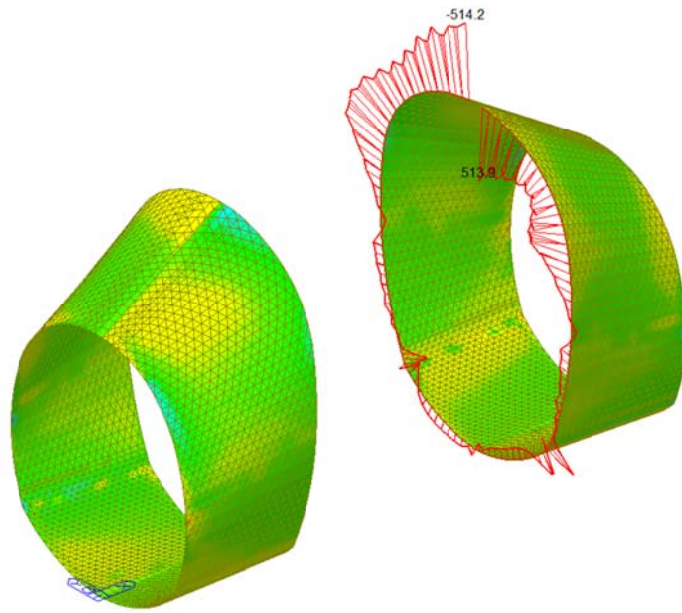


Plate force\_Vyy / ST\_N5

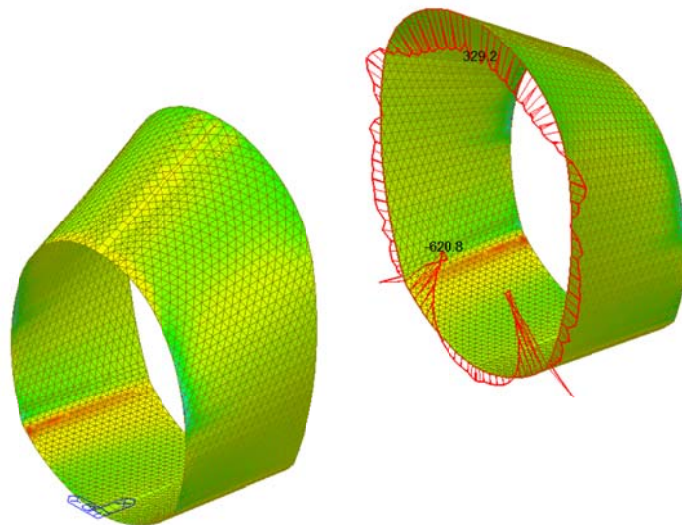


Plate force\_Fxx / ST\_N6

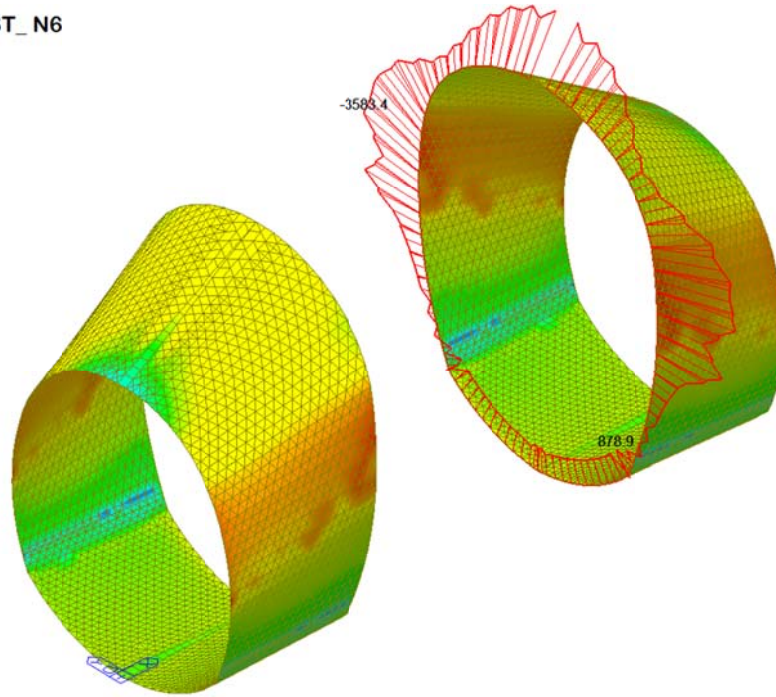


Plate force\_Fyy / ST\_N6

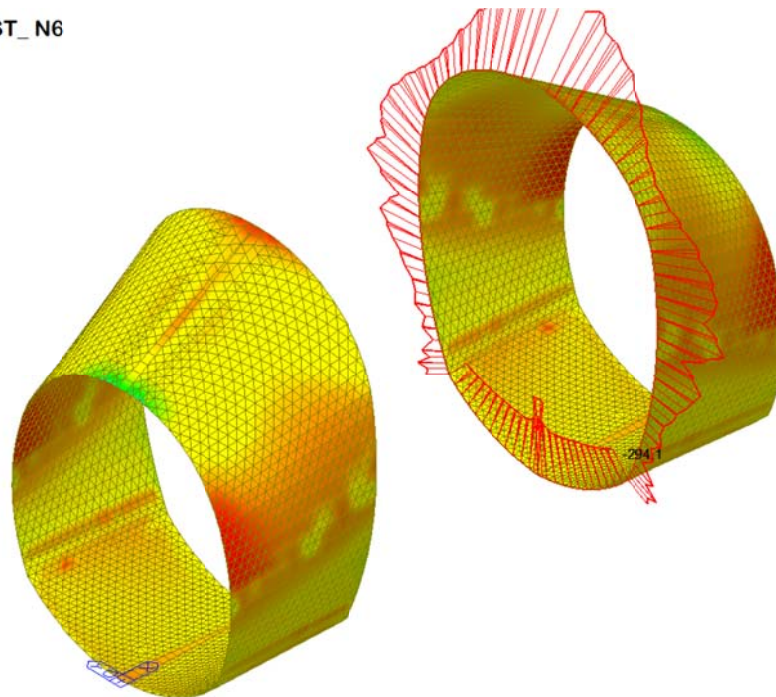
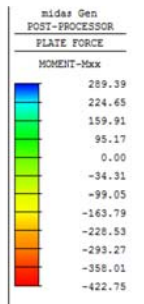
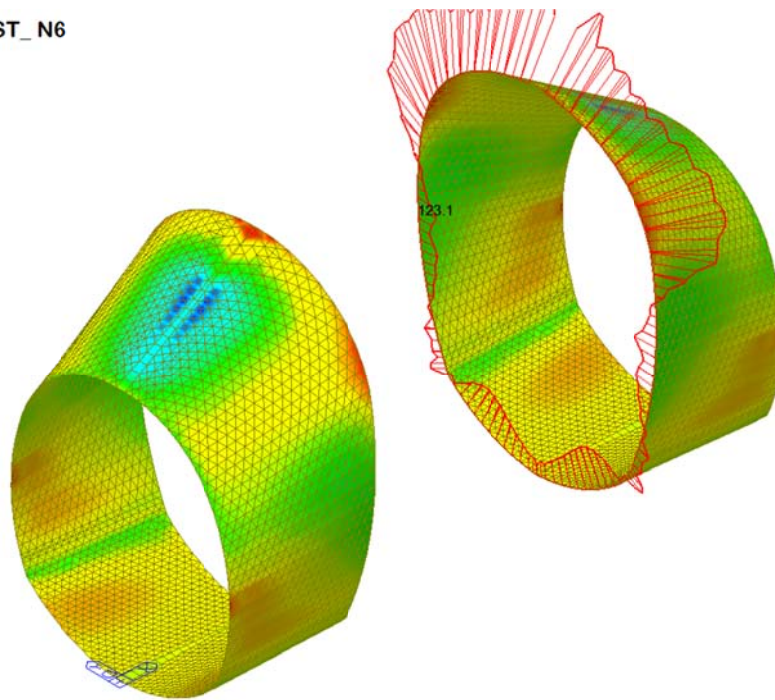
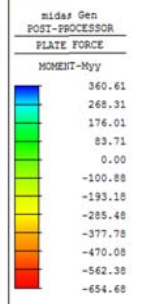
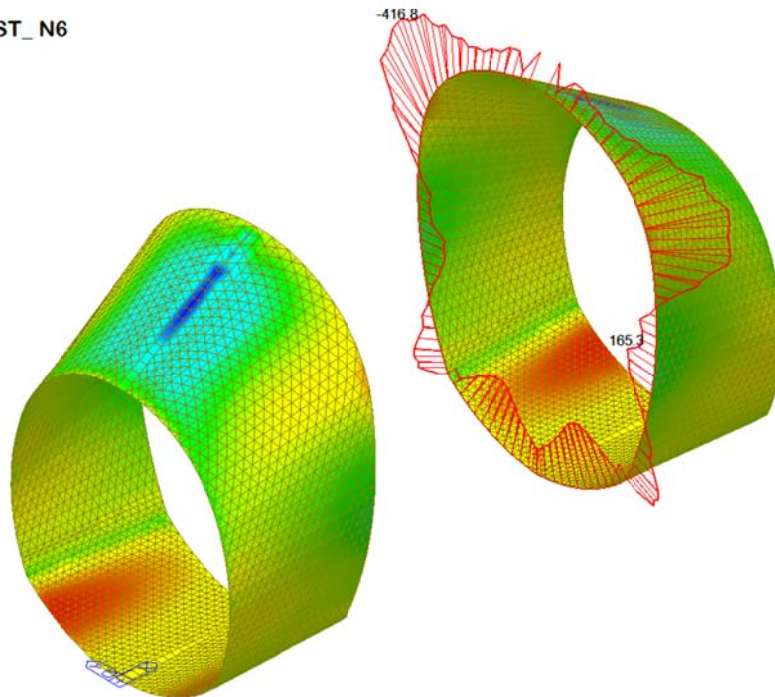


Plate force\_Mxx / ST\_N6



ST: N6  
Avg Nodal Active-  
MAX : 3614  
MIN : 2451  
FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: 0.570  
Y: 0.622  
Z: 0.537

Plate force\_Myy / ST\_N6



ST: N6  
Avg Nodal Active-  
MAX : 3605  
MIN : 9789  
FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: 0.570  
Y: 0.622  
Z: 0.537

Plate force\_Vxx / ST\_N6

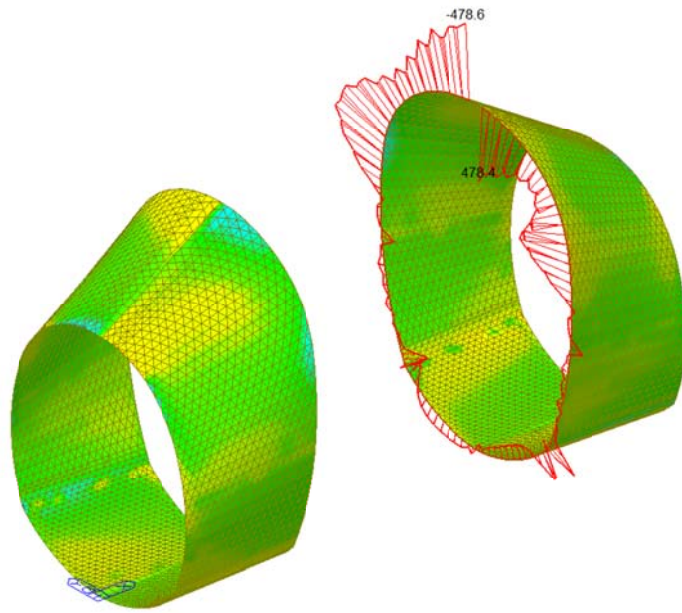


Plate force\_Vyy / ST\_N6

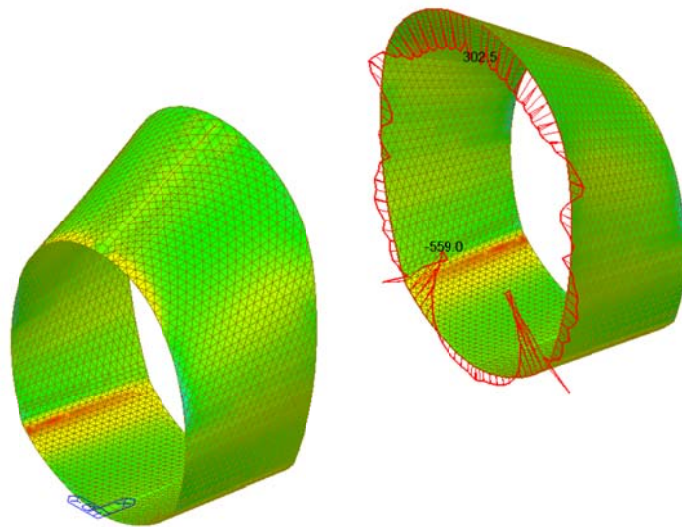




Plate force\_Fxx / ST\_N11

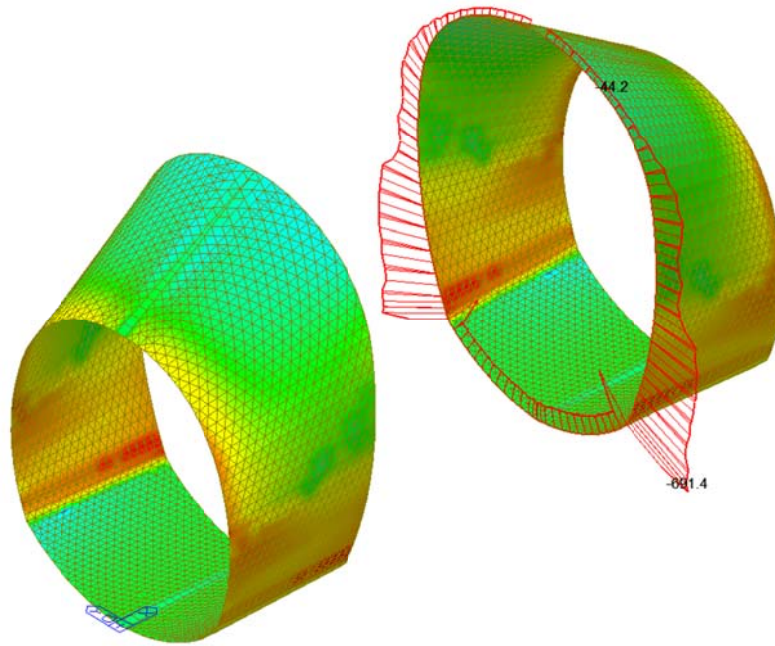


Plate force\_Fyy / ST\_N11

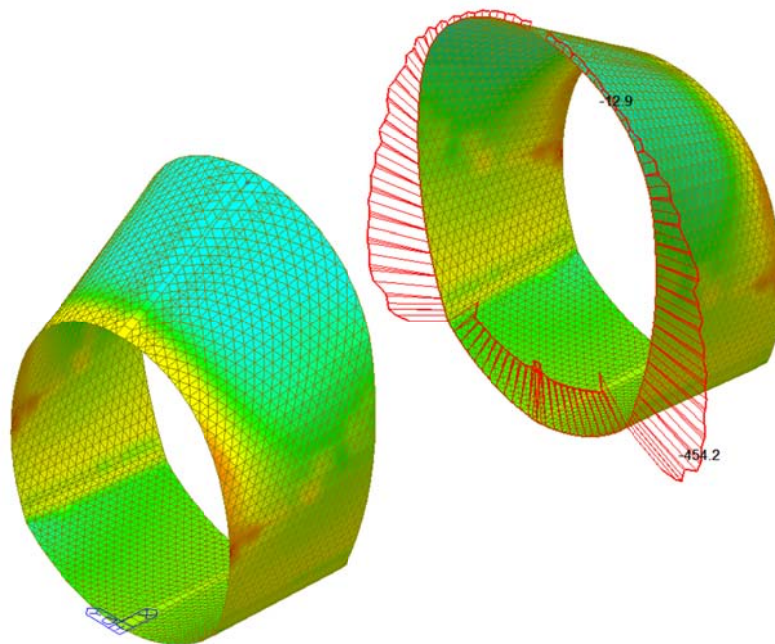
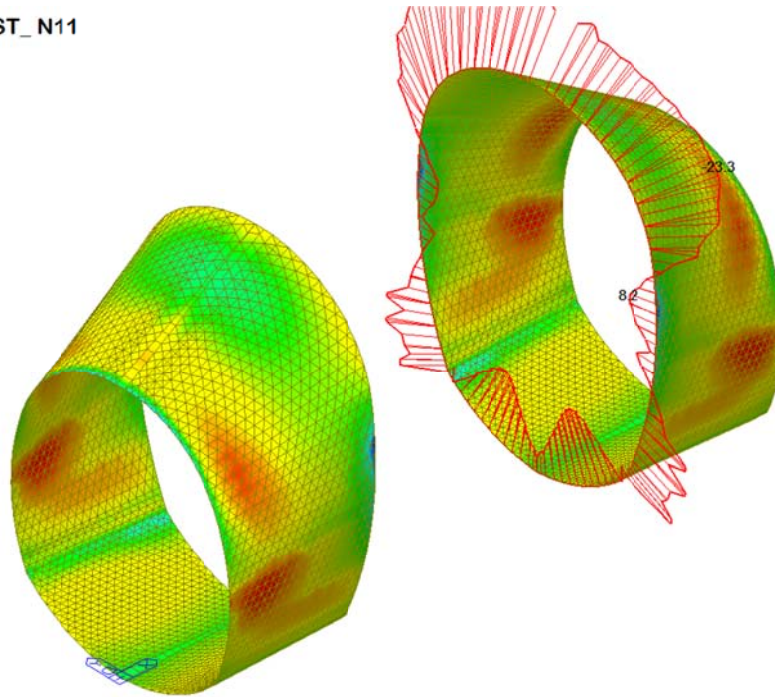


Plate force\_Mxx / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

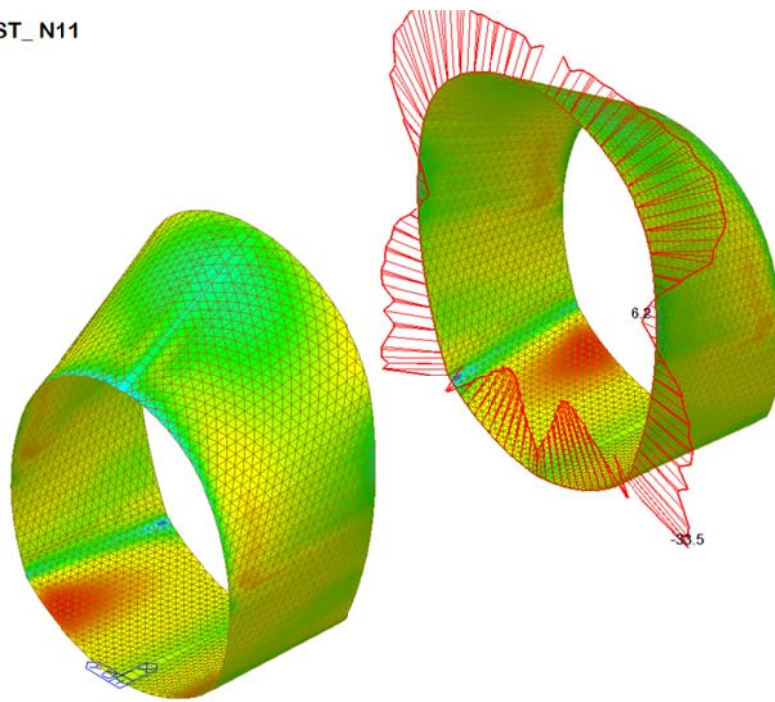
8.35
3.63
0.00
-5.83
-10.55
-15.28
-20.01
-24.74
-29.46
-34.19
-38.92
-43.64

ST: N11  
Avg Nodal Active-  
MAX : 2674  
MIN : 4916

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Myy / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

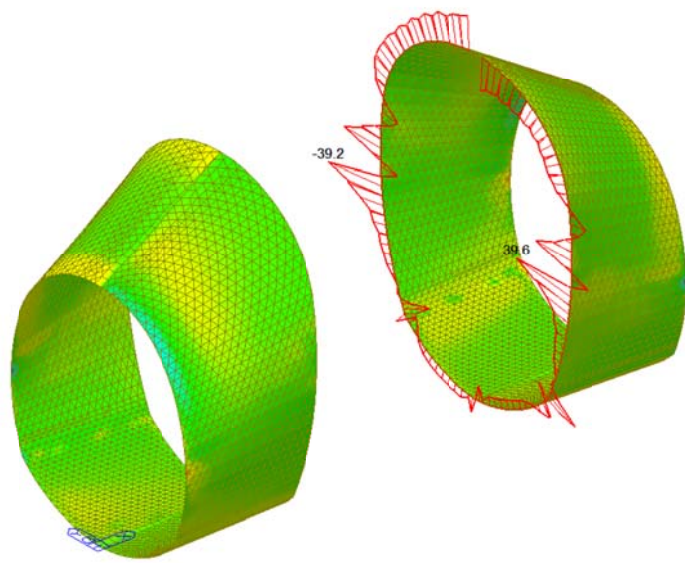
13.45
6.49
0.00
-7.44
-14.41
-21.38
-28.34
-35.31
-42.27
-49.24
-56.20
-63.17

ST: N11  
Avg Nodal Active-  
MAX : 12657  
MIN : 1772

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Vxx / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vxx

117.63
96.24
74.86
53.47
32.08
10.70
0.00
-32.08
-53.46
-74.85
-96.24
-117.63

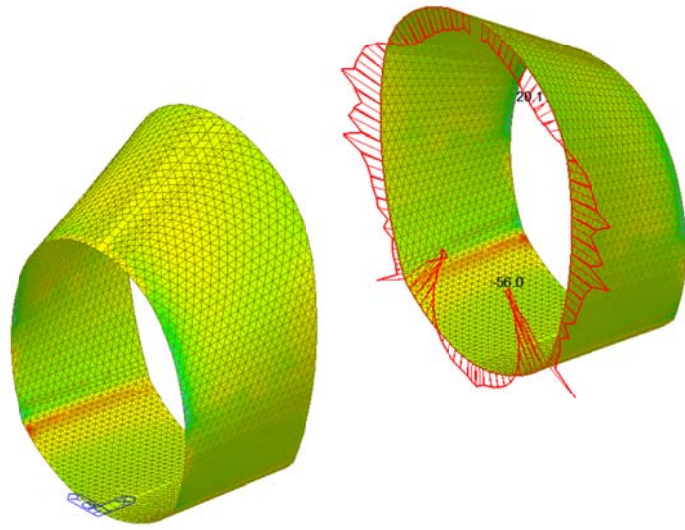
ST: N11  
Avg Nodal Active-

MAX : 10488  
MIN : 2451

FILE: F02-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

Plate force\_Vyy / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vyy

111.02
90.28
69.53
48.79
28.04
0.00
-13.45
-34.19
-54.94
-75.68
-96.43
-117.18

ST: N11  
Avg Nodal Active-

MAX : 12405  
MIN : 10186

FILE: F02-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

Plate force\_Fxx / ST\_N12

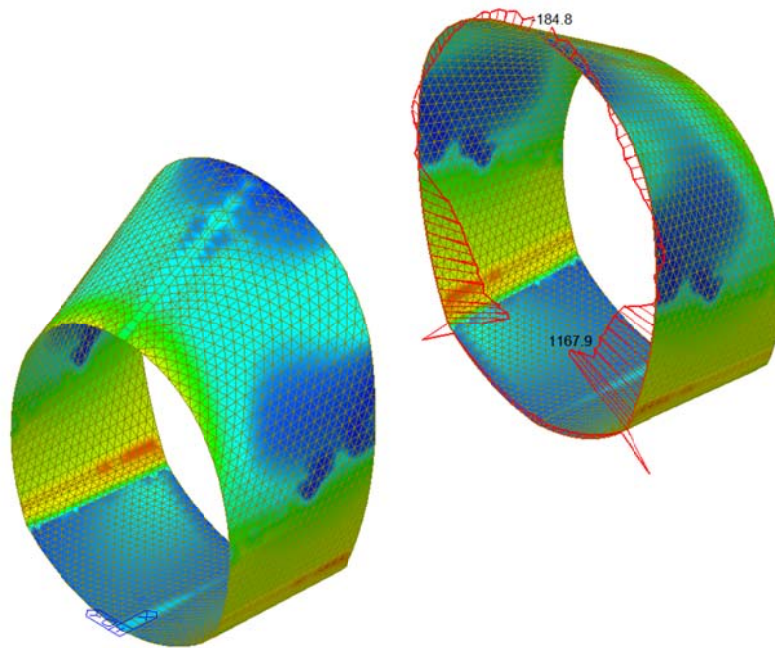


Plate force\_Fyy / ST\_N12

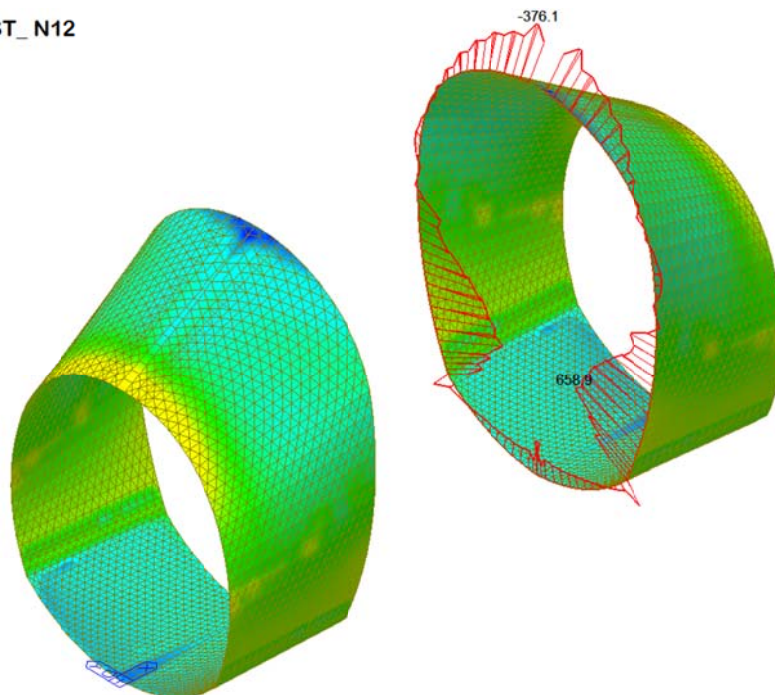
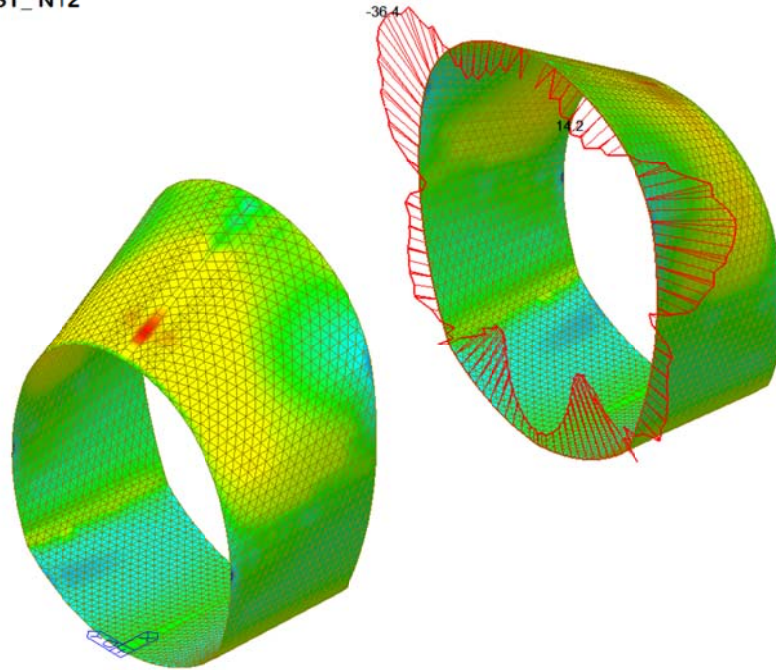


Plate force\_Mxx / ST\_N12



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

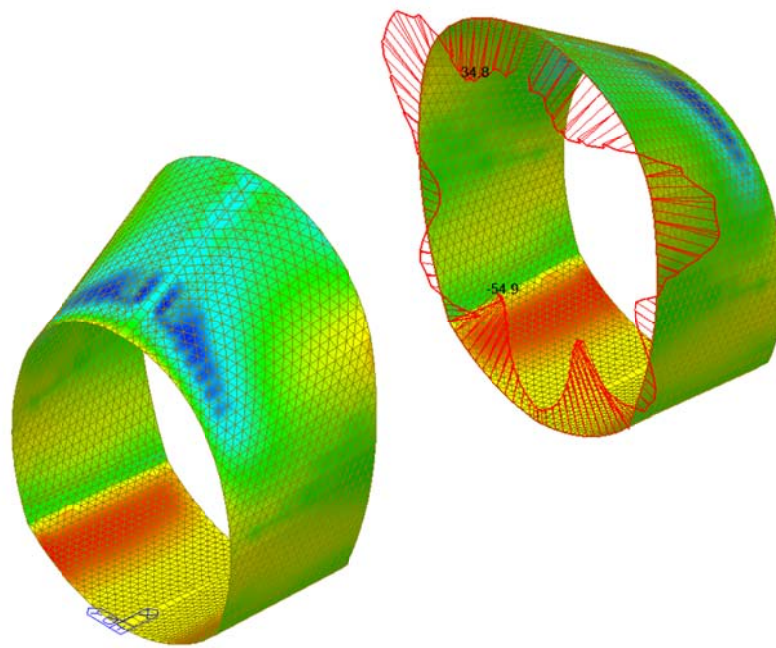
74.23
62.87
51.51
40.16
28.80
17.44
6.09
0.00
-16.63
-27.98
-39.34
-50.70

ST: N12  
Avg Nodal Active-  
MAX : 11463  
MIN : 2451

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Myy / ST\_N12



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

52.92
40.68
28.45
16.22
0.00
-8.24
-20.47
-32.70
-44.93
-57.17
-69.40
-81.63

ST: N12  
Avg Nodal Active-  
MAX : 11599  
MIN : 1747

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Vxx / ST\_N12

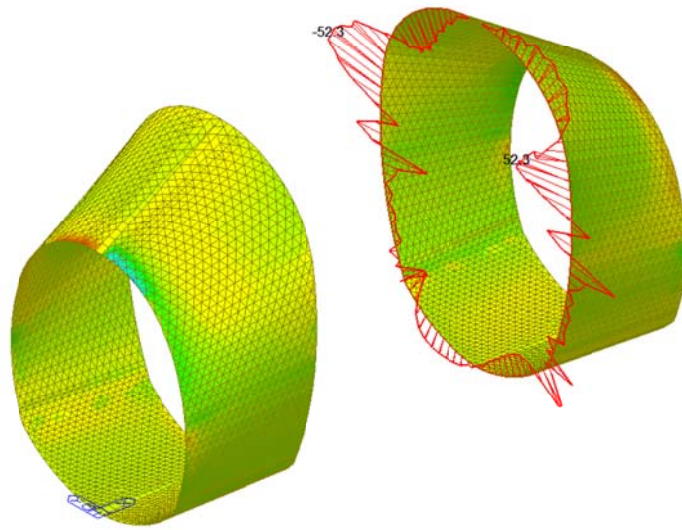


Plate force\_Vyy / ST\_N12

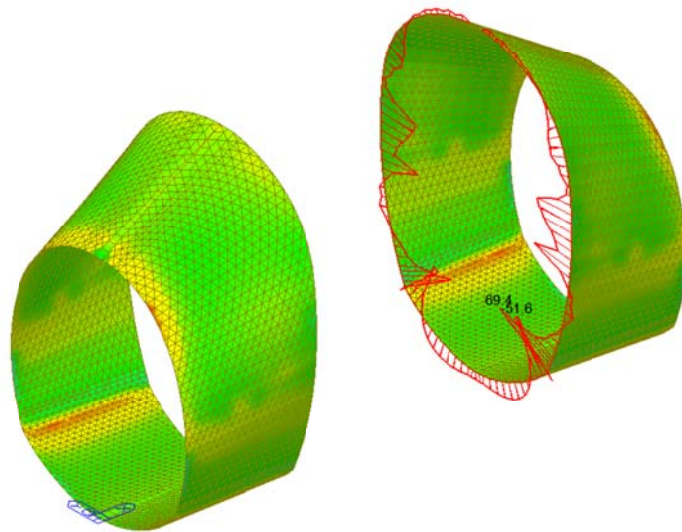


Plate force\_Fxx / ST\_N21

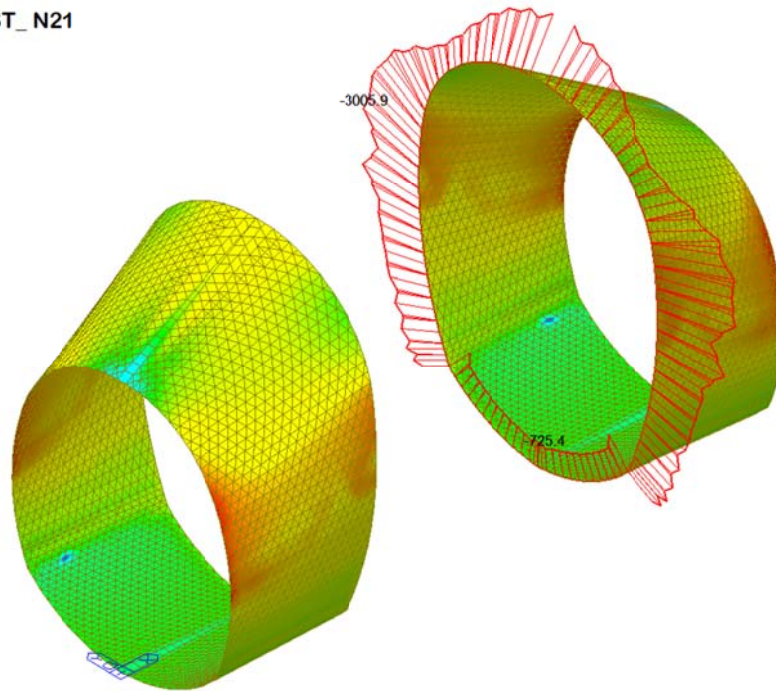


Plate force\_Fyy / ST\_N21

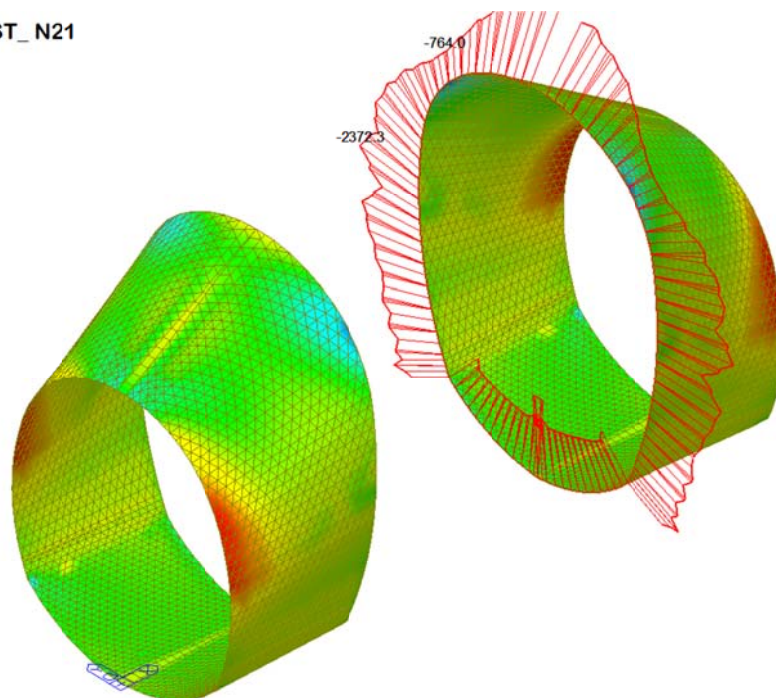
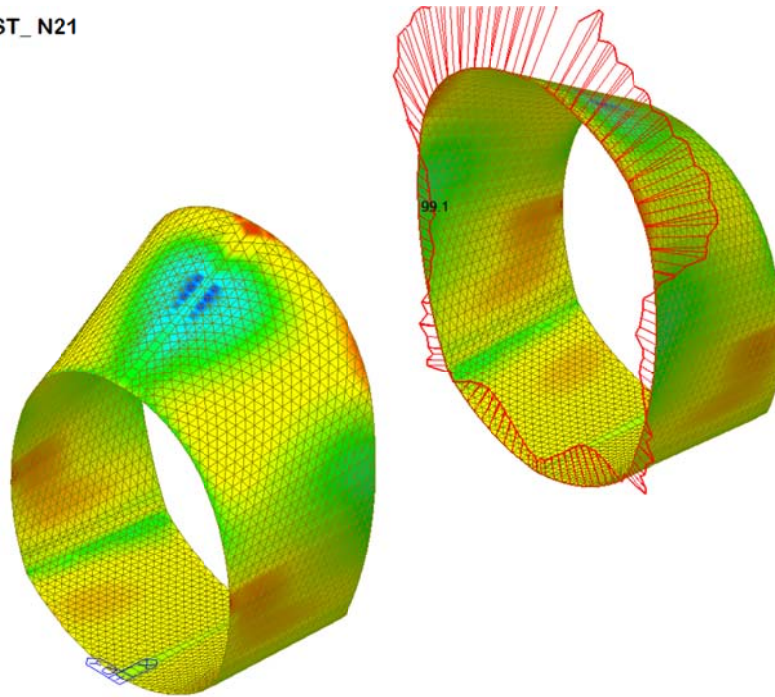


Plate force\_Mxx / ST\_N21



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

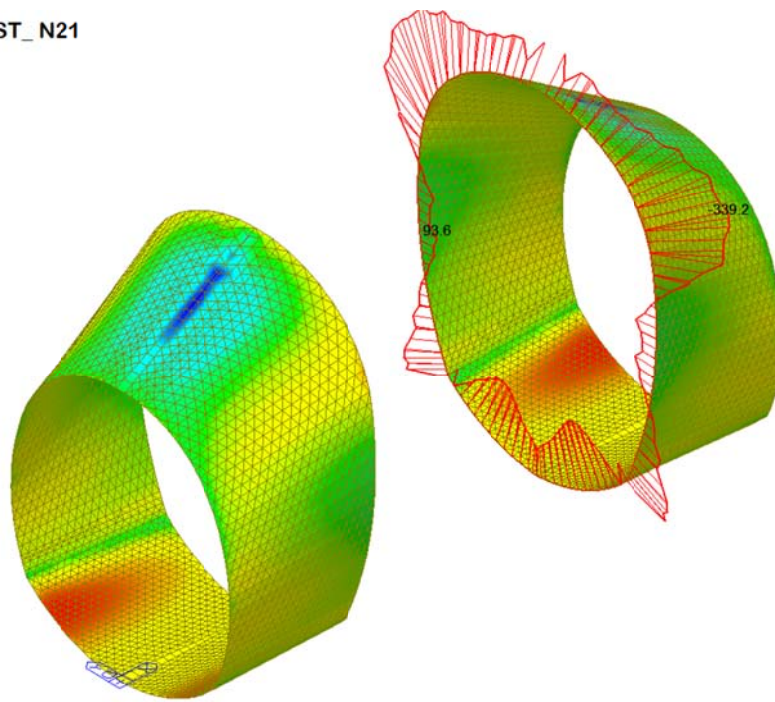
194.09
143.09
92.08
41.07
0.00
-60.94
-111.94
-162.95
-213.95
-264.96
-315.96
-366.97

ST: N21  
Avg Nodal Active-  
MAX : 6130  
MIN : 4979

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Myy / ST\_N21



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

239.97
169.38
96.78
0.00
-42.40
-112.99
-183.58
-254.18
-324.77
-395.36
-465.95
-536.54

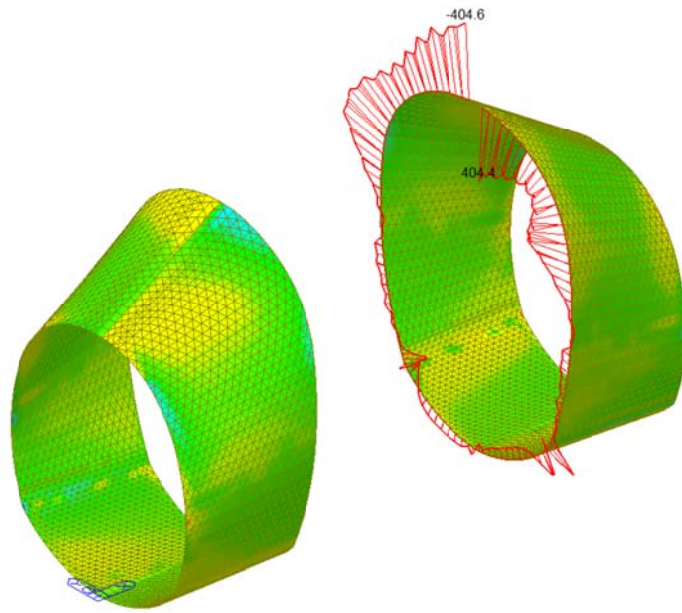
ST: N21  
Avg Nodal Active-  
MAX : 6124  
MIN : 9789

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537



Plate force\_Vxx / ST\_N21

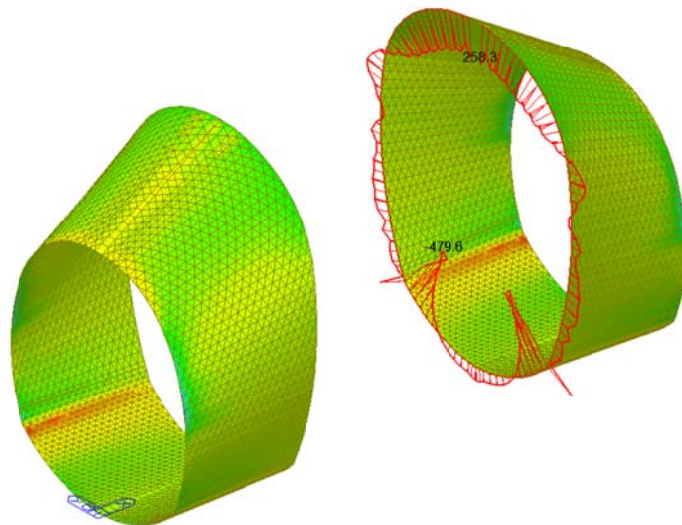


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
598.96	
490.06	
381.16	
272.26	
163.36	
54.45	
0.00	
-163.35	
-272.25	
-381.15	
-490.05	
-598.96	

ST: N21
Avg Nodal Active-
MAX : 4979
MIN : 15003
FILE: FdZ-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X1: -0.553
X2: -0.683
Z: 0.477

Plate force\_Vyy / ST\_N21



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
675.57	
528.34	
381.12	
233.89	
86.67	
0.00	
-207.78	
-355.01	
-502.23	
-649.46	
-796.68	
-943.91	

ST: N21
Avg Nodal Active-
MAX : 5272
MIN : 2105
FILE: FdZ-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X1: -0.553
X2: -0.683
Z: 0.477

A.5.3.10. Load combination SLU 22

Plate force\_Fxx / ST\_N22

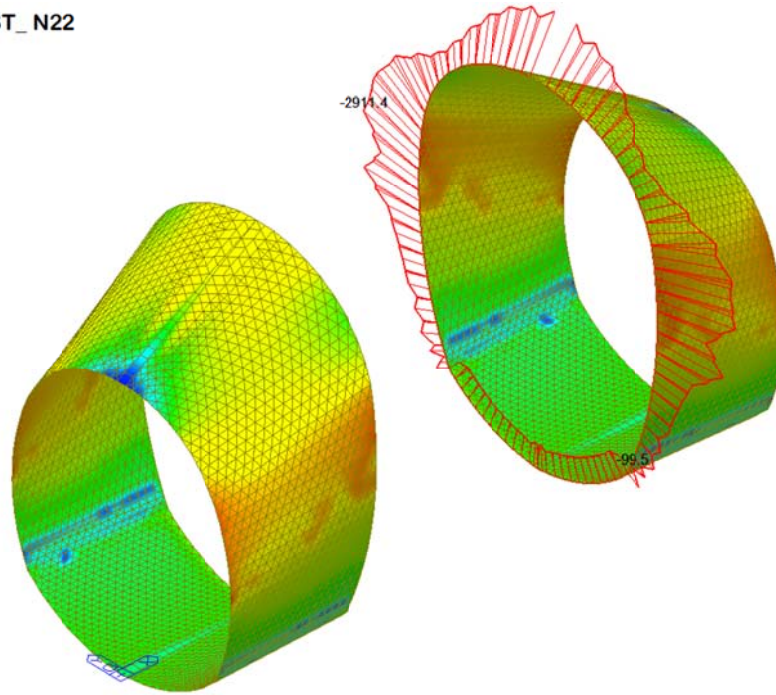


Plate force\_Fyy / ST\_N22

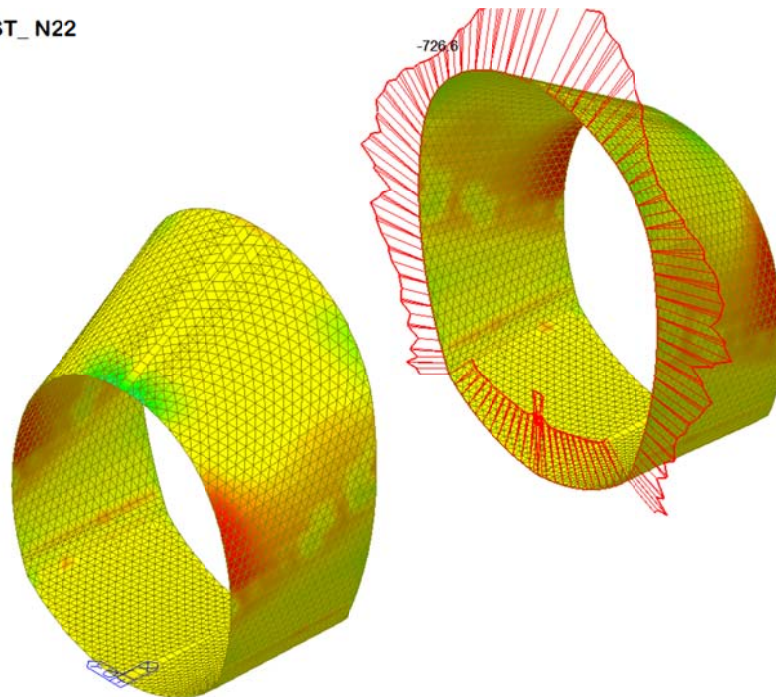


Plate force\_Mxx / ST\_N22

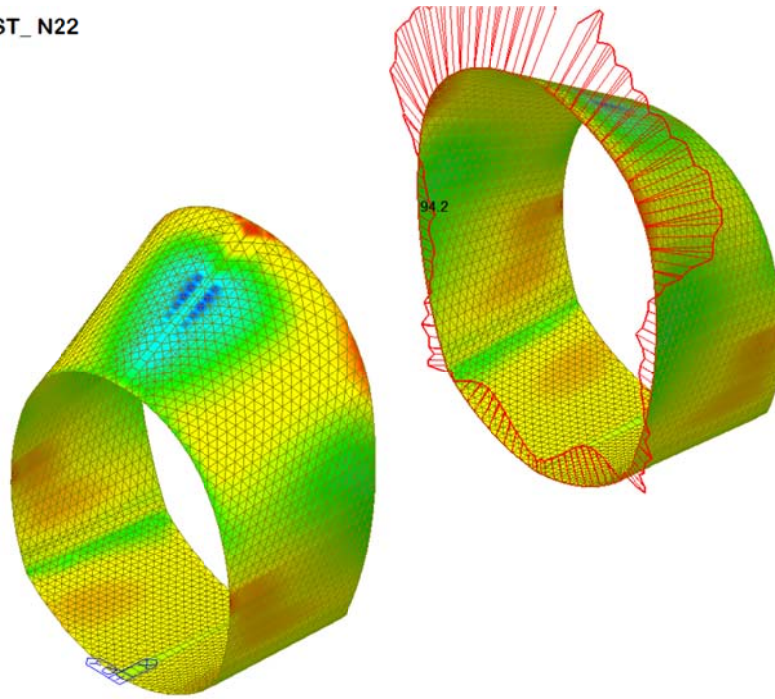


Plate force\_Myy / ST\_N22

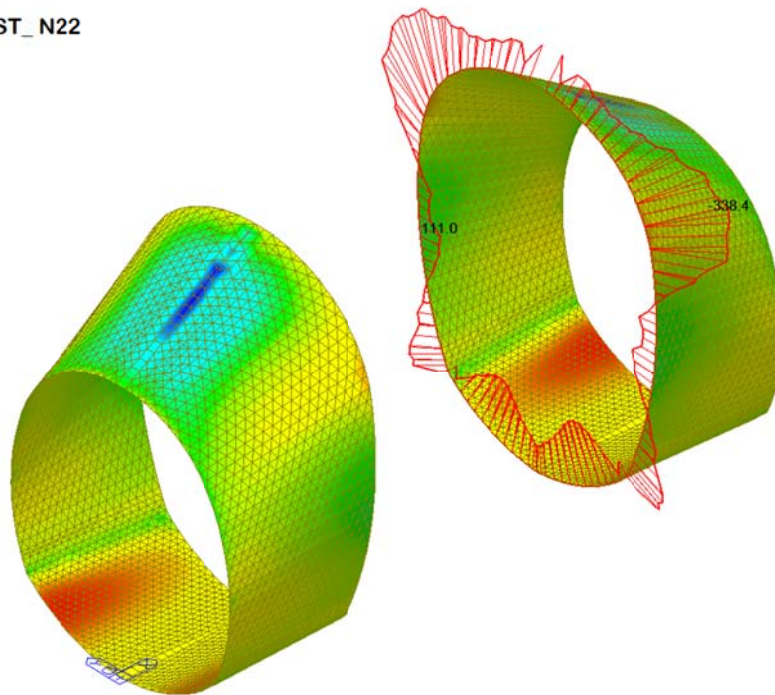
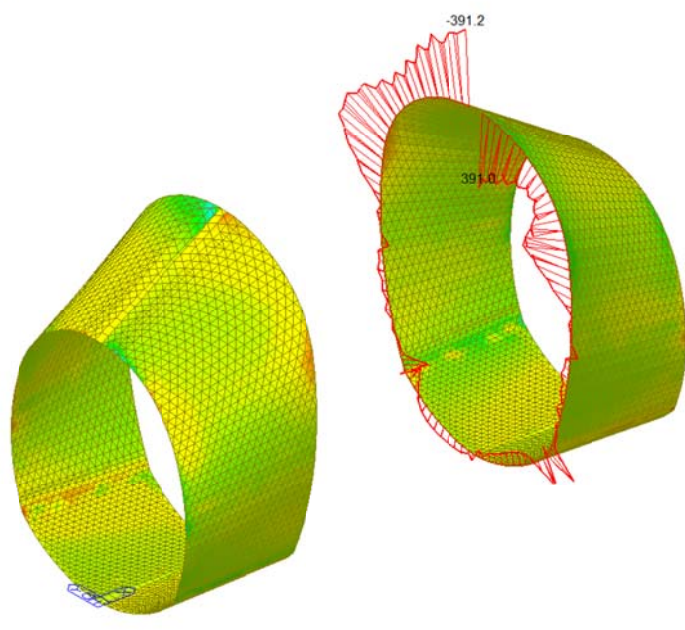


Plate force\_Vxx / ST\_N22



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vxx

530.02
433.65
337.28
240.92
144.55
0.00
-48.18
-144.55
-240.92
-337.28
-433.65
-530.02

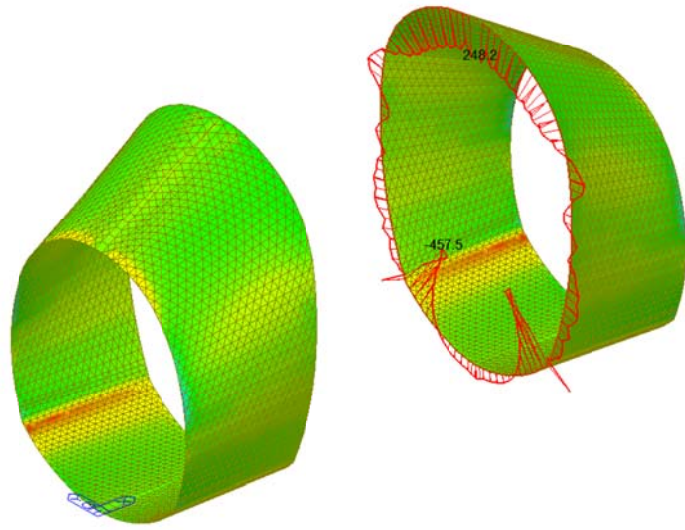
ST: N22  
Avg Nodal Active-

MAX : 10106  
MIN : 2105

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

Plate force\_Vyy / ST\_N22



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vyy

589.81
454.62
319.43
184.24
0.00
-86.14
-221.33
-356.52
-491.71
-626.90
-762.09
-897.28

ST: N22  
Avg Nodal Active-

MAX : 2714  
MIN : 2105

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X1: -0.553  
X2: -0.683  
Z: 0.477

A.5.3.11. Section checking: M-N iteration

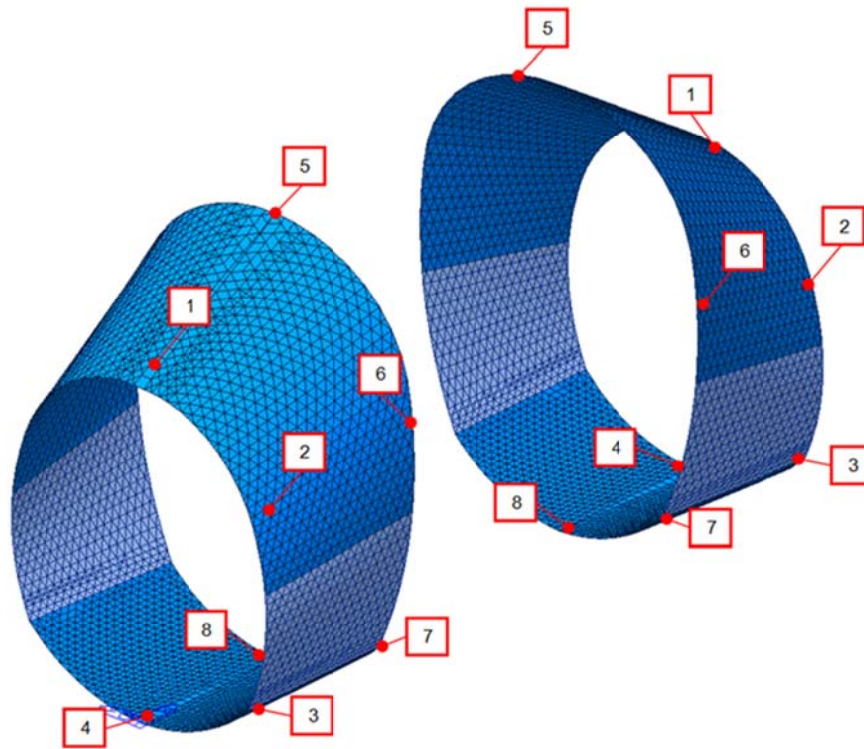


Figure 6 Numbering of sections checked

Spessore anello [cm]		60				90				120				120			
Sezioni		1				2				3				4			
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)
SLU	1	-397.3	-80.5	-47.4	0.08	-1281.2	-97.3	-87.9	0.10	-105.9	-46.7	38.2	0.01	-262.0	-22.2	15.6	0.02
	2	519.2	106.4	70.8	0.72	716.5	9.7	72.7	0.58	-16.2	-16.4	17.9	0.01	29.1	-9.2	6.0	0.03
	3	-398.8	-80.8	-47.7	0.08	-1274.6	-96.4	-88.2	0.10	-103.0	-45.9	37.2	0.01	-278.1	-21.1	15.4	0.02
	4	517.8	106.1	70.6	0.72	723.8	10.1	72.9	0.59	-17.7	-16.2	17.4	0.01	8.3	-8.4	6.1	0.01
	5	-510.3	35.7	69.4	0.06	-3941.0	-309.5	-190.1	0.31	-439.1	-137.1	227.2	0.04	-896.6	-109.5	70.3	0.06
	6	426.0	220.6	188.3	0.99	-2583.4	-236.0	-44.1	0.21	-364.3	-123.1	217.1	0.04	-650.8	-103.2	65.6	0.04
	11	-152.8	-32.4	-19.2	0.03	-536.6	-35.4	-42.2	0.04	-54.7	-15.7	18.0	0.00	-147.6	-8.7	6.8	0.01
	12	357.5	74.2	50.1	0.50	442.1	-17.7	52.7	0.38	-19.4	-23.3	15.7	0.02	-20.9	-8.7	6.6	0.00
	21	-257.5	62.1	77.0	0.07	-2825.0	-230.4	-125.7	0.24	-330.2	-105.9	178.1	0.03	-669.4	-85.3	54.9	0.04
22	269.9	129.6	120.3	0.64	-2350.1	-207.2	-71.1	0.20	-304.8	-99.7	175.0	0.03	-576.6	-82.9	53.1	0.04	

Spessore anello [cm]		60				90				120				120			
Sezioni		5				6				7				8			
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)
SLU	1	-279.2	-66.3	-48.7	0.07	-1796.1	30.3	-60.7	0.12	-108.9	-13.0	0.0	0.01	-245.2	-28.1	-10.0	0.01
	2	-79.5	-11.2	-7.8	0.01	1488.8	-27.4	13.6	0.99	-199.3	-5.6	1.2	0.01	-10.3	-5.4	3.6	0.00
	3	-274.9	-65.5	-47.8	0.07	-1792.8	30.4	-59.2	0.12	-118.9	-12.6	0.0	0.01	-261.2	-26.3	-10.2	0.02
	4	-78.0	-10.9	-7.1	0.01	1494.8	-26.4	14.7	1.00	-202.5	3.8	1.5	0.01	-28.4	-5.4	2.3	0.00
	5	-2396.4	-503.2	-486.1	0.51	-2045.7	135.4	-176.6	0.15	-1076.0	-45.6	3.1	0.06	-942.2	-113.6	-34.5	0.06
	6	-2409.6	-464.4	-481.5	0.48	1322.3	91.9	-124.2	0.99	-1218.6	-35.1	4.6	0.06	-747.6	-99.4	-28.4	0.05
	11	-77.4	-20.8	-13.3	0.02	-711.5	16.3	-21.8	0.05	-74.7	-5.3	0.0	0.00	-140.4	-9.7	-4.7	0.01
	12	-85.2	-16.2	-10.0	0.02	1484.7	-24.3	-10.9	0.99	-156.4	-2.1	1.0	0.01	-38.4	-8.4	-3.1	0.00
	21	-1916.0	-393.8	-387.5	0.46	-962.0	103.0	-129.1	0.09	-881.8	-34.2	2.7	0.05	-715.1	-86.9	-26.2	0.05
22	-1920.9	-383.5	-385.8	0.45	609.7	77.8	-106.1	0.52	-935.3	-30.1	3.3	0.05	-641.0	-81.5	-23.9	0.04	

• SECTION 1

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	0	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.00	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>206.60</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>211.48</b>	<b>kN</b>			
$V_{Rd} =$	<b>211.48</b>	<b>kN</b>	$V_{Ed} =$	<b>188.30</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

• SECTION 2

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.488		Coefficiente
$h =$	900	mm	Altezza geometrica della sezione
$d =$	841	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00202		Percentuale di armatura
$N_{Ed} =$	3'900	kN	Azione assiale di progetto
$A_c =$	841'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>759.12</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>795.17</b>	<b>kN</b>			
$V_{Rd} =$	<b>795.17</b>	<b>kN</b>	$V_{Ed} =$	<b>190.10</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 3

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.419		Coefficiente
$h =$	1'200	mm	Altezza geometrica della sezione
$d =$	1'141	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00149		Percentuale di armatura
$N_{Ed} =$	0	kN	Azione assiale di progetto
$A_c =$	1'141'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.00	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>299.76</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>369.60</b>	<b>kN</b>			
$V_{Rd} =$	<b>369.60</b>	<b>kN</b>	$V_{Ed} =$	<b>227.20</b>	<b>kN</b>
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 4

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.419		Coefficiente
$h =$	1'200	mm	Altezza geometrica della sezione
$d =$	1'140	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00184		Percentuale di armatura
$N_{Ed} =$	890	kN	Azione assiale di progetto
$A_c =$	1'140'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.78	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>454.93</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>502.85</b>	<b>kN</b>			
$V_{Rd} =$	<b>502.85</b>	<b>kN</b>	$V_{Ed} =$	<b>70.30</b>	<b>kN</b>
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 5

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	2'400	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>529.93</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>534.81</b>	kN			
$V_{Rd} =$	<b>534.81</b>	kN	$V_{Ed} =$	<b>486.10</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 6

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.488		Coefficiente
$h =$	900	mm	Altezza geometrica della sezione
$d =$	840	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00249		Percentuale di armatura
$N_{Ed} =$	2'000	kN	Azione assiale di progetto
$A_c =$	840'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	2.38	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>574.99</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>592.27</b>	kN			
$V_{Rd} =$	<b>592.27</b>	kN	$V_{Ed} =$	<b>176.60</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA



- SECTION 7

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.419		Coefficiente
$h =$	1'200	mm	Altezza geometrica della sezione
$d =$	1'140	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00184		Percentuale di armatura
$N_{Ed} =$	1'200	kN	Azione assiale di progetto
$A_c =$	1'140'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	1.05	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>501.43</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>549.35</b>	<b>kN</b>			
$V_{Rd} =$	<b>549.35</b>	<b>kN</b>	$V_{Ed} =$	<b>4.60</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 8

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.419		Coefficiente
$h =$	1'200	mm	Altezza geometrica della sezione
$d =$	1'140	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00184		Percentuale di armatura
$N_{Ed} =$	900	kN	Azione assiale di progetto
$A_c =$	1'140'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.79	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>456.43</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>504.35</b>	<b>kN</b>			
$V_{Rd} =$	<b>504.35</b>	<b>kN</b>	$V_{Ed} =$	<b>34.50</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

A.5.3.13. Section checking for fire combinations load: V

• SECTION 1

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	491	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00346		Percentuale di armatura
$N_{Ed} =$	0	kN	Azione assiale di progetto
$A_c =$	491'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.00	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>197.30</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>197.37</b>	<b>kN</b>			
$V_{Rd} =$	<b>197.37</b>	<b>kN</b>	$V_{Ed} =$	<b>120.30</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

• SECTION 2

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.503		Coefficiente
$h =$	850	mm	Altezza geometrica della sezione
$d =$	791	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00214		Percentuale di armatura
$N_{Ed} =$	2'800	kN	Azione assiale di progetto
$A_c =$	791'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.54	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>668.73</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>699.37</b>	<b>kN</b>			
$V_{Rd} =$	<b>699.37</b>	<b>kN</b>	$V_{Ed} =$	<b>125.70</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 3

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.428		Coefficiente
$h =$	1'150	mm	Altezza geometrica della sezione
$d =$	1'091	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00155		Percentuale di armatura
$N_{Ed} =$	330	kN	Azione assiale di progetto
$A_c =$	1'091'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.30	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>342.38</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>406.46</b>	kN			
$V_{Rd} =$	<b>406.46</b>	kN	$V_{Ed} =$	<b>178.10</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 4

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.428		Coefficiente
$h =$	1'150	mm	Altezza geometrica della sezione
$d =$	1'090	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00192		Percentuale di armatura
$N_{Ed} =$	660	kN	Azione assiale di progetto
$A_c =$	1'090'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.61	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>413.05</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>455.70</b>	kN			
$V_{Rd} =$	<b>455.70</b>	kN	$V_{Ed} =$	<b>54.90</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 5

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	491	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00346		Percentuale di armatura
$N_{Ed} =$	1'900	kN	Azione assiale di progetto
$A_c =$	491'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.87	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>482.30</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>482.37</b>	<b>kN</b>			
$V_{Rd} =$	<b>482.37</b>	<b>kN</b>	$V_{Ed} =$	<b>387.50</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 6

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.503		Coefficiente
$h =$	850	mm	Altezza geometrica della sezione
$d =$	790	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00265		Percentuale di armatura
$N_{Ed} =$	900	kN	Azione assiale di progetto
$A_c =$	790'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	1.14	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>401.66</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>414.10</b>	<b>kN</b>			
$V_{Rd} =$	<b>414.10</b>	<b>kN</b>	$V_{Ed} =$	<b>129.10</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 7

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.428		Coefficiente
$h =$	1'150	mm	Altezza geometrica della sezione
$d =$	1'090	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00192		Percentuale di armatura
$N_{Ed} =$	900	kN	Azione assiale di progetto
$A_c =$	1'090'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.83	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>449.05</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>491.70</b>	kN			
$V_{Rd} =$	<b>491.70</b>	kN	$V_{Ed} =$	<b>3.30</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 8

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.428		Coefficiente
$h =$	1'150	mm	Altezza geometrica della sezione
$d =$	1'090	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00192		Percentuale di armatura
$N_{Ed} =$	700	kN	Azione assiale di progetto
$A_c =$	1'090'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.64	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>419.05</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>461.70</b>	kN			
$V_{Rd} =$	<b>461.70</b>	kN	$V_{Ed} =$	<b>26.20</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

A.5.3.14. Load combination SLE 1

Plate force\_Fxx / ST\_NSLE-1

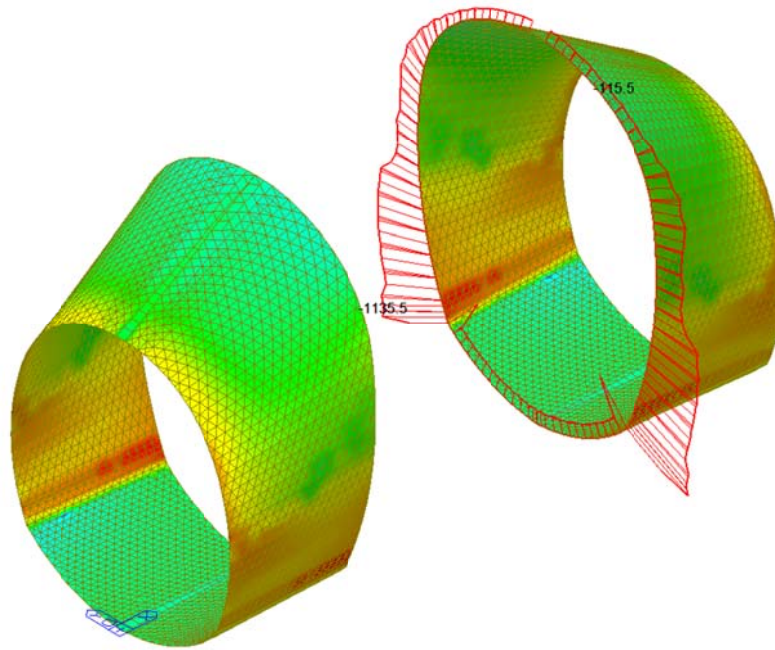


Plate force\_Fyy / ST\_NSLE-1

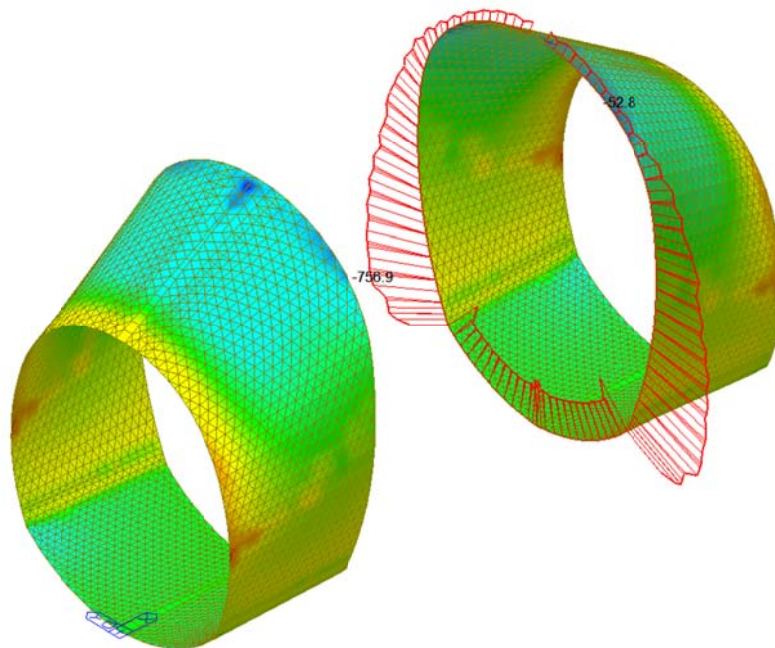


Plate force\_Mxx / ST\_NSLE-1

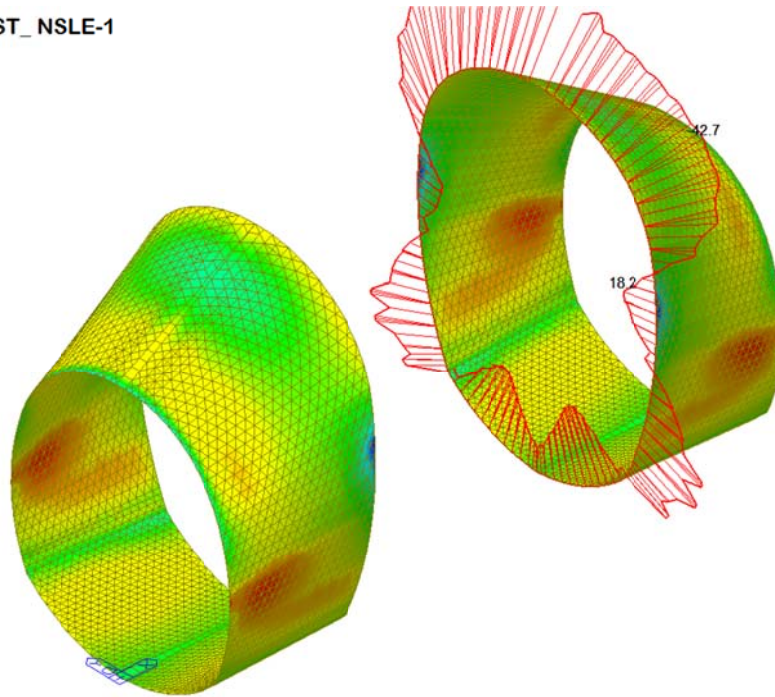
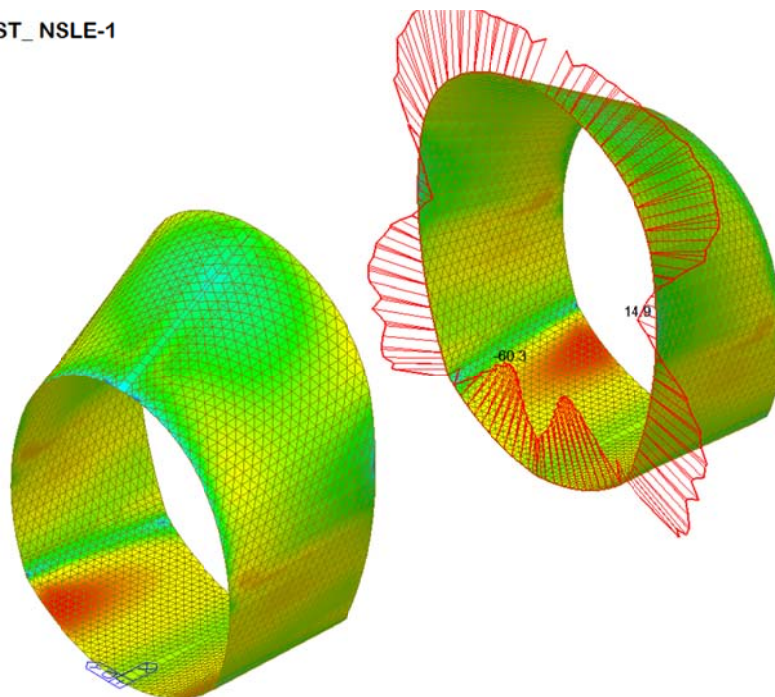


Plate force\_Myy / ST\_NSLE-1



A.5.3.15. Load combination SLE 2

Plate force\_Fxx / ST\_NSLE-2

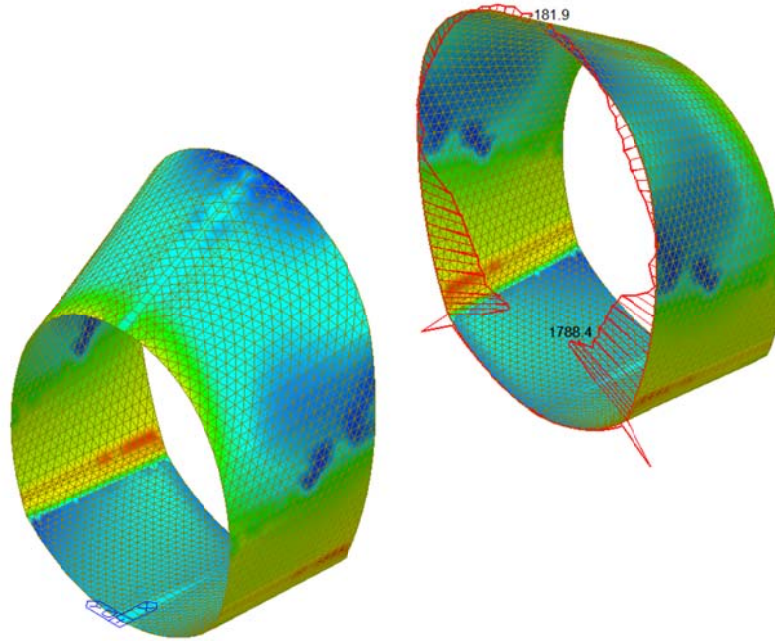


Plate force\_Fyy / ST\_NSLE-2

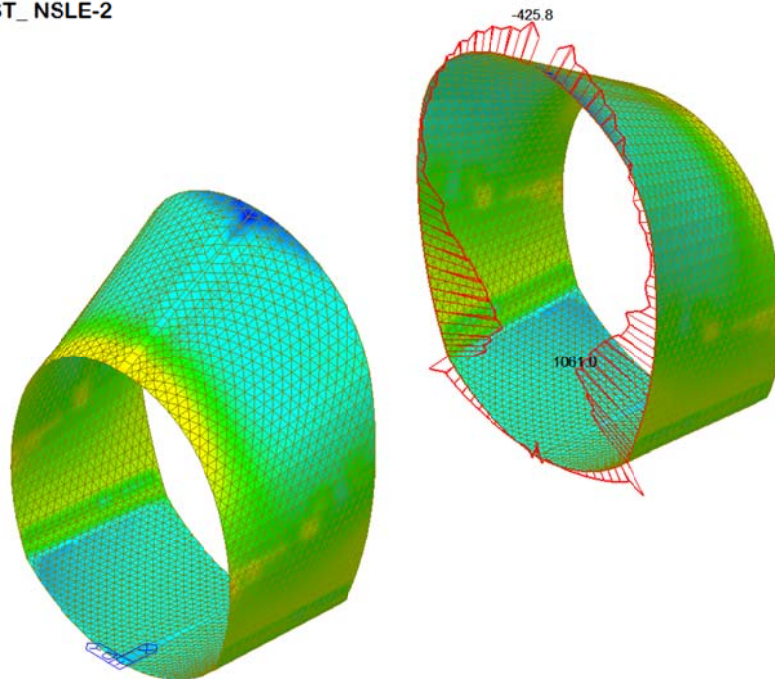




Plate force\_Mxx / ST\_NSLE-2

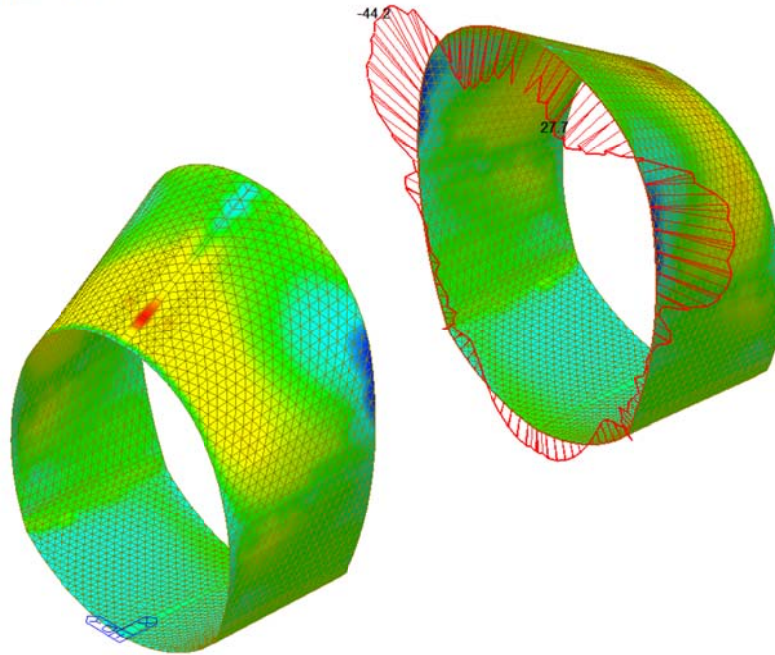
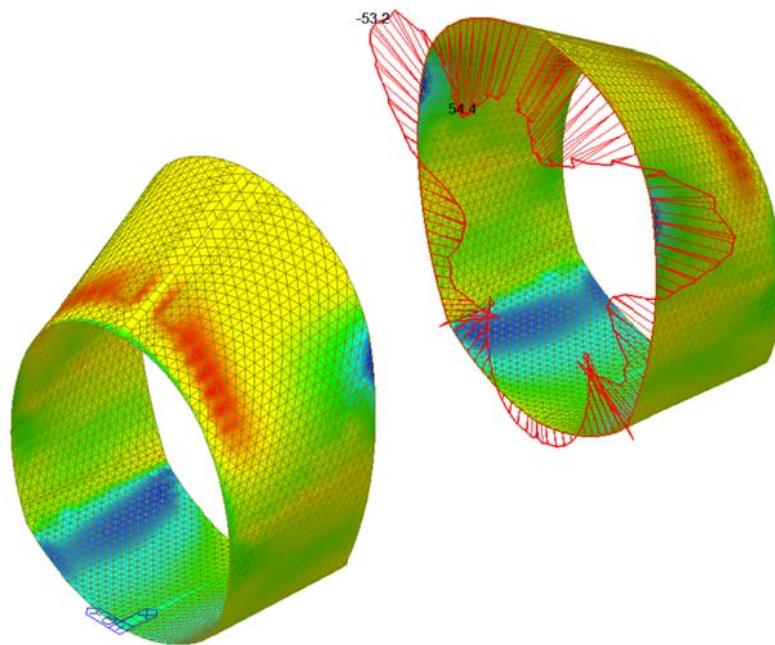


Plate force\_Myy / ST\_NSLE-2



A.5.3.16. Load combination SLE 3

Plate force\_Fxx / ST\_NSLE-3

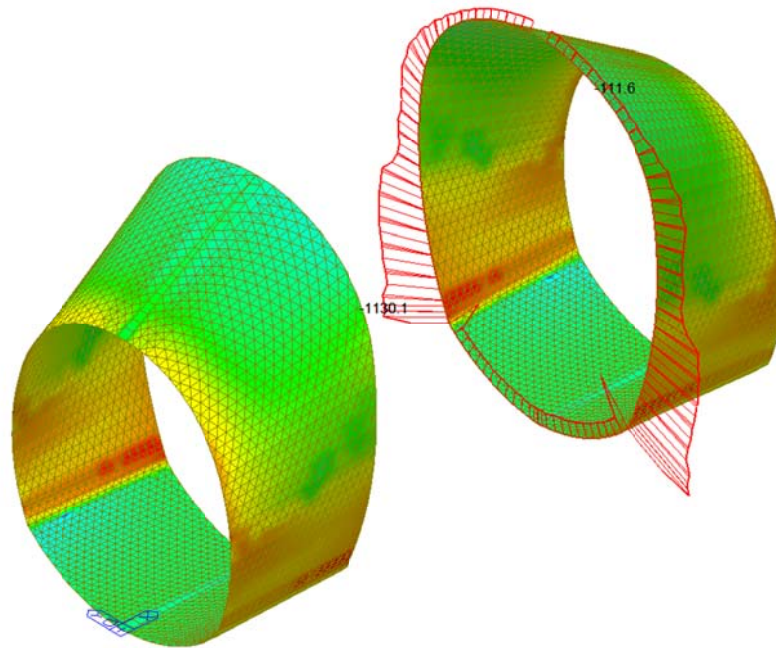


Plate force\_Fyy / ST\_NSLE-3

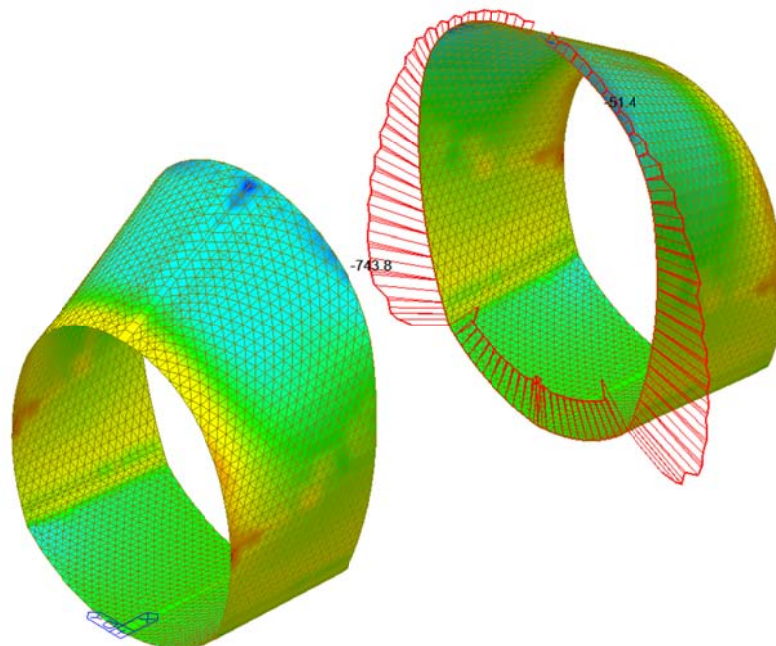
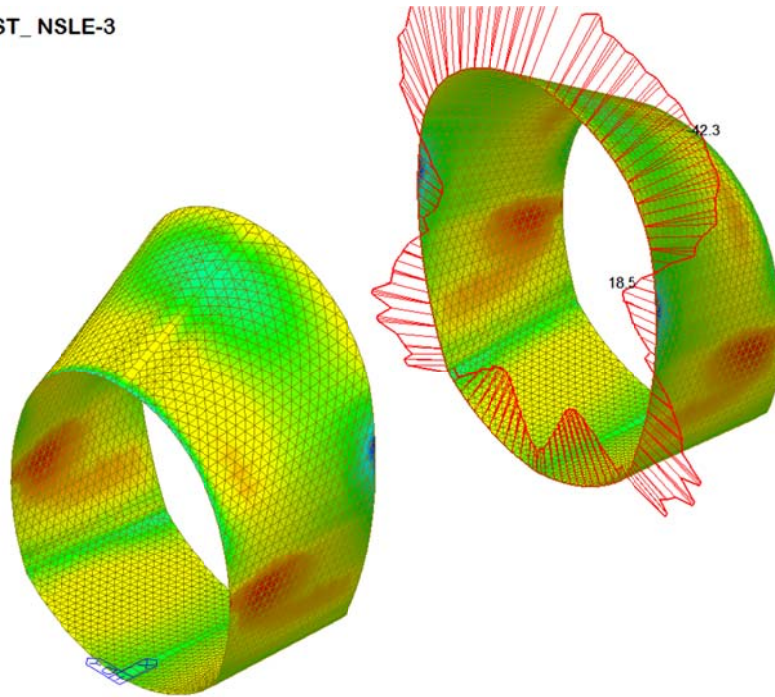


Plate force\_Mxx / ST\_NSLE-3



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

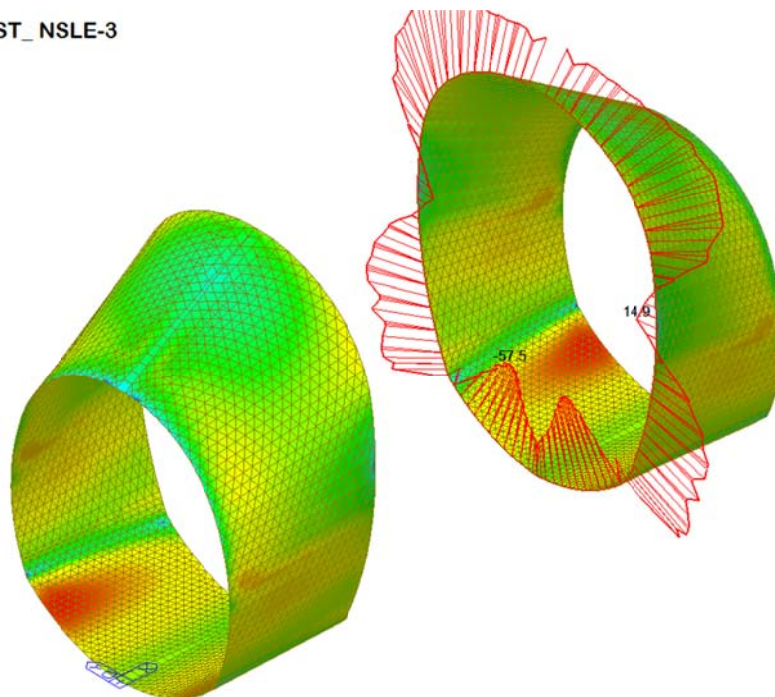
18.64
9.15
0.00
-9.84
-19.33
-28.82
-38.32
-47.81
-57.30
-66.79
-76.29
-85.78

ST: NSLE-3  
Avg Nodal Active-  
MAX : 2748  
MIN : 4979

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

Plate force\_Myy / ST\_NSLE-3



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

17.66
6.16
0.00
-16.85
-28.35
-39.86
-51.36
-62.86
-74.37
-85.87
-97.37
-108.88

ST: NSLE-3  
Avg Nodal Active-  
MAX : 1979  
MIN : 1772

FILE: FdE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.570  
Y: -0.622  
Z: 0.537

A.5.3.17. Load combination SLE 4

Plate force\_Fxx / ST\_NSLE-4

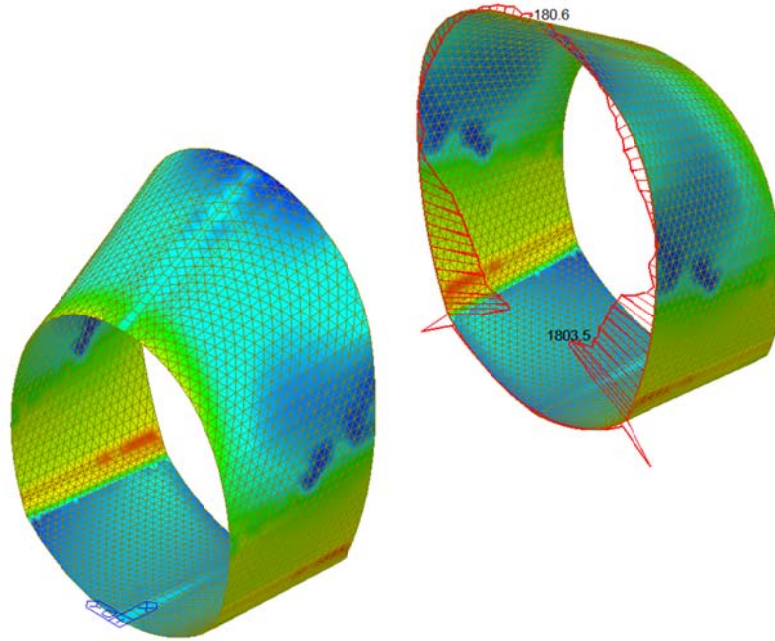


Plate force\_Fyy / ST\_NSLE-4

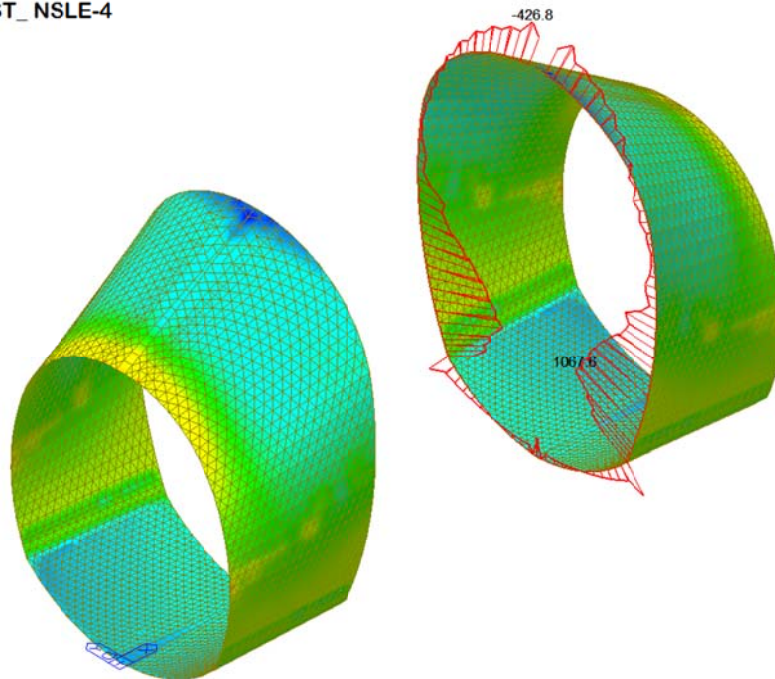


Plate force\_Mxx / ST\_NSLE-4

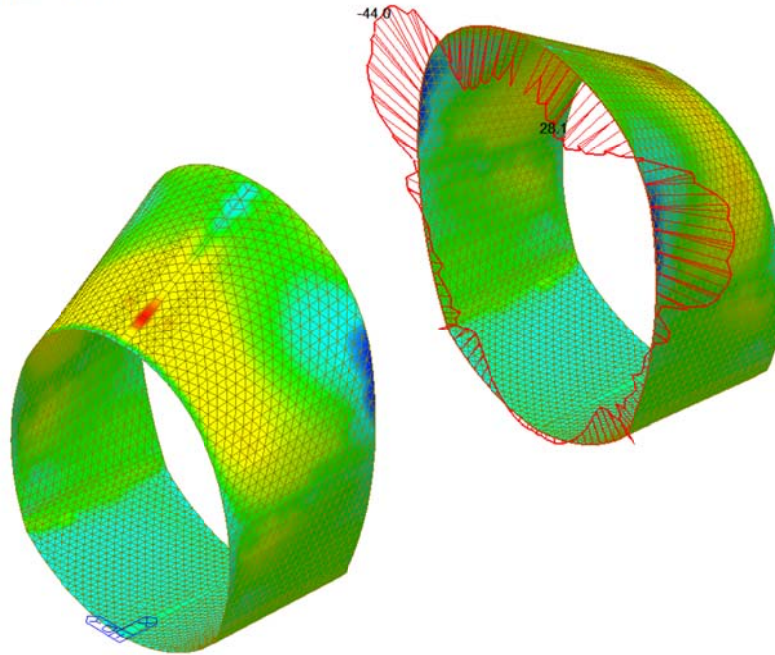
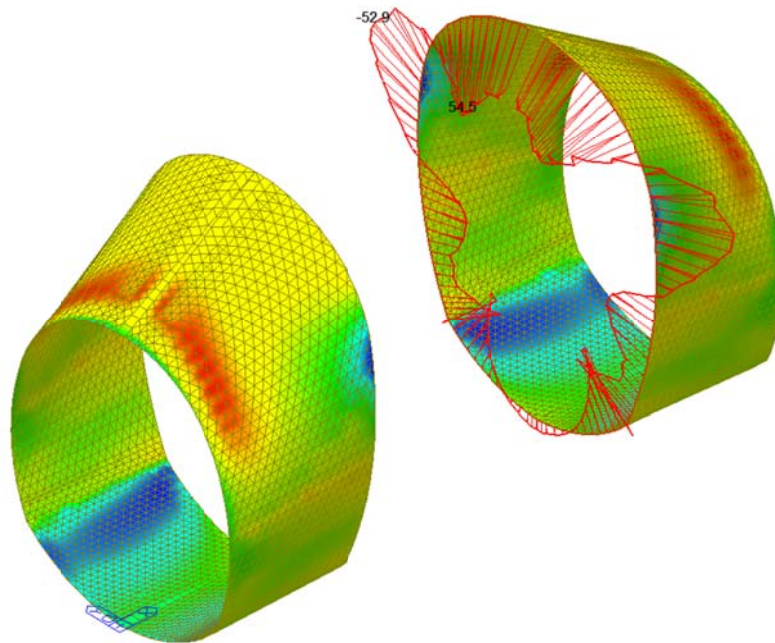


Plate force\_Myy / ST\_NSLE-4



A.5.3.18. Load combination SLE 5

Plate force\_Fxx / ST\_NSLE-5

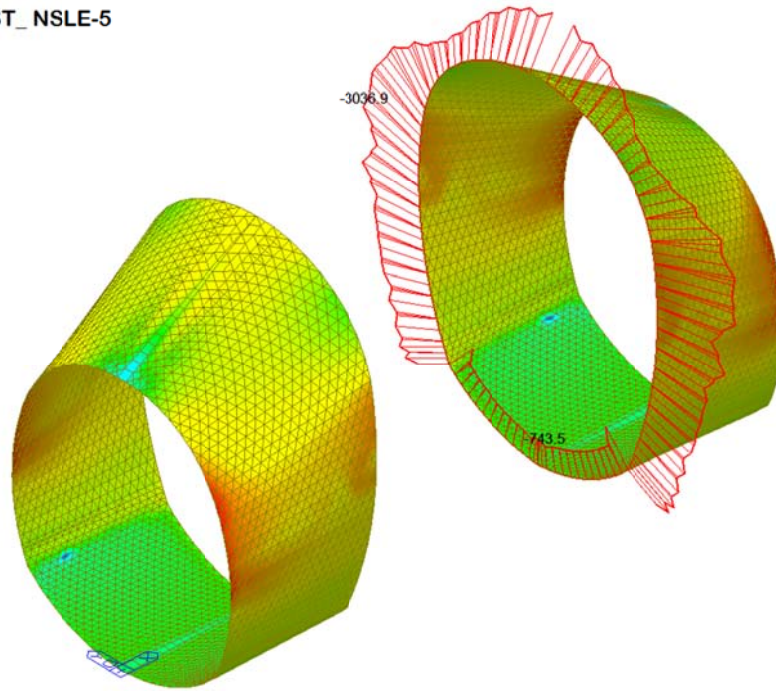


Plate force\_Fyy / ST\_NSLE-5

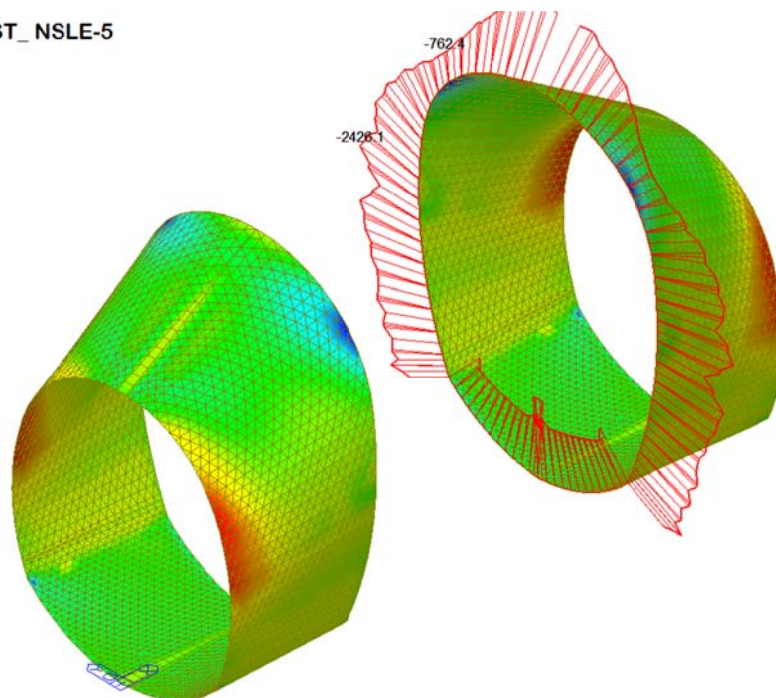


Plate force\_Mxx / ST\_NSLE-5

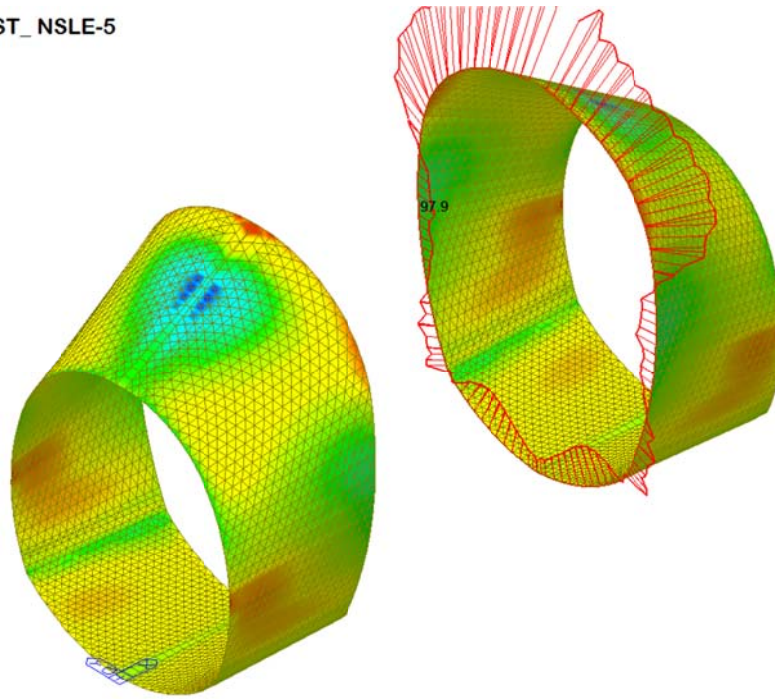
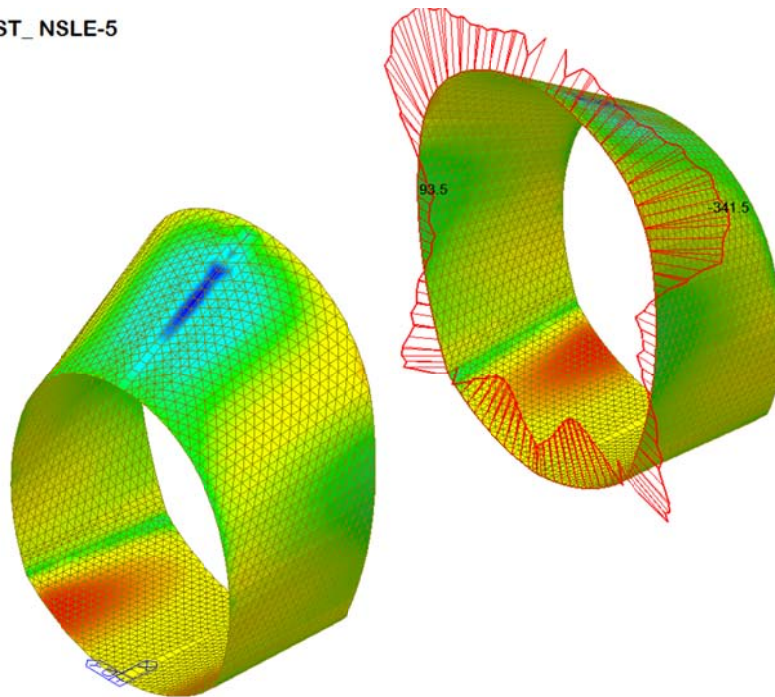


Plate force\_Myy / ST\_NSLE-5



A.5.3.19. Load combination SLE 6

Plate force\_Fxx / ST\_NSLE-6

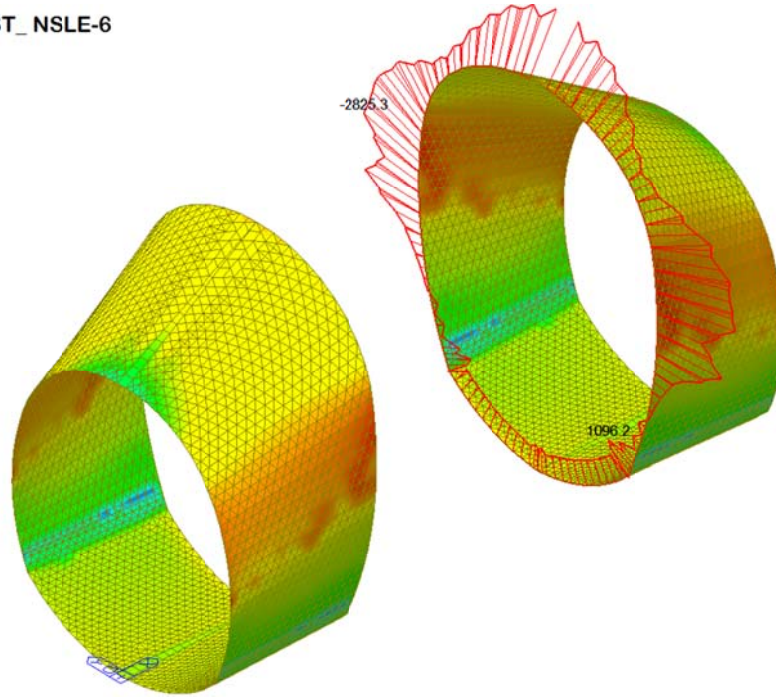


Plate force\_Fyy / ST\_NSLE-6

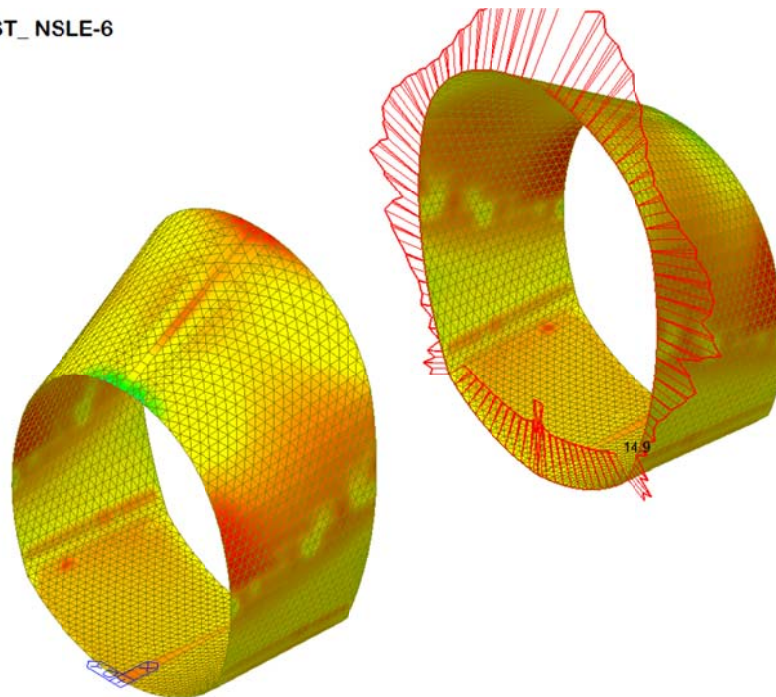




Plate force\_Mxx / ST\_NSLE-6

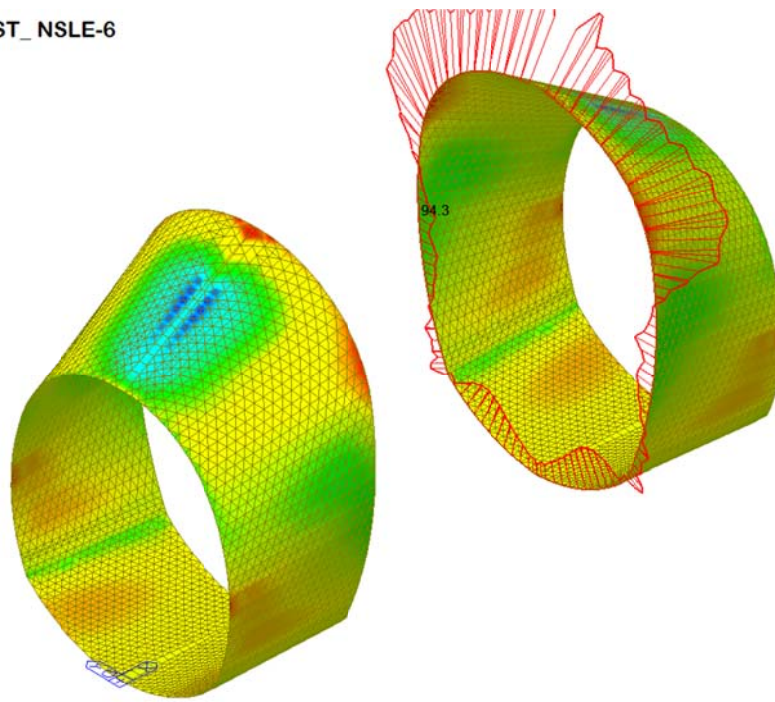
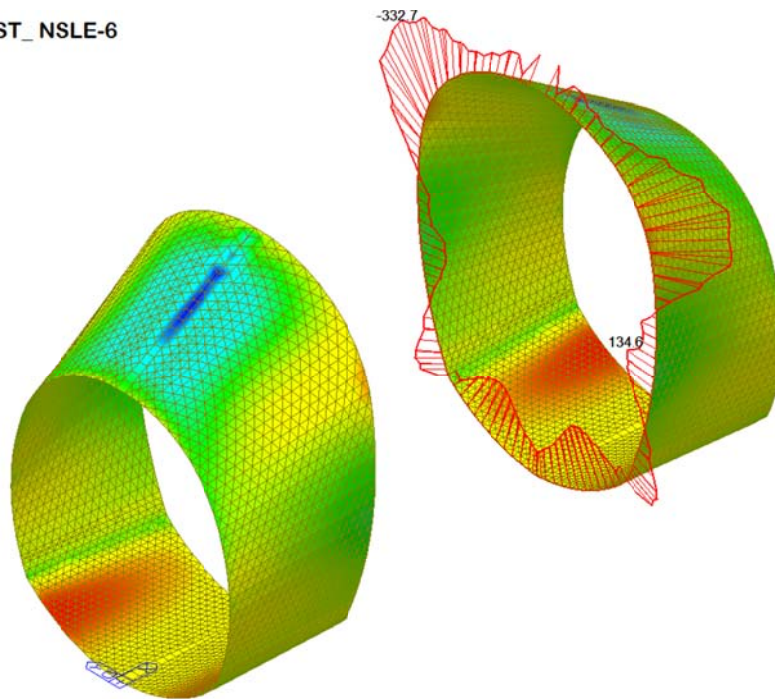


Plate force\_Myy / ST\_NSLE-6



A.5.3.20. Stress checking:

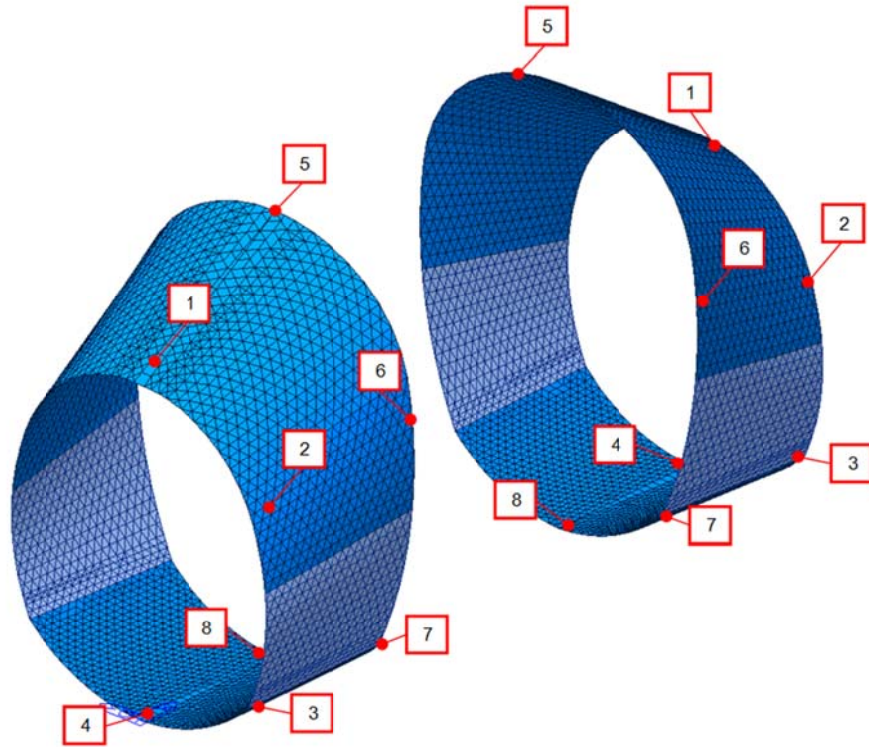


Figure 7 Numbering of sections checked

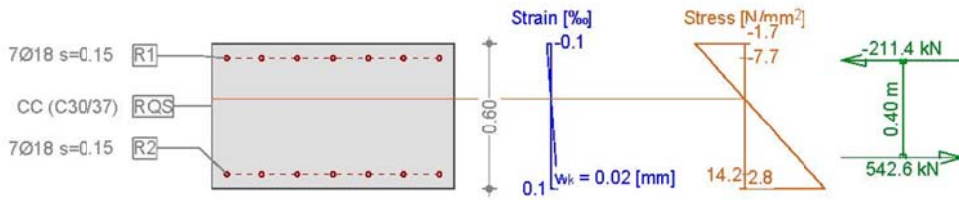
Spessore anello [cm]		60				Ø	90				Ø	120				Ø	120				Ø	
Sezioni		1				18/15 18/15	2				18/15 18/15	3				18/15 18/15	4				20/15 20/15	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	
SLE	1	-263.0	-53.2	-31.3	0.00	-863.9	-66.4	-58.8	0.00	-75.0	-32.5	26.7	0.00	-182.3	-15.4	10.9	0.00					
	2	508.6	102.4	67.6	0.02	786.6	16.8	76.2	0.00	19.2	-7.8	12.4	0.00	79.4	-5.7	3.0	0.00					
	3	-264.5	-53.5	-31.5	0.00	-857.2	-65.4	-59.0	0.00	-71.8	-31.6	25.8	0.00	-198.2	-14.3	10.6	0.00					
	4	507.9	102.2	67.4	0.02	800.4	17.3	77.1	0.00	14.7	-8.0	12.1	0.00	44.1	-5.2	3.8	0.00					
	5	-359.1	39.4	62.3	0.00	-3032.9	-240.5	-143.0	0.00	-341.6	-107.4	179.6	0.00	-698.8	-86.2	55.5	0.00					
	6	594.2	195.4	162.6	0.37	-1905.3	-181.2	25.0	0.00	-280.7	-94.6	171.6	0.00	-488.5	-81.0	51.4	0.00					

Spessore anello [cm]		60				Ø	90				Ø	120				Ø	120				Ø	
Sezioni		5				18/15 18/15	6				20/15 20/15	7				20/15 20/15	8				20/15 20/15	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	
SLE	1	-181.5	-43.5	-31.5	0.00	-1198.3	20.1	-41.3	0.00	-78.3	-9.1	0.0	0.00	-170.6	-19.6	-7.0	0.00					
	2	75.4	-9.4	-5.7	0.00	2213.9	-36.6	18.9	0.00	-204.9	-16.7	0.6	0.00	53.8	9.6	7.1	0.00					
	3	-177.2	-42.7	-30.6	0.00	-1194.7	20.3	-39.9	0.00	-88.4	-8.6	0.0	0.00	-186.4	-17.7	-7.2	0.00					
	4	79.0	-8.9	-5.2	0.00	2219.5	-34.8	20.3	0.00	-181.9	6.1	1.5	0.00	20.3	0.4	3.9	0.00					
	5	-1913.9	-399.1	-387.9	0.02	-1408.4	106.3	-136.3	0.00	-864.9	-35.4	2.5	0.00	-738.4	-88.7	-27.0	0.00					
	6	-1923.9	-368.9	-383.8	0.00	2052.7	62.0	-95.7	0.00	-987.1	-26.1	3.8	0.00	-571.5	-76.5	-21.7	0.00					

• SECTION 1

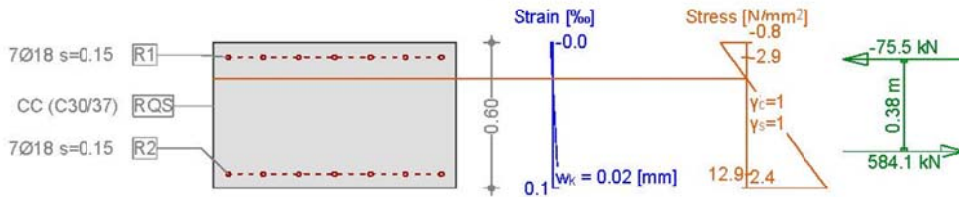
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-263.0; M_y=-53.2;$

Scale 1 :30.0



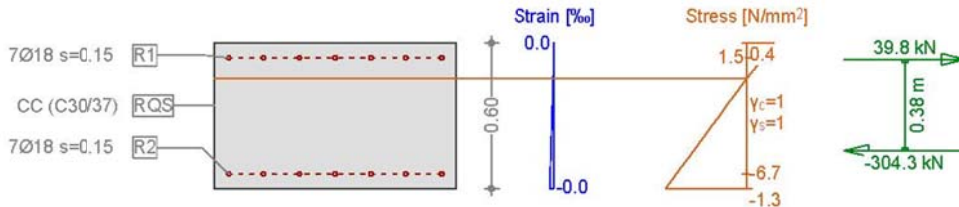
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=508.6; M_y=102.4;$

Scale 1 :30.0



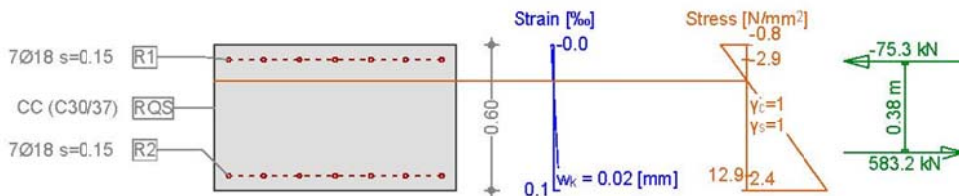
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-264.5; M_y=-53.5;$

Scale 1 :30.0



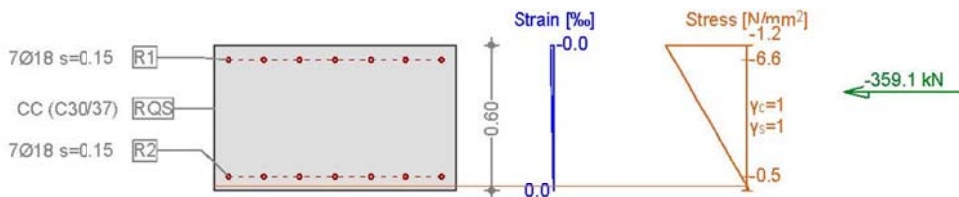
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=507.9; M_y=102.2;$

Scale 1 :30.0



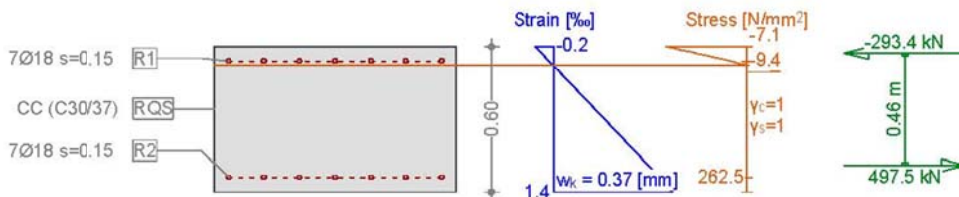
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-359.1; M_y=39.4;$

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=594.2; M_y=195.4;$

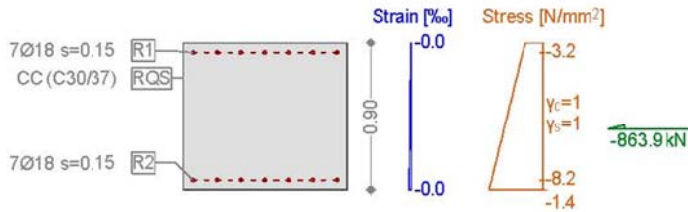
Scale 1 :30.0



• SECTION 2

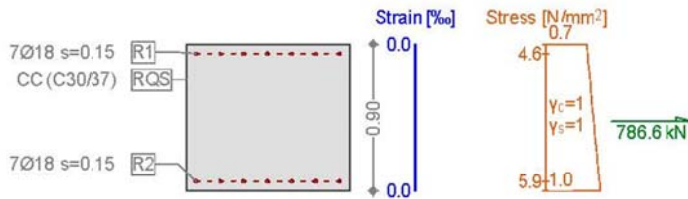
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-863.9$ ;  $M_y=66.4$ ;

Scale 1 :45.0



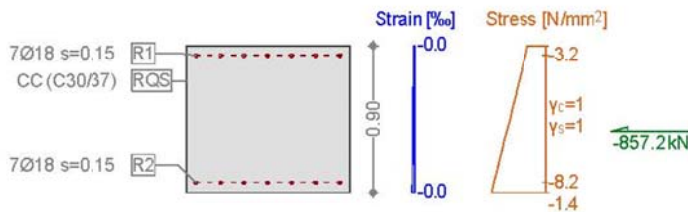
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=786.6$ ;  $M_y=16.8$ ;

Scale 1 :45.0



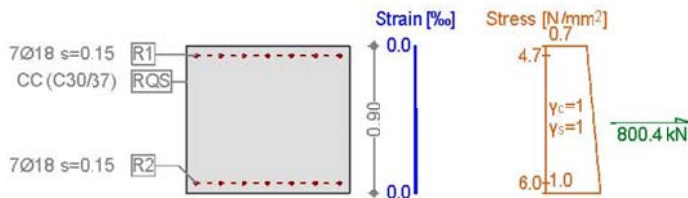
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-857.2$ ;  $M_y=65.4$ ;

Scale 1 :45.0



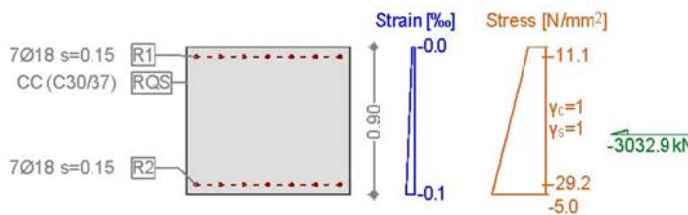
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=800.4$ ;  $M_y=17.3$ ;

Scale 1 :45.0



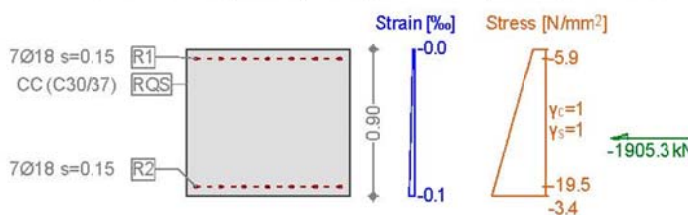
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3032.9$ ;  $M_y=240.5$ ;

Scale 1 :45.0



Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1905.3$ ;  $M_y=181.2$ ;

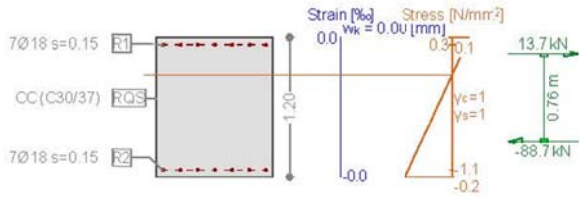
Scale 1 :45.0



- SECTION 3

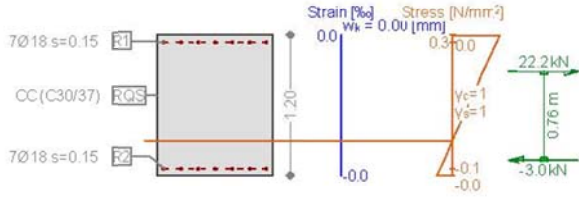
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-75.0;M_y=-32.5;$

Scale 1 :65.0



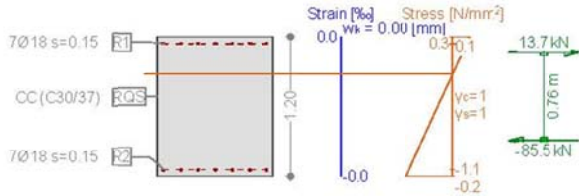
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=19.2;M_y=-7.8;$

Scale 1 :65.0



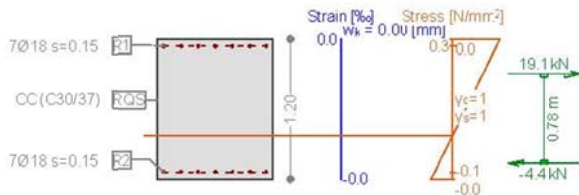
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-71.8;M_y=-31.6;$

Scale 1 :65.0



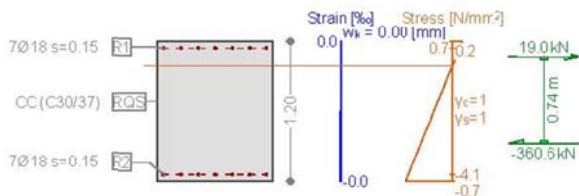
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=14.7;M_y=-8.0;$

Scale 1 :65.0



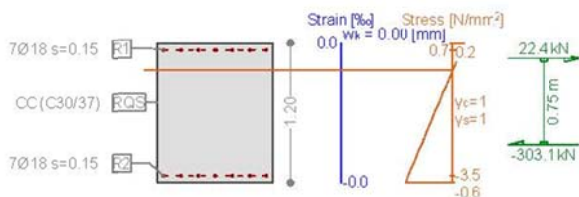
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-341.6;M_y=-107.4;$

Scale 1 :65.0



Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-280.7;M_y=-94.6;$

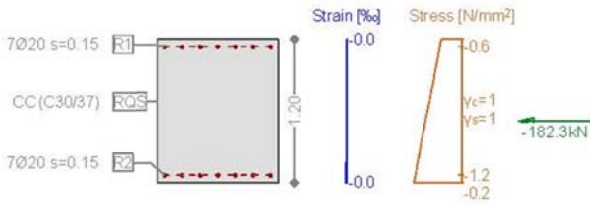
Scale 1 :65.0



- SECTION 4

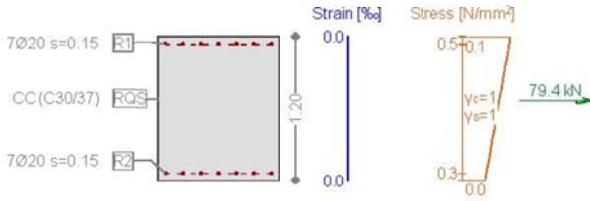
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-182.3$ ;  $M_y=-15.4$ ;

Scale 1 :65.0



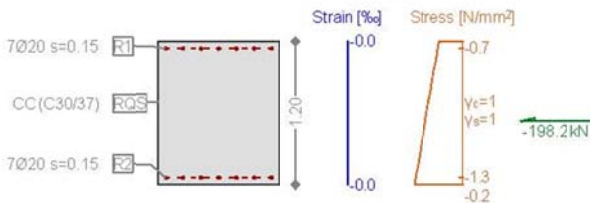
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=79.4$ ;  $M_y=-5.7$ ;

Scale 1 :65.0



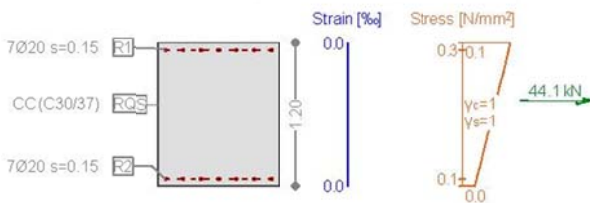
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-198.2$ ;  $M_y=-14.3$ ;

Scale 1 :65.0



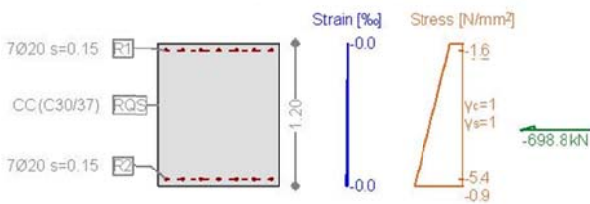
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=44.1$ ;  $M_y=-5.2$ ;

Scale 1 :65.0



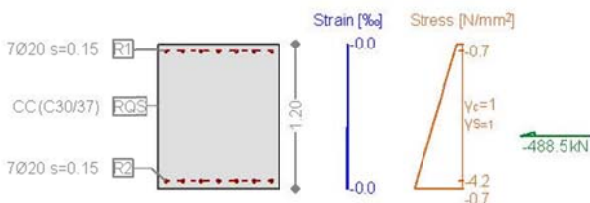
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-698.8$ ;  $M_y=-86.2$ ;

Scale 1 :65.0



Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-488.5$ ;  $M_y=-81.0$ ;

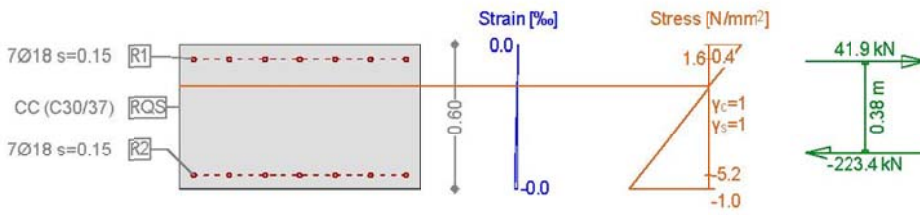
Scale 1 :65.0



- SECTION 5

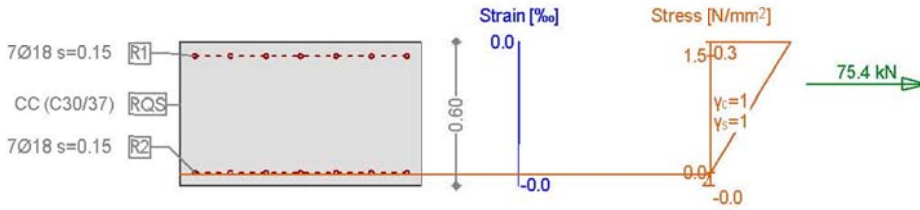
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-181.5; M_y=-43.5;$

Scale 1 :30.0



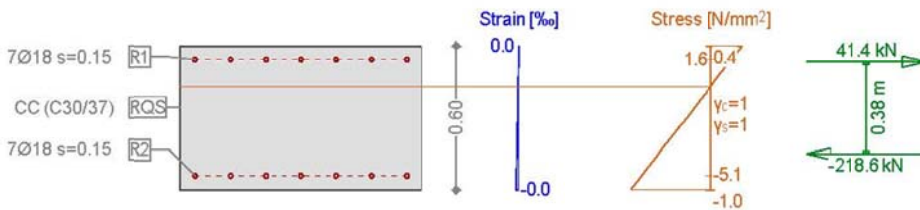
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=75.4; M_y=-9.4;$

Scale 1 :30.0



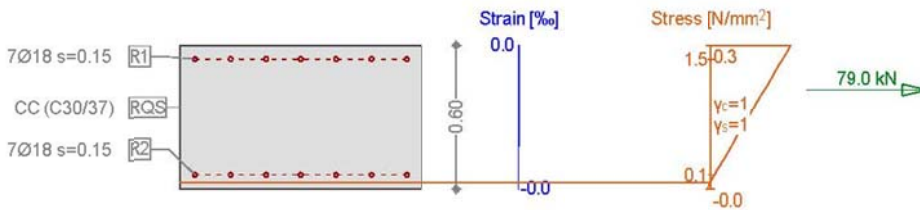
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-177.2; M_y=-42.7;$

Scale 1 :30.0



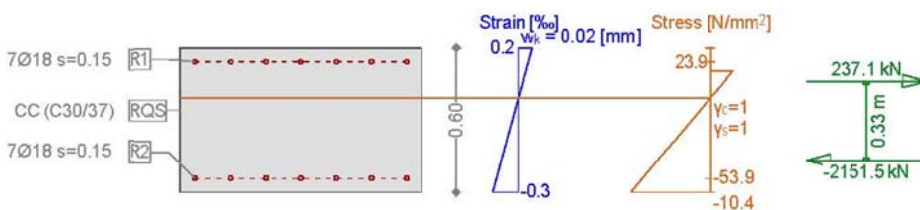
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=79.0; M_y=-8.9;$

Scale 1 :30.0



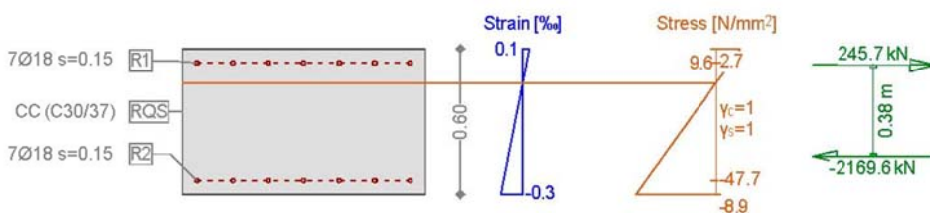
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1913.9; M_y=-399.1;$

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1923.9; M_y=-368.9;$

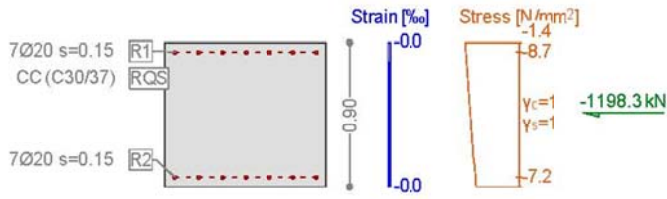
Scale 1 :30.0



- SECTION 6

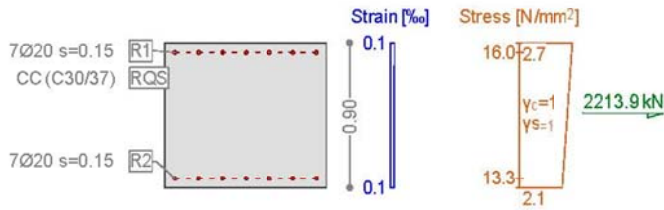
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1198.3;M_y=20.1$ ;

Scale 1 :45.0



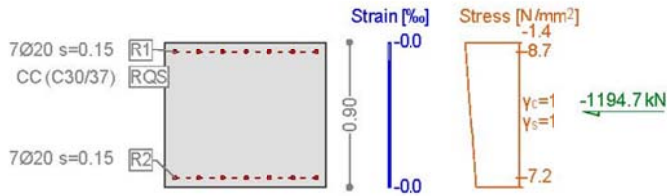
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=2213.9;M_y=-36.6$ ;

Scale 1 :45.0



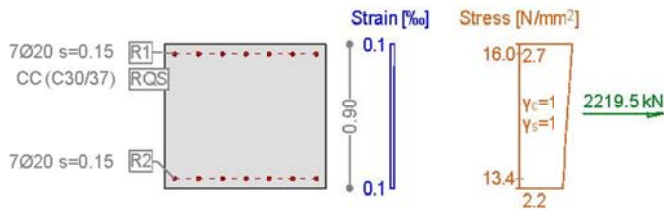
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1194.7;M_y=20.3$ ;

Scale 1 :45.0



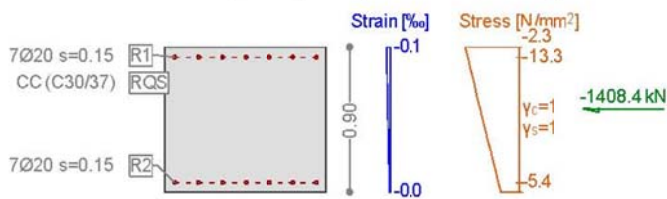
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=2219.5;M_y=-34.8$ ;

Scale 1 :45.0



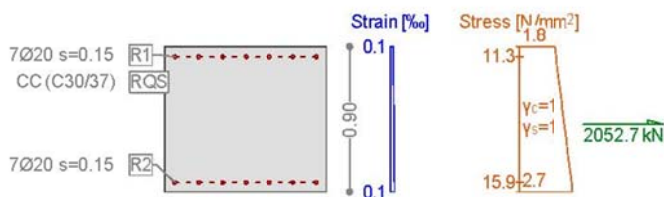
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1408.4;M_y=106.3$ ;

Scale 1 :45.0



Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=2052.7;M_y=62.0$ ;

Scale 1 :45.0

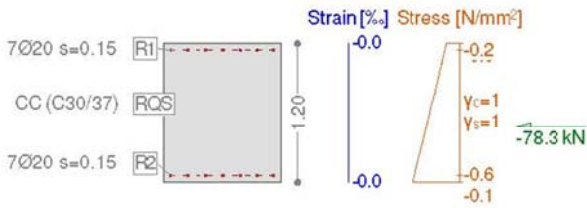




- SECTION 7

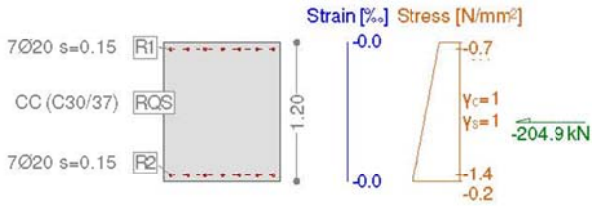
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-78.3$ ;  $M_y=-9.1$ ;

Scale 1 :65.0



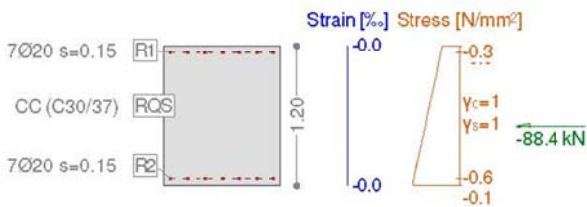
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-204.9$ ;  $M_y=-16.7$ ;

Scale 1 :65.0



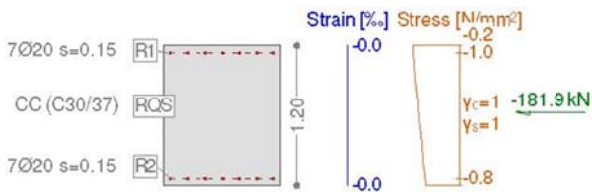
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-88.4$ ;  $M_y=-8.6$ ;

Scale 1 :65.0



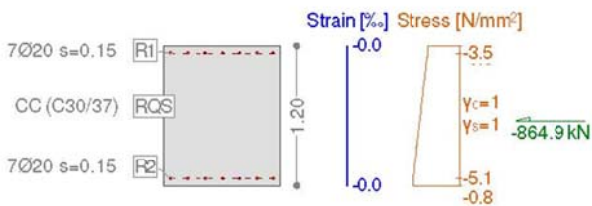
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-181.9$ ;  $M_y=6.1$ ;

Scale 1 :65.0



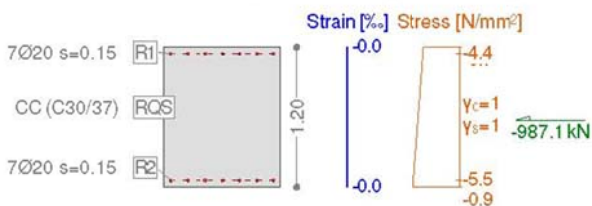
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-864.9$ ;  $M_y=-35.4$ ;

Scale 1 :65.0



Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-987.1$ ;  $M_y=-26.1$ ;

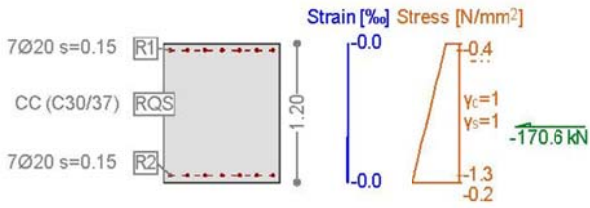
Scale 1 :65.0



- SECTION 8**

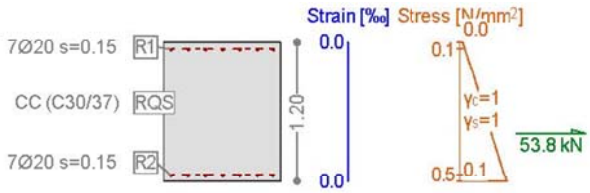
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-170.6$ ;  $M_y=-19.6$ ;

Scale 1 :65.0



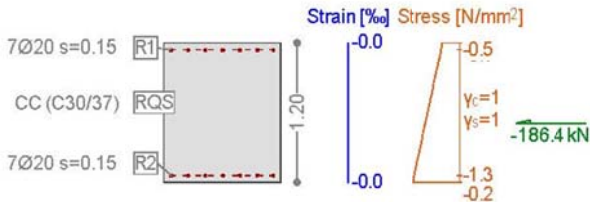
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=53.8$ ;  $M_y=9.6$ ;

Scale 1 :65.0



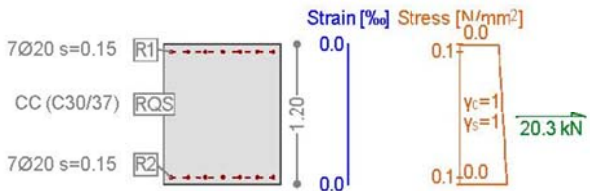
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-186.4$ ;  $M_y=-17.7$ ;

Scale 1 :65.0



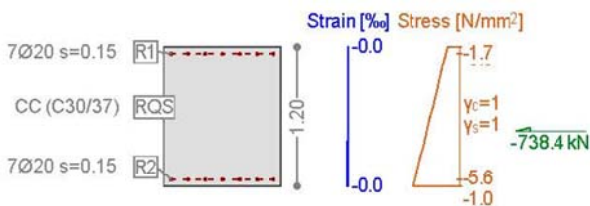
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=20.3$ ;  $M_y=0.4$ ;

Scale 1 :65.0



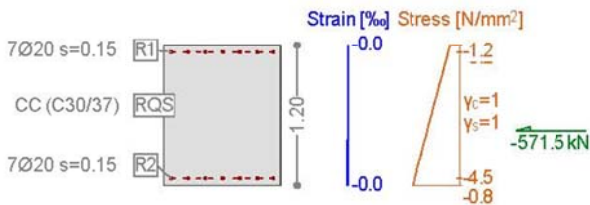
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-738.4$ ;  $M_y=-88.7$ ;

Scale 1 :65.0



Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-571.5$ ;  $M_y=-76.5$ ;

Scale 1 :65.0



## A.5.4. Output and check result for cross section FdE-V-T4/FdE-Va-T4

### A.5.4.1. Load combination SLU 1

Plate force\_Fxx / ST\_N2

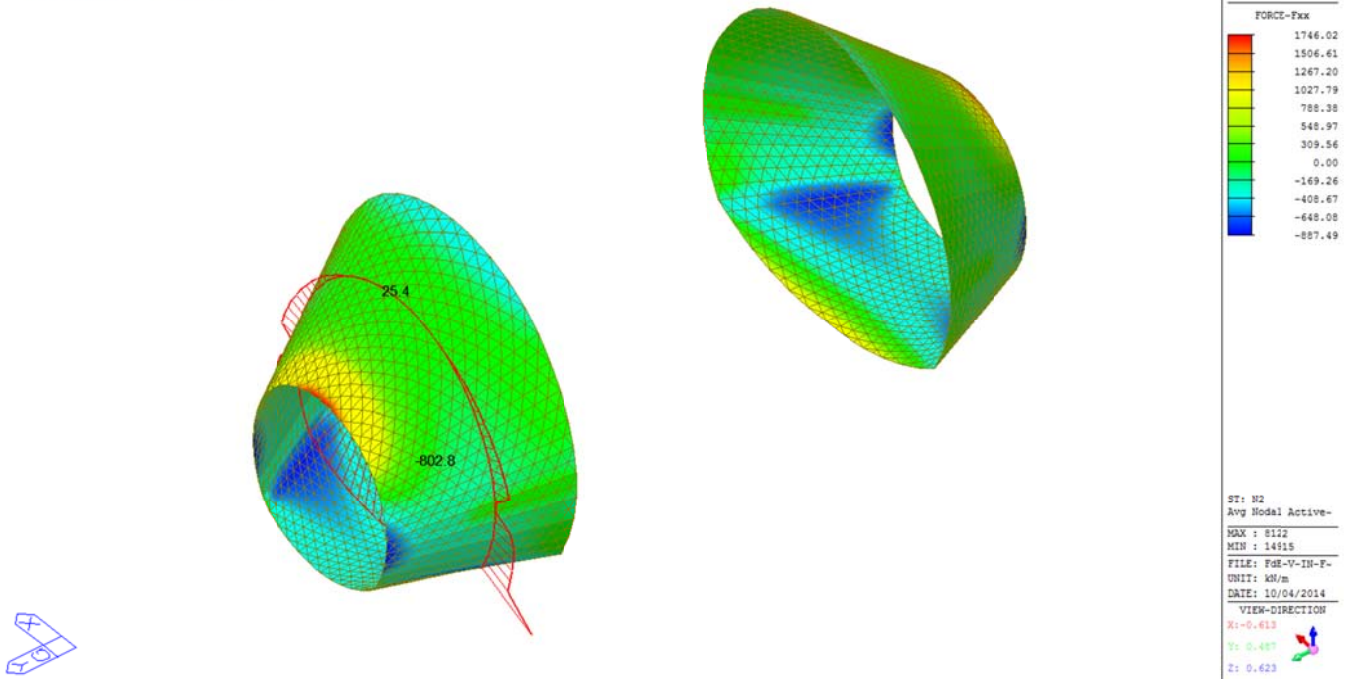


Plate force\_Fyy / ST\_N1

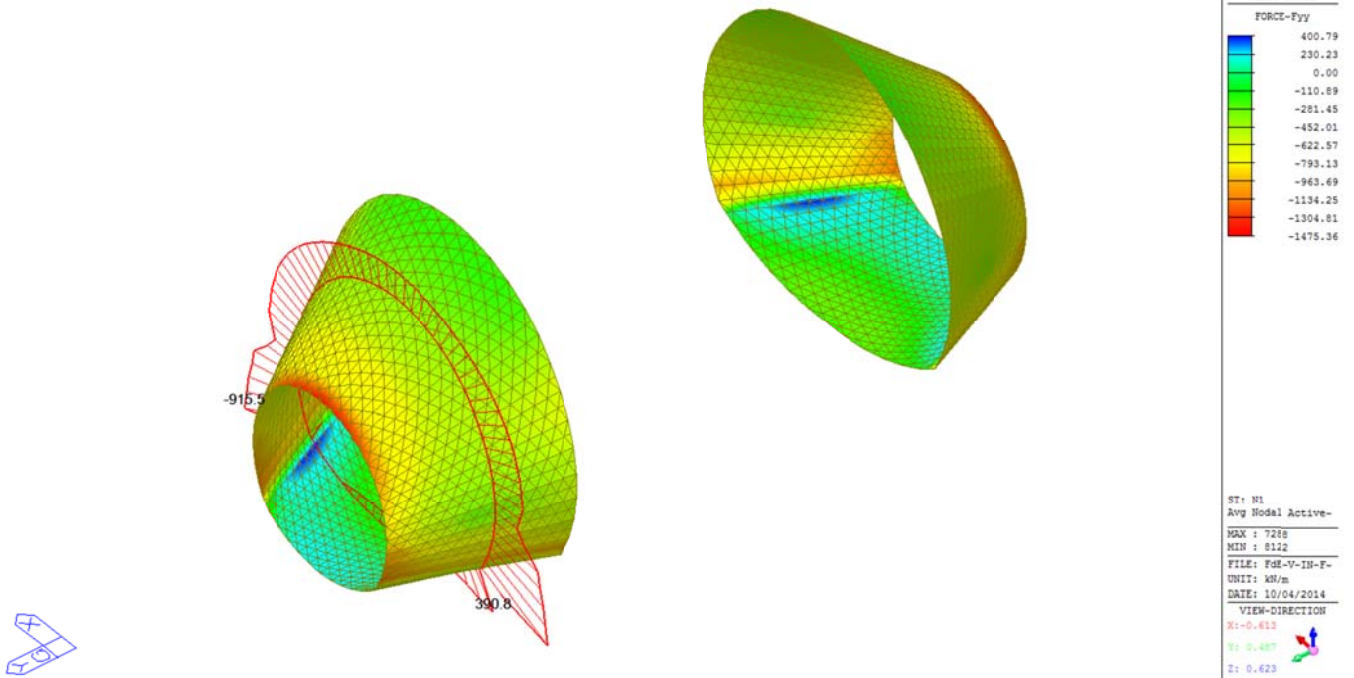
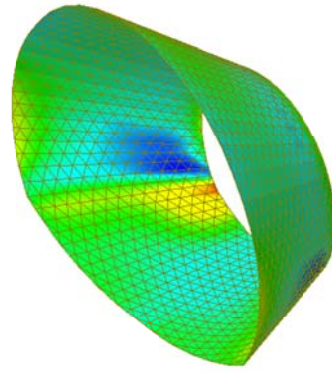
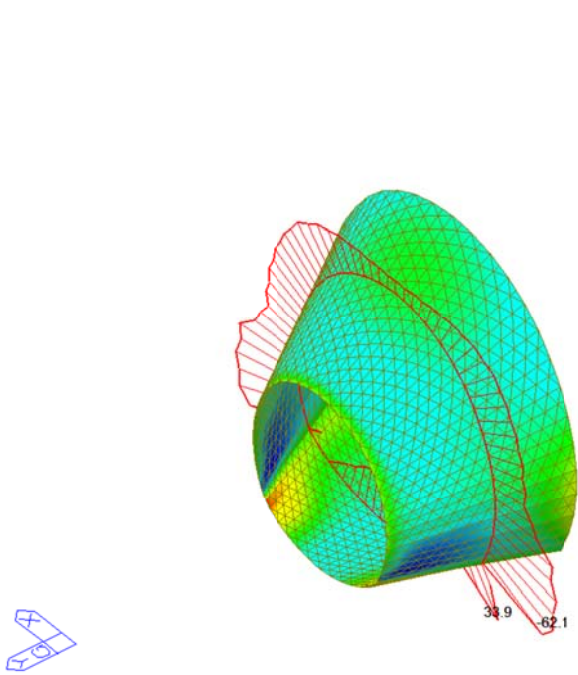


Plate force\_Mxx / ST\_N1

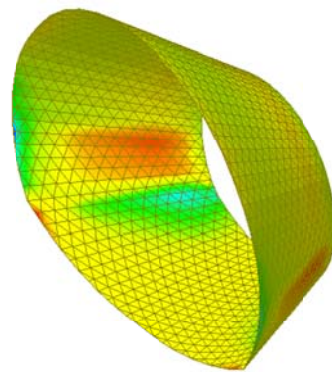
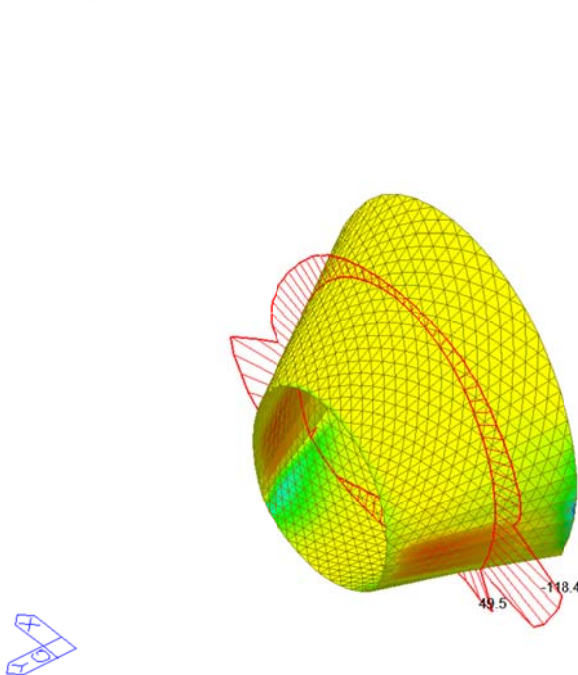


midas Gen POST-PROCESSOR	
PLATE FORCE	
MOMENT-Mxx	
169.41	
144.34	
119.26	
94.18	
69.10	
44.02	
18.94	
0.00	
-31.22	
-56.30	
-81.38	
-106.46	

ST: N1
Avg Nodal Active-
MAX : 8471
MIN : 8522
FILE: F02-V-IN-F-
UNIT: kN*m/m
DATE: 10/04/2014
VIEW-DIRECTION
X: -0.613
Y: 0.487
Z: 0.623

Plate force\_Myy / ST\_N1

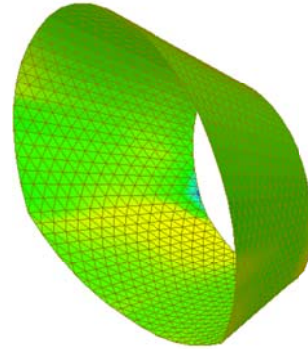
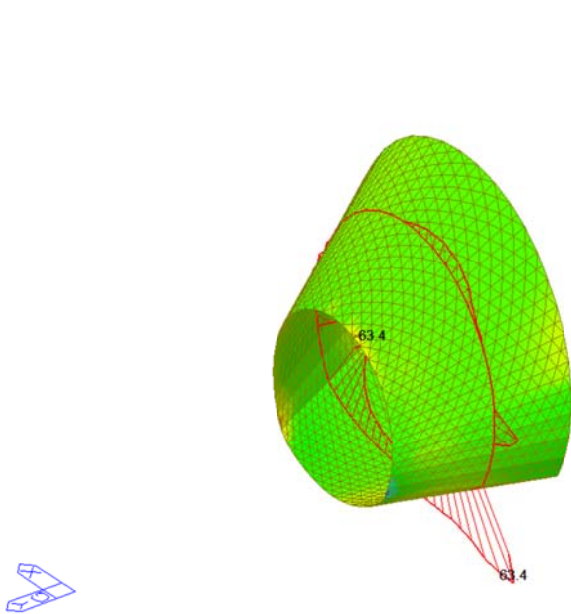


midas Gen POST-PROCESSOR	
PLATE FORCE	
MOMENT-Myy	
137.30	
107.21	
77.13	
47.05	
16.96	
0.00	
-43.21	
-73.29	
-103.37	
-133.46	
-163.54	
-193.62	

ST: N1
Avg Nodal Active-
MAX : 7438
MIN : 8417
FILE: F02-V-IN-F-
UNIT: kN*m/m
DATE: 10/04/2014
VIEW-DIRECTION
X: -0.613
Y: 0.487
Z: 0.623

Plate force\_Vxx / ST\_N1

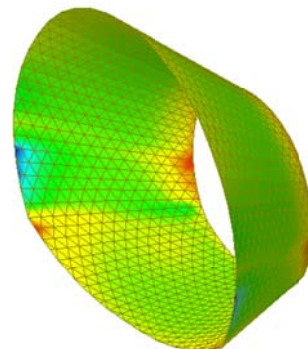
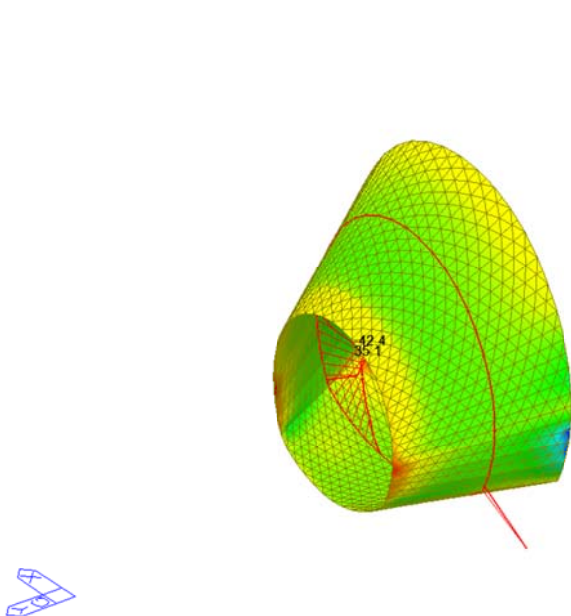


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
623.44	
510.09	
396.74	
283.39	
170.04	
56.69	
0.00	
-170.02	
-283.37	
-396.72	
-510.07	
-623.42	

ST: N1	
Avg Modal Active-	
MAX : 8529	
MIN : 15886	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.696	
Y: 0.325	
Z: 0.500	

Plate force\_Vyy / ST\_N1



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
255.24	
197.15	
139.07	
60.99	
0.00	
-35.18	
-93.26	
-151.34	
-209.43	
-267.51	
-325.59	
-383.68	

ST: N1	
Avg Modal Active-	
MAX : 7438	
MIN : 7265	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.696	
Y: 0.325	
Z: 0.500	

A.5.4.2. Load combination SLU 2

Plate force\_Fxx / ST\_N2

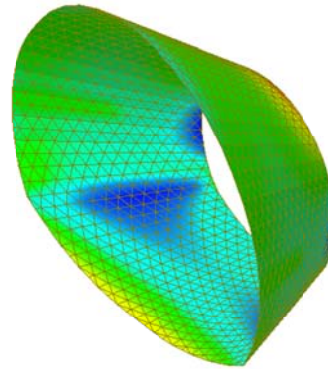
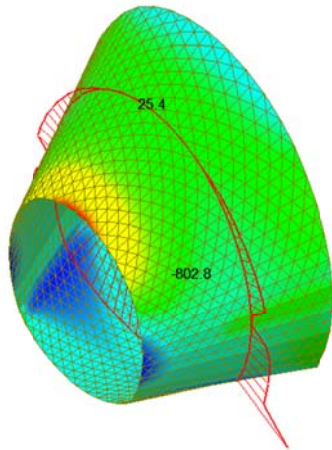


Plate force\_Fyy / ST\_N2

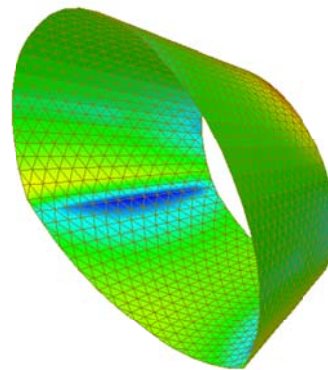
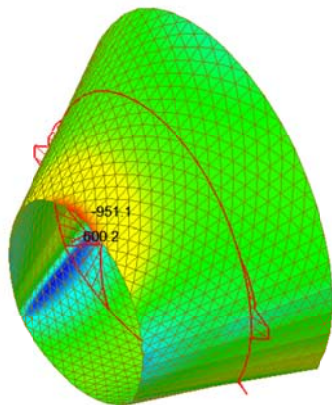
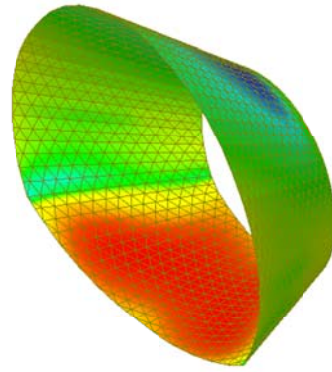
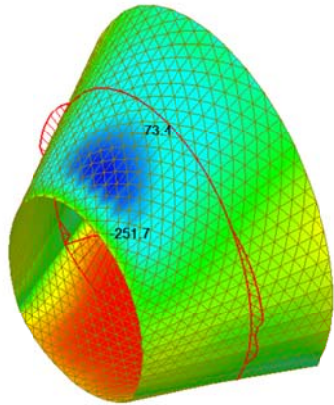


Plate force\_Mxx / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

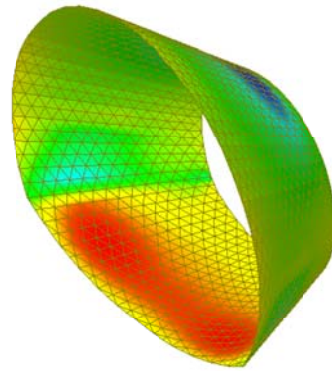
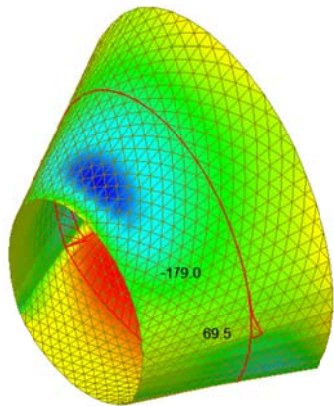
MOMENT-Mxx

100.20
68.16
36.12
0.00
-27.97
-60.01
-92.06
-124.10
-156.15
-188.19
-220.23
-252.28

ST: N2  
Avg Nodal Active-  
MAX : 8114  
MIN : 15420  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

Plate force\_Myy / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

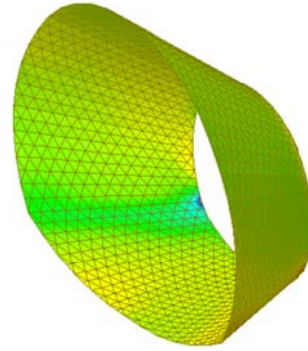
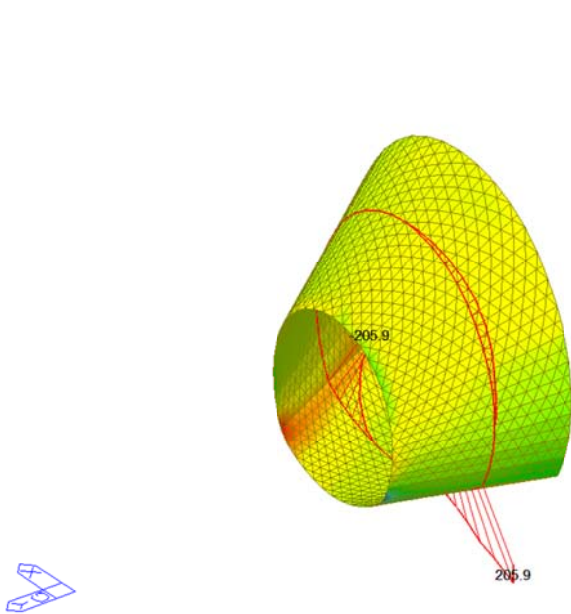
MOMENT-Myy

112.13
82.99
53.85
24.71
0.00
-33.56
-62.70
-91.84
-120.98
-150.12
-179.26
-208.39

ST: N2  
Avg Nodal Active-  
MAX : 8114  
MIN : 7156  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

Plate force\_Vxx / ST\_N2

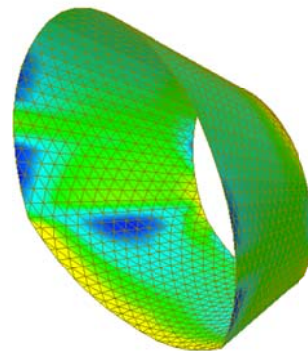
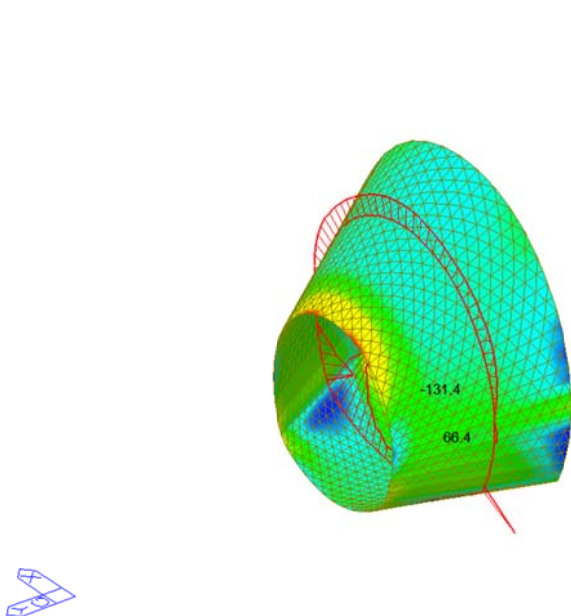


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
367.69	
300.84	
233.98	
167.13	
100.27	
0.00	
-33.43	
-100.29	
-167.14	
-234.00	
-300.85	
-367.70	

ST: N2
Avg Modal Active-
MAX : 15127
MIN : 8470
FILE: FdL-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.694
Y: 0.325
Z: 0.500

Plate force\_Vyy / ST\_N2



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
305.27	
263.83	
222.39	
180.94	
139.50	
98.06	
56.62	
0.00	
-26.27	
-67.71	
-109.15	
-150.59	

ST: N2
Avg Modal Active-
MAX : 7959
MIN : 7280
FILE: FdL-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.694
Y: 0.325
Z: 0.500



A.5.4.3. Load combination SLU 3

Plate force\_Fxx / ST\_N3

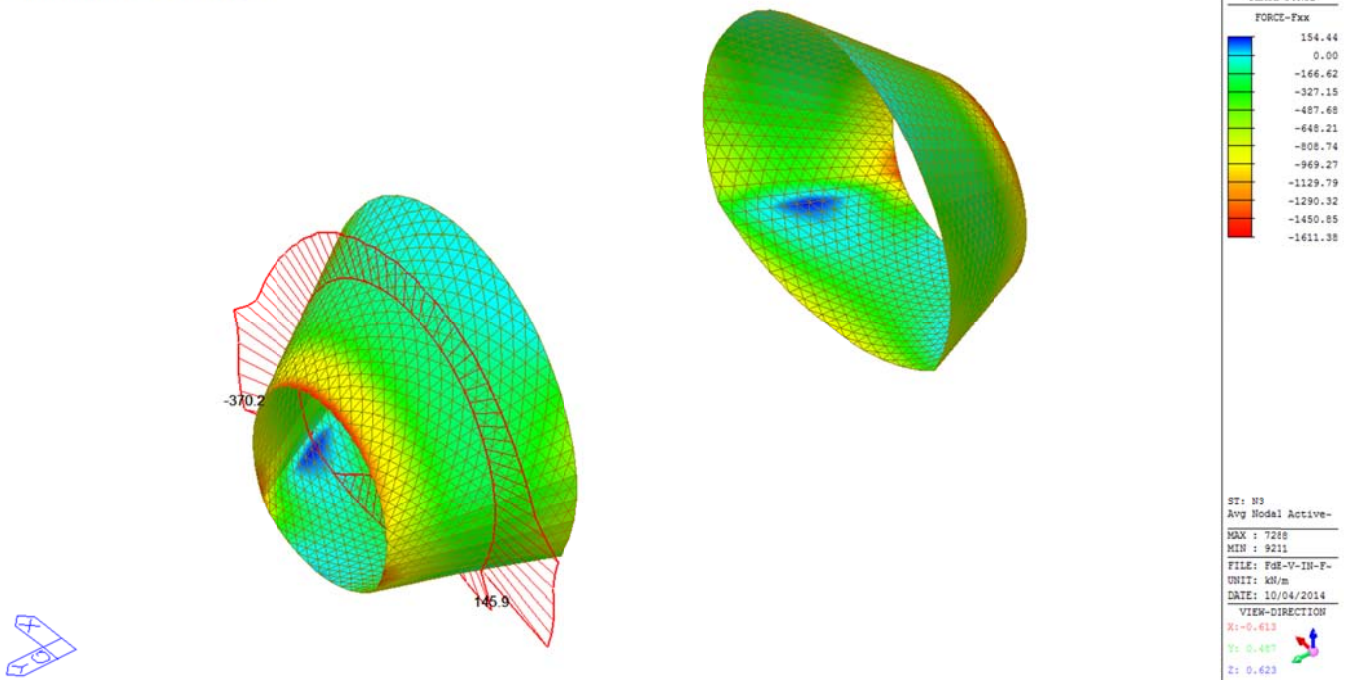


Plate force\_Fyy / ST\_N3

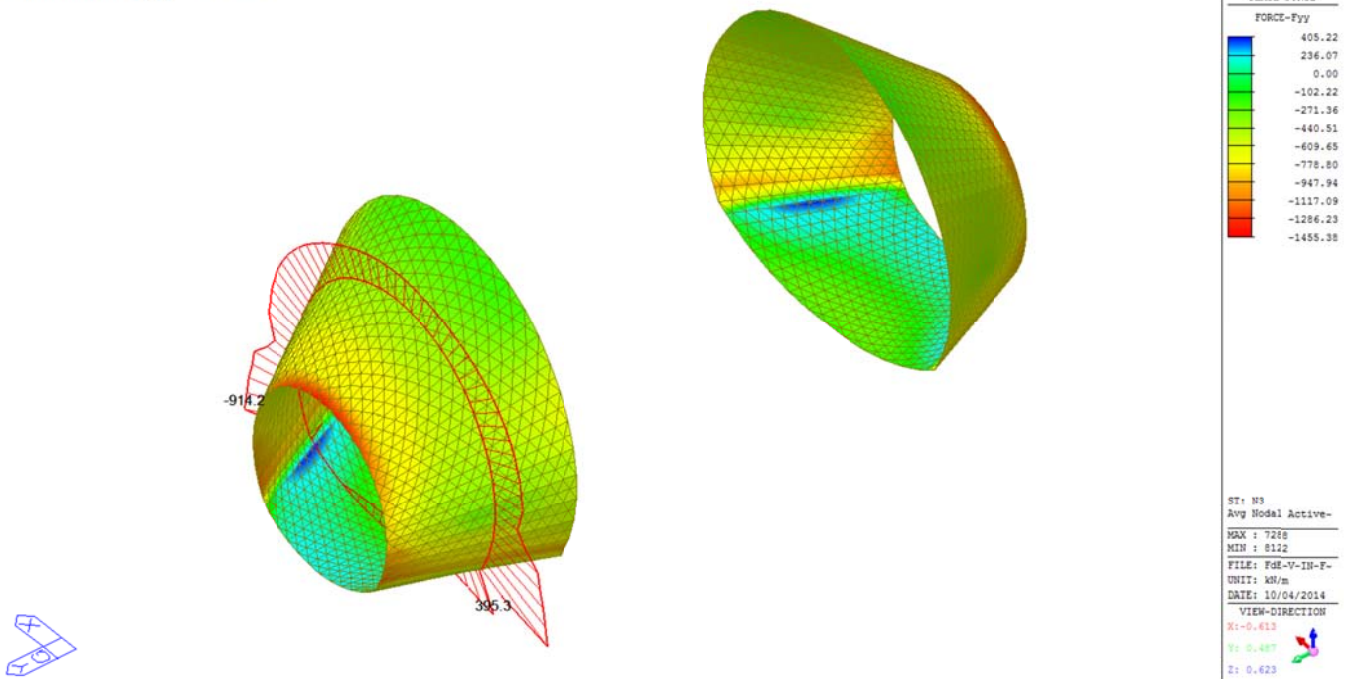
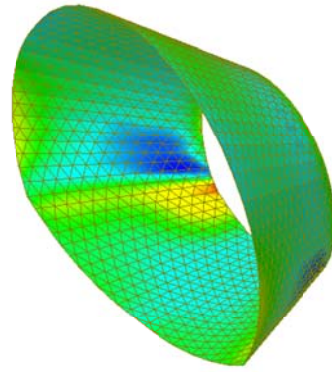
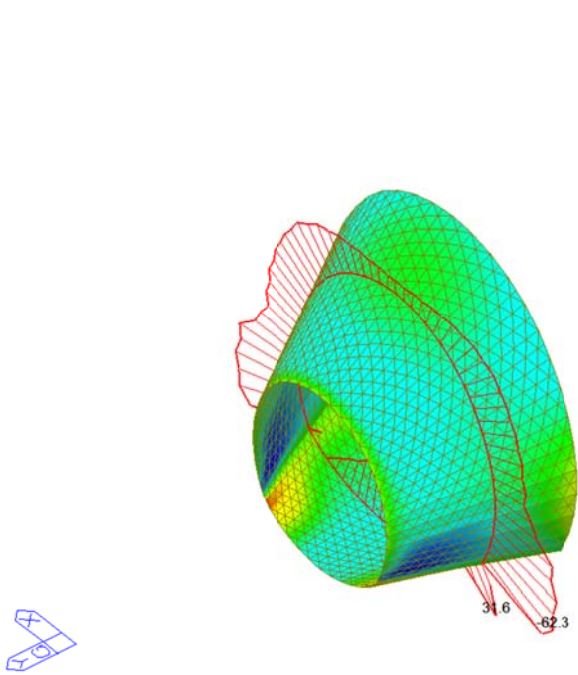


Plate force\_Mxx / ST\_N3

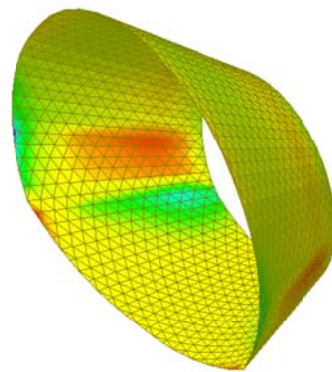
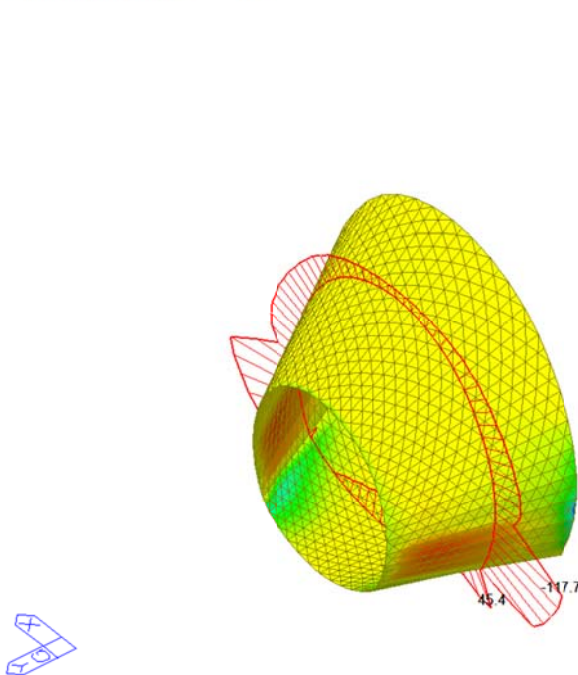


midas Gen POST-PROCESSOR	
PLATE FORCE	
MOMENT-Mxx	
167.30	
142.43	
117.55	
92.67	
67.80	
42.92	
18.04	
0.00	
-31.71	
-56.58	
-81.46	
-106.34	

ST: N3
Avg Nodal Active-
MAX : 8471
MIN : 8522
FILE: F02-V-IN-F-
UNIT: kN*m/m
DATE: 10/04/2014
VIEW-DIRECTION
X: -0.613
Y: 0.487
Z: 0.623

Plate force\_Myy / ST\_N3

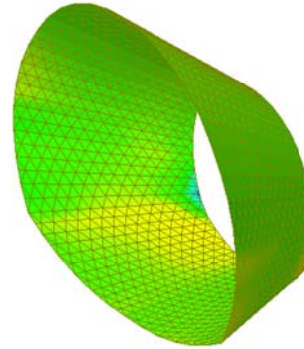
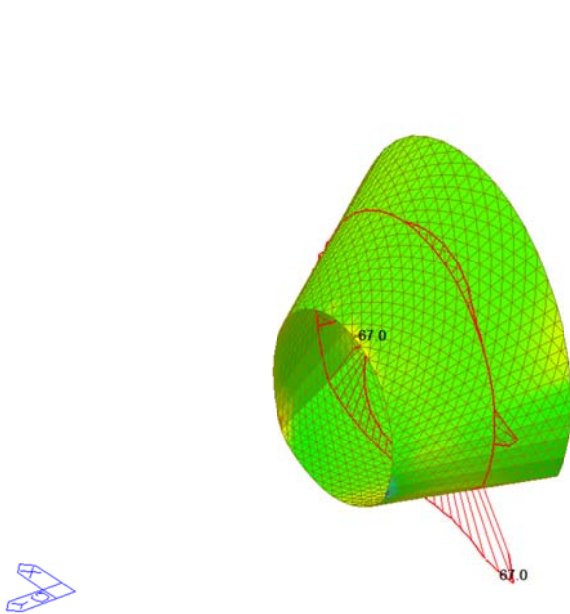


midas Gen POST-PROCESSOR	
PLATE FORCE	
MOMENT-Myy	
137.86	
108.08	
78.29	
48.51	
18.73	
0.00	
-40.84	
-70.62	
-100.41	
-130.19	
-159.97	
-189.76	

ST: N3
Avg Nodal Active-
MAX : 7438
MIN : 8417
FILE: F02-V-IN-F-
UNIT: kN*m/m
DATE: 10/04/2014
VIEW-DIRECTION
X: -0.613
Y: 0.487
Z: 0.623

Plate force\_Vxx / ST\_N3

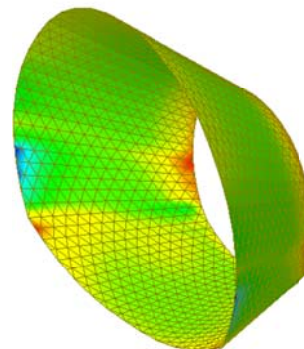
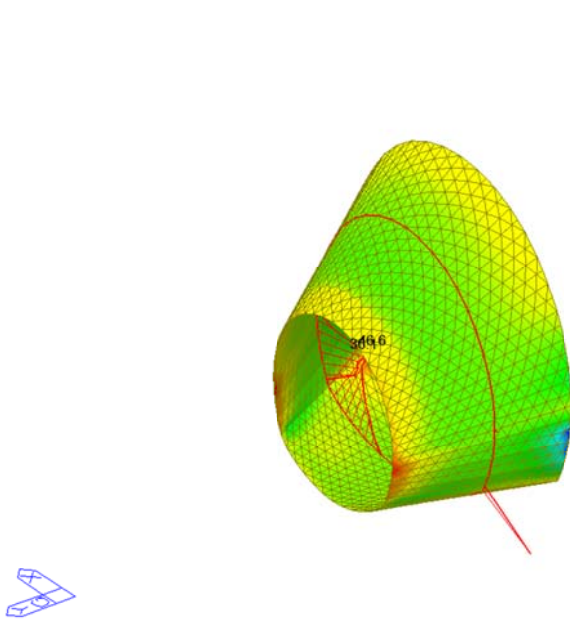


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
615.60	
503.67	
391.75	
279.82	
167.90	
55.97	
0.00	
-167.88	
-279.80	
-391.73	
-503.65	
-615.58	

ST: N3	
Avg Modal Active-	
MAX : 8529	
MIN : 15886	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.694	
Y: 0.325	
Z: 0.500	

Plate force\_Vyy / ST\_N3



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
254.21	
197.23	
140.25	
83.27	
0.00	
-30.69	
-87.67	
-144.65	
-201.63	
-258.61	
-315.59	
-372.57	

ST: N3	
Avg Modal Active-	
MAX : 7438	
MIN : 7265	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.694	
Y: 0.325	
Z: 0.500	

A.5.4.4. Load combination SLU 4

Plate force\_Fxx / ST\_N4

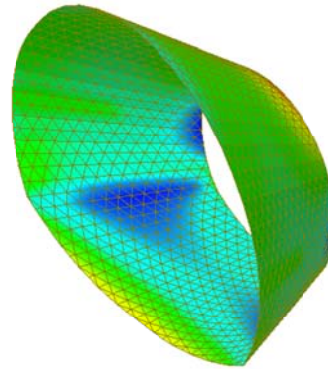
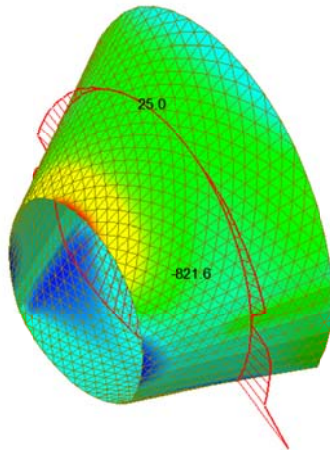


Plate force\_Fyy / ST\_N4

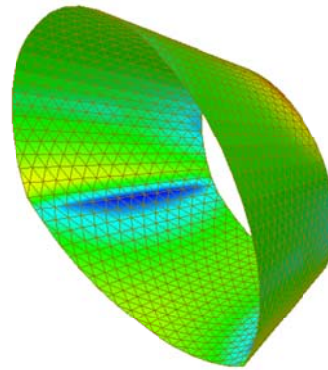
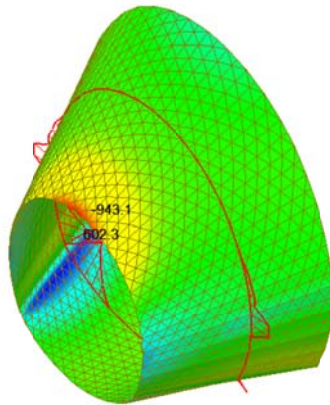
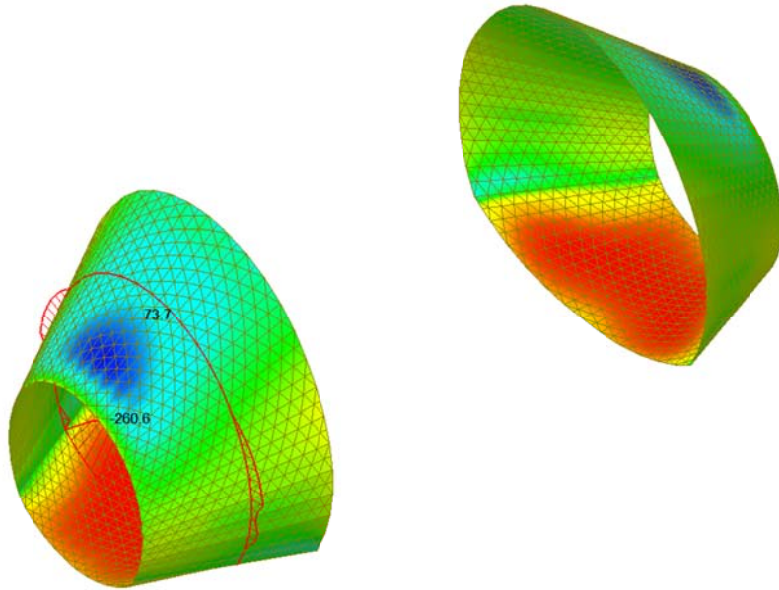


Plate force\_Mxx / ST\_N4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

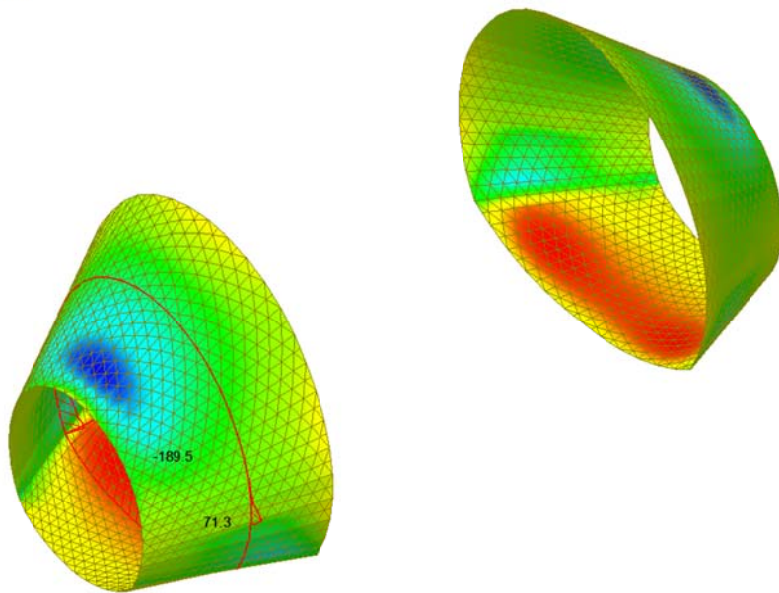
101.48
68.53
35.57
0.00
-30.33
-63.28
-96.24
-129.19
-162.14
-195.10
-228.05
-261.00

ST: N4  
Avg Nodal Active-  
MAX : 8114  
MIN : 15420  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623



Plate force\_Myy / ST\_N4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

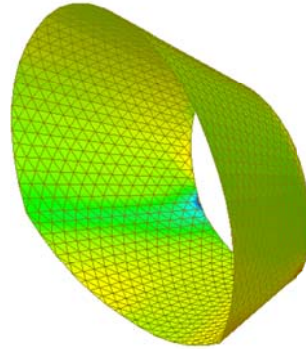
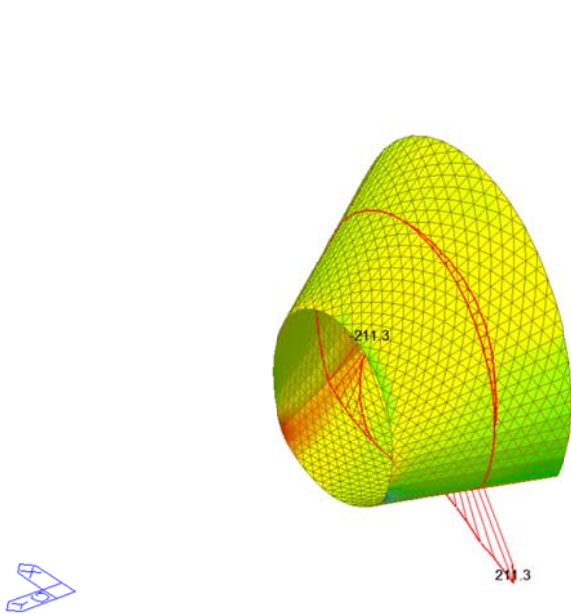
113.78
83.49
53.21
22.92
0.00
-37.64
-67.93
-98.21
-128.49
-158.78
-189.06
-219.35

ST: N4  
Avg Nodal Active-  
MAX : 8114  
MIN : 7156  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

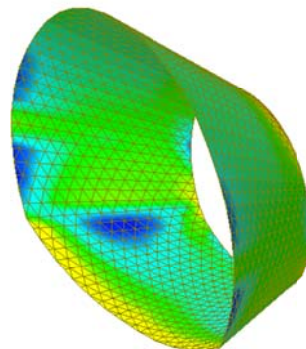
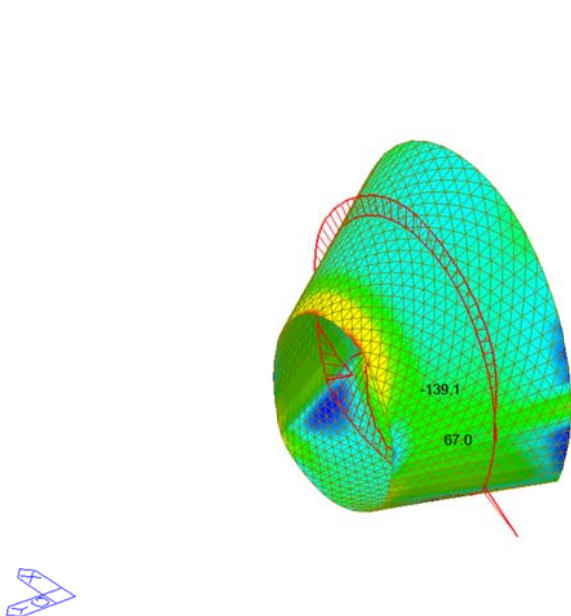


Plate force\_Vxx / ST\_N4



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
	379.40
	310.41
	241.43
	172.45
	103.47
	0.00
	-34.50
	-103.48
	-172.46
	-241.44
	-310.43
	-379.41
ST: N4	
Avg Modal Active-	
MAX :	15127
MIN :	8470
FILE :	FdL-V-IN-F-
UNIT :	kN/m
DATE :	10/06/2014
VIEW-DIRECTION	
X :	-0.694
Y :	0.325
Z :	0.500

Plate force\_Vyy / ST\_N4



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
	308.33
	266.47
	224.61
	182.76
	140.90
	99.04
	57.18
	0.00
	-26.54
	-68.40
	-110.26
	-152.12
ST: N4	
Avg Modal Active-	
MAX :	7959
MIN :	7280
FILE :	FdL-V-IN-F-
UNIT :	kN/m
DATE :	10/06/2014
VIEW-DIRECTION	
X :	-0.694
Y :	0.325
Z :	0.500

A.5.4.5. Load combination SLU 5

Plate force\_Fxx / ST\_N5

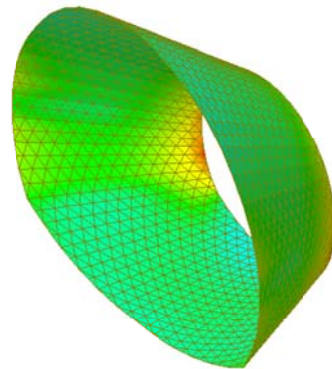
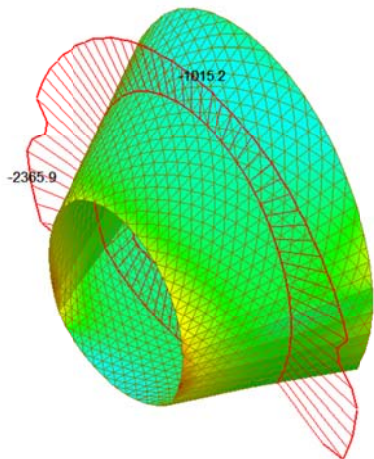


Plate force\_Fyy / ST\_N5

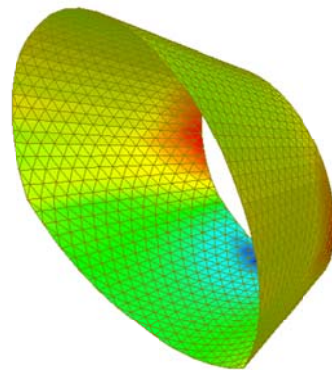
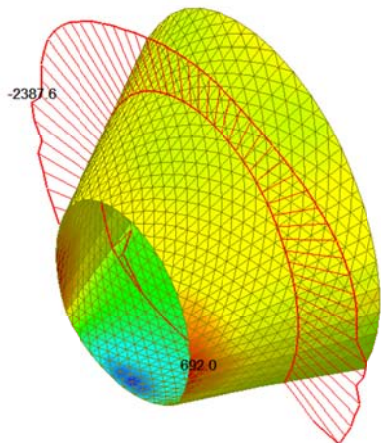
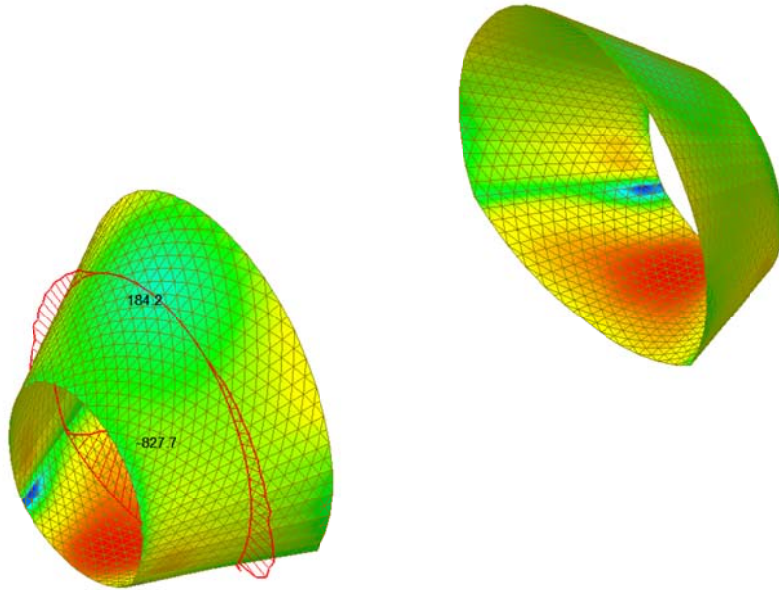


Plate force\_Mxx / ST\_N5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

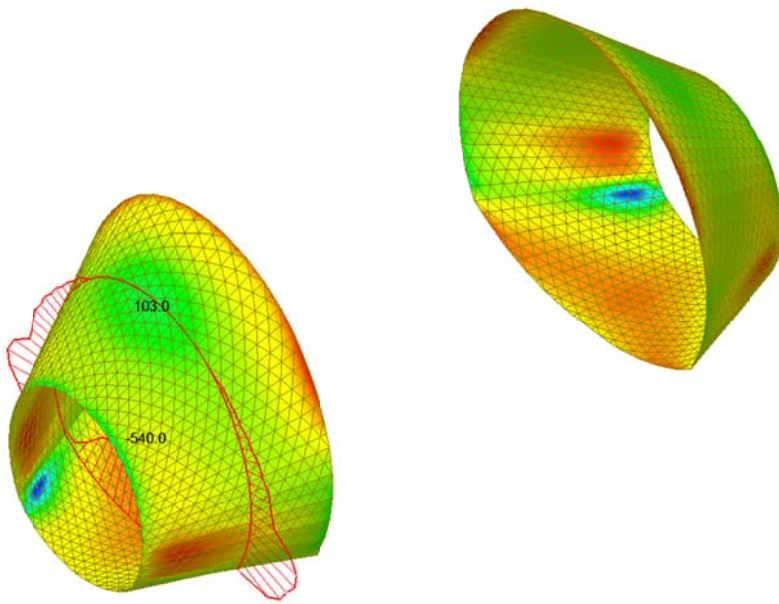
393.33
274.47
155.60
0.00
-82.14
-201.01
-319.88
-438.75
-557.61
-676.48
-795.35
-914.22

ST: N5  
Avg Nodal Active-  
MAX : 8464  
MIN : 7013  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623



Plate force\_Myy / ST\_N5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

342.27
248.56
154.86
61.15
0.00
-126.26
-219.96
-313.66
-407.37
-501.07
-594.78
-688.48

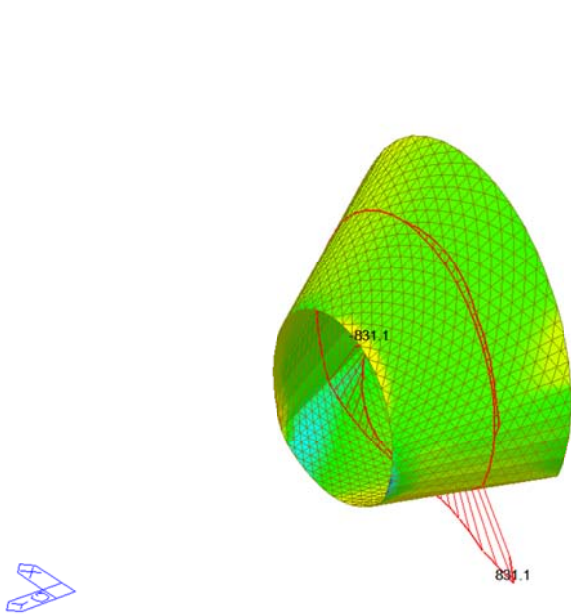
ST: N5  
Avg Nodal Active-  
MAX : 8459  
MIN : 16233  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623





Plate force\_Vxx / ST\_N5

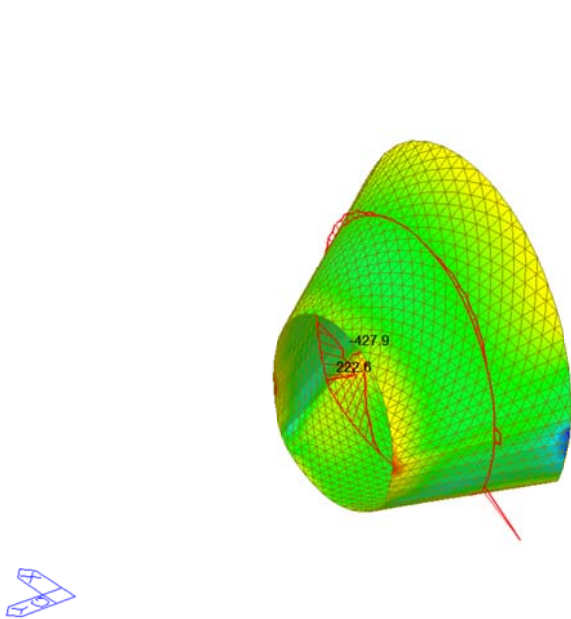


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
1828.87	
1496.35	
1163.83	
831.31	
498.79	
166.27	
0.00	
-498.77	
-831.29	
-1163.82	
-1496.34	
-1828.86	

ST: N5	
Avg Modal Active-	
MAX : 8517	
MIN : 15944	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.696	
Y: 0.525	
Z: 0.500	

Plate force\_Vyy / ST\_N5



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
625.54	
416.91	
208.28	
0.00	
-208.98	
-417.61	
-626.24	
-834.88	
-1043.51	
-1252.14	
-1460.77	
-1669.40	

ST: N5	
Avg Modal Active-	
MAX : 7438	
MIN : 8644	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.696	
Y: 0.525	
Z: 0.500	

A.5.4.6. Load combination SLU 6

Plate force\_Fxx / ST\_N6

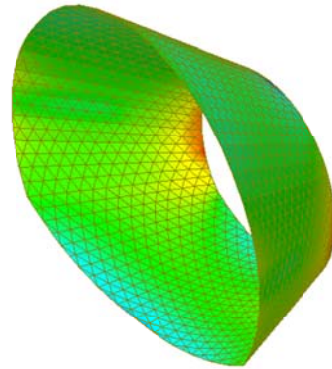
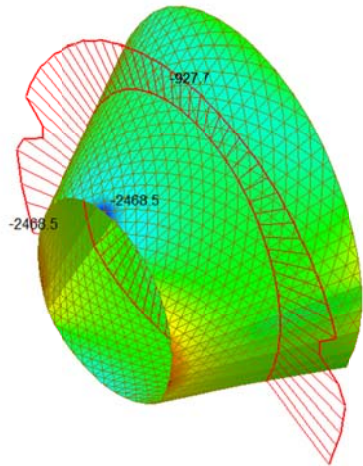


Plate force\_Fyy / ST\_N6

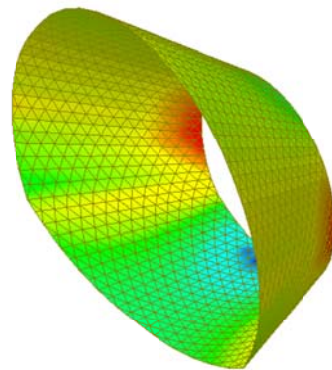
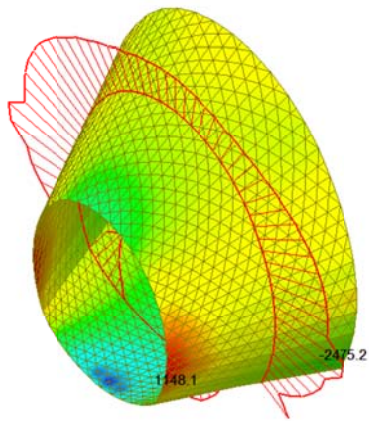
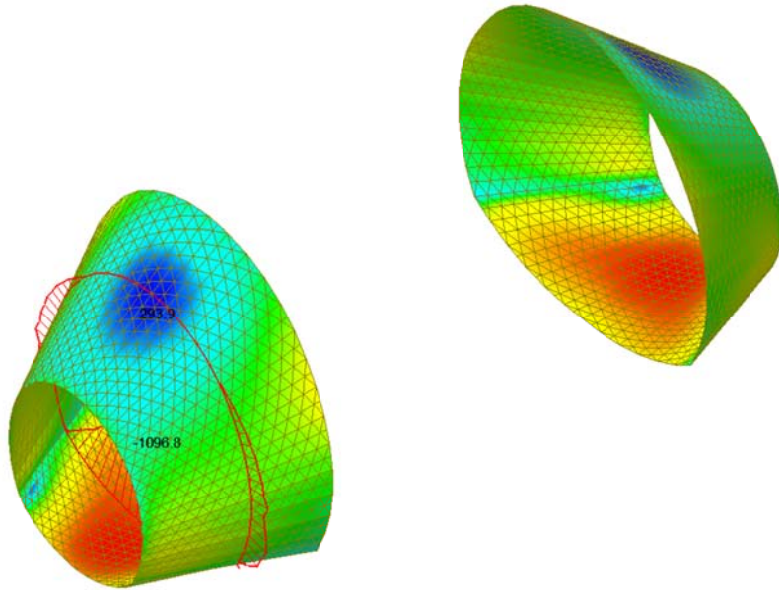


Plate force\_Mxx / ST\_N6



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

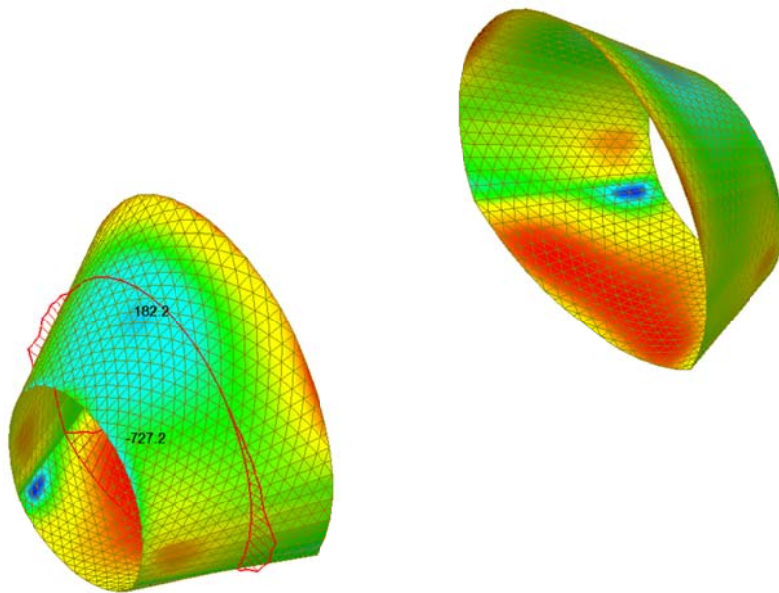
294.64
161.07
0.00
-106.08
-239.65
-373.23
-506.80
-640.37
-773.95
-907.52
-1041.09
-1174.67

ST: N6  
Avg Nodal Active-  
MAX : 8073  
MIN : 7009  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623



Plate force\_Myy / ST\_N6



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

251.25
160.71
70.17
0.00
-110.92
-201.46
-292.01
-382.55
-473.09
-563.63
-654.18
-744.72

ST: N6  
Avg Nodal Active-  
MAX : 8459  
MIN : 14468  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623



Plate force\_Vxx / ST\_N6

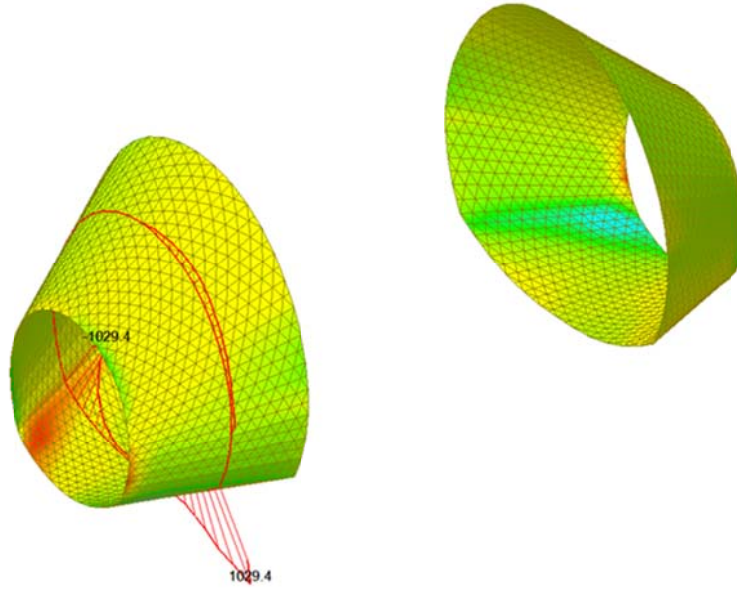
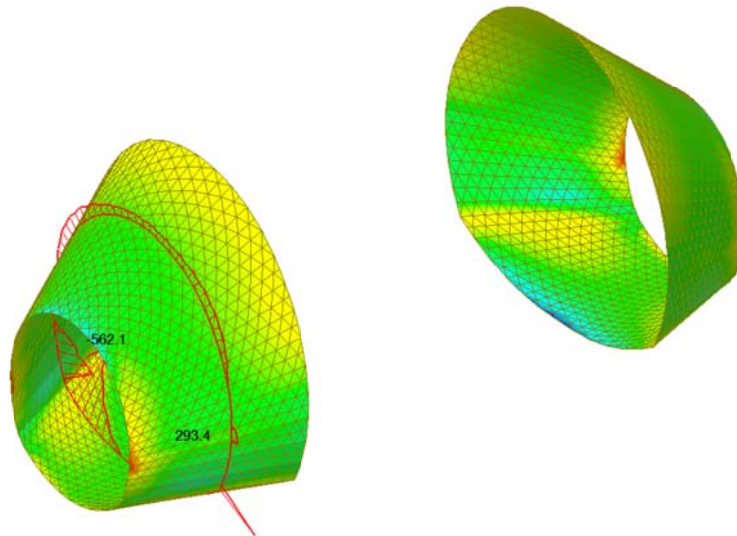


Plate force\_Vyy / ST\_N6



A.5.4.7. Load combination SLU 11

Plate force\_Fxx / ST\_N11

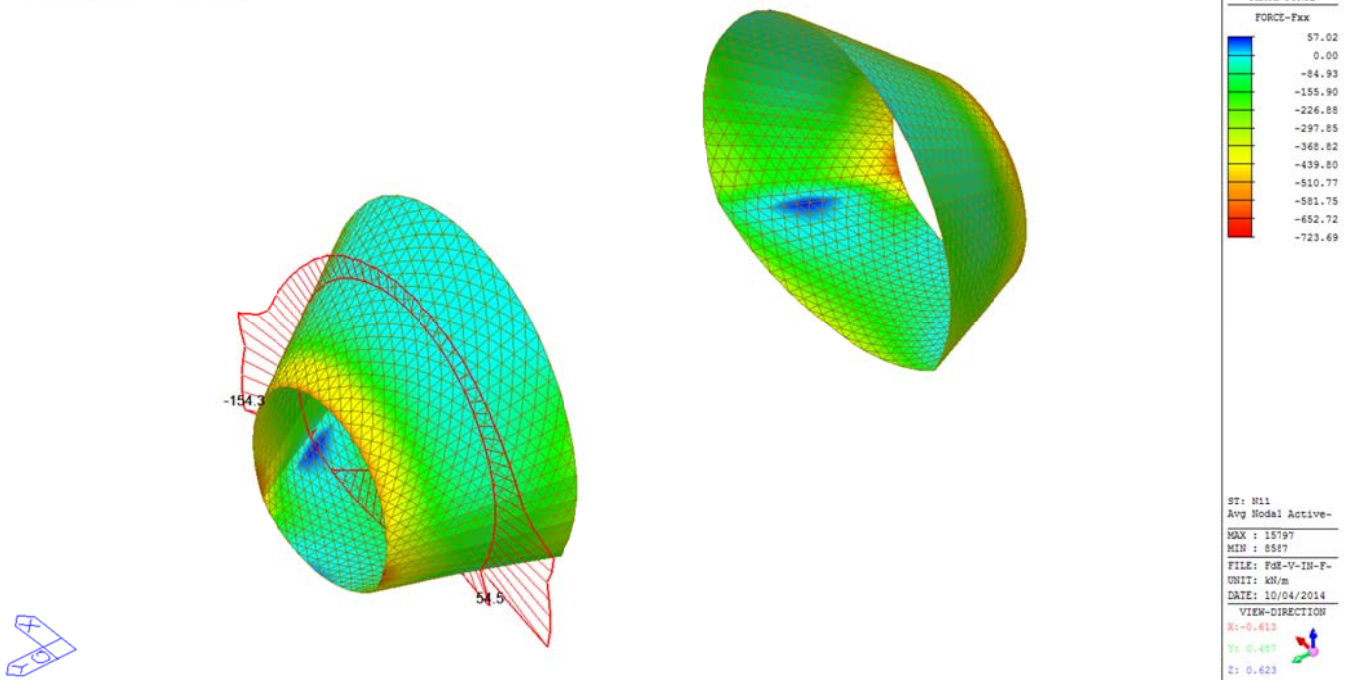


Plate force\_Fyy / ST\_N11

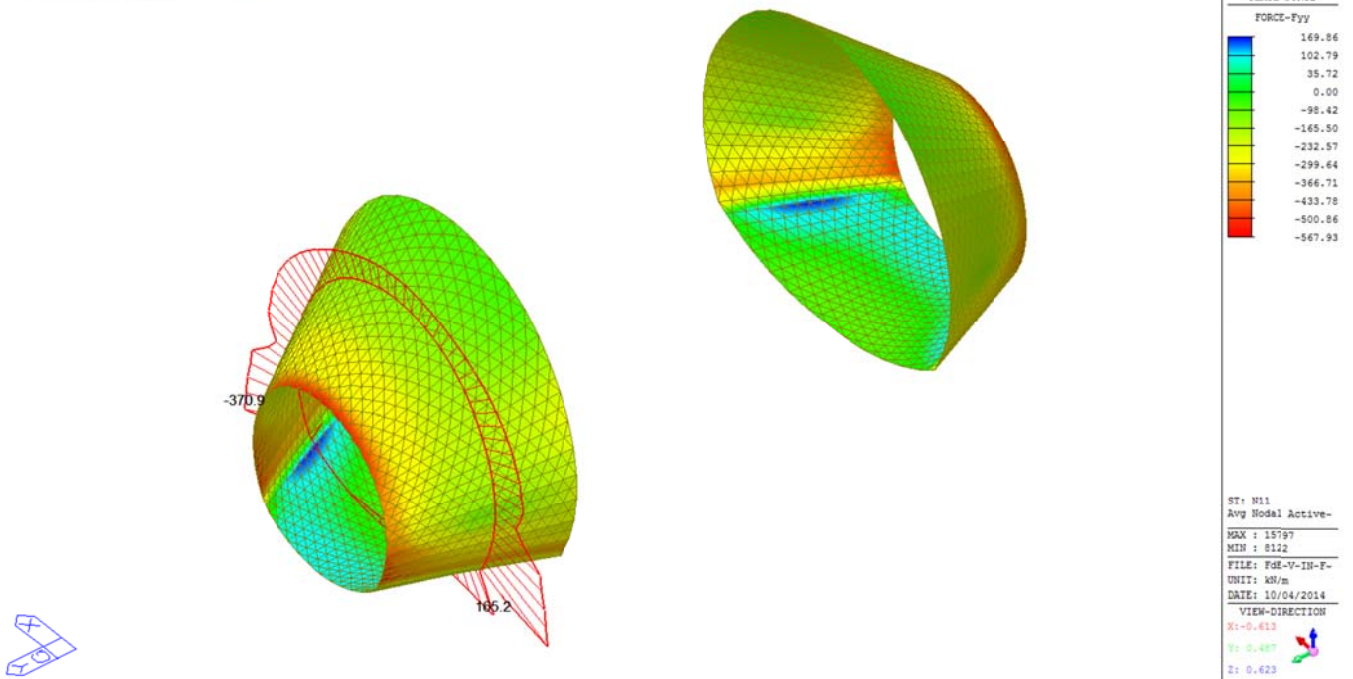
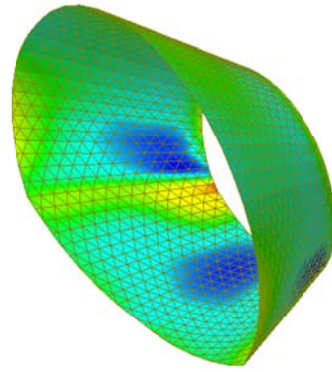
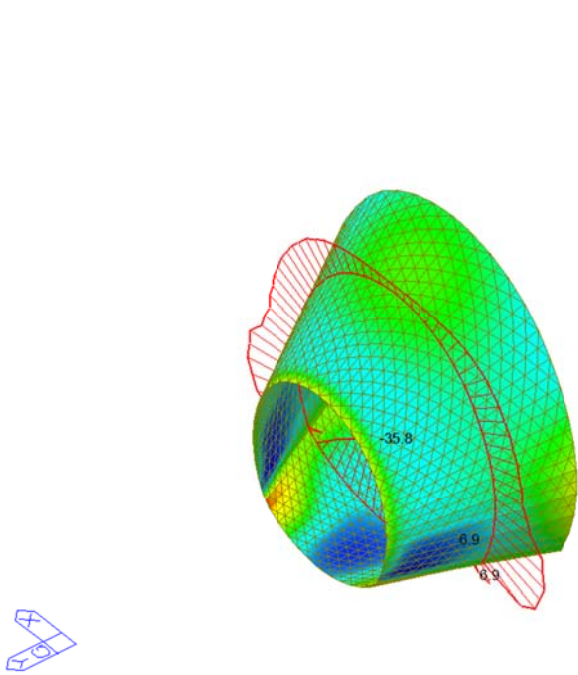


Plate force\_Mxx / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

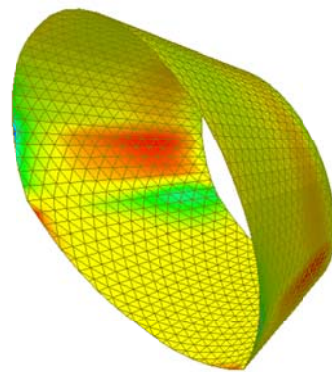
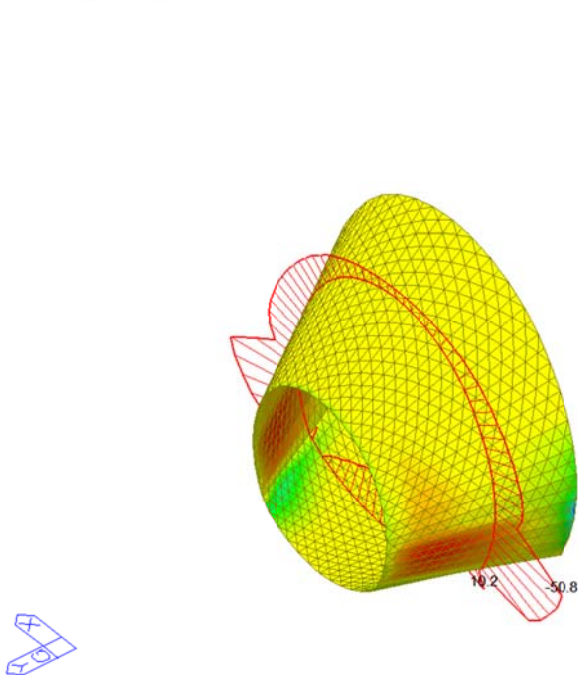
MOMENT-Mxx

66.14
55.88
45.62
35.35
25.09
14.83
0.00
-5.70
-15.96
-26.22
-36.48
-46.75

ST: N11  
Avg Nodal Active-  
MAX : 8471  
MIN : 8522  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

Plate force\_Myy / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

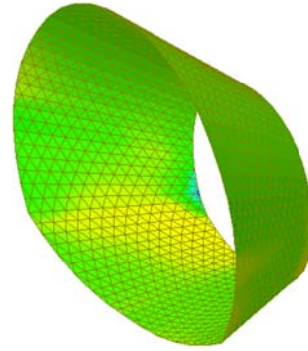
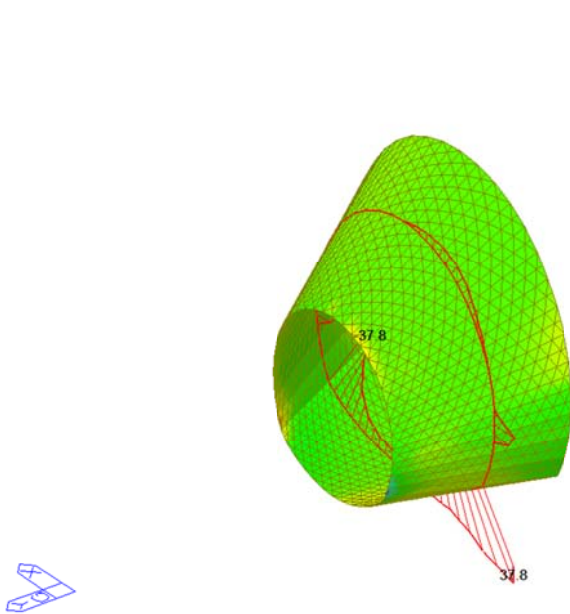
MOMENT-Myy

60.49
48.17
35.84
23.52
11.20
0.00
-13.45
-25.77
-38.09
-50.42
-62.74
-75.06

ST: N11  
Avg Nodal Active-  
MAX : 7438  
MIN : 8417  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

Plate force\_Vxx / ST\_N11

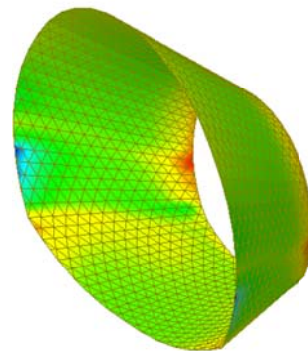
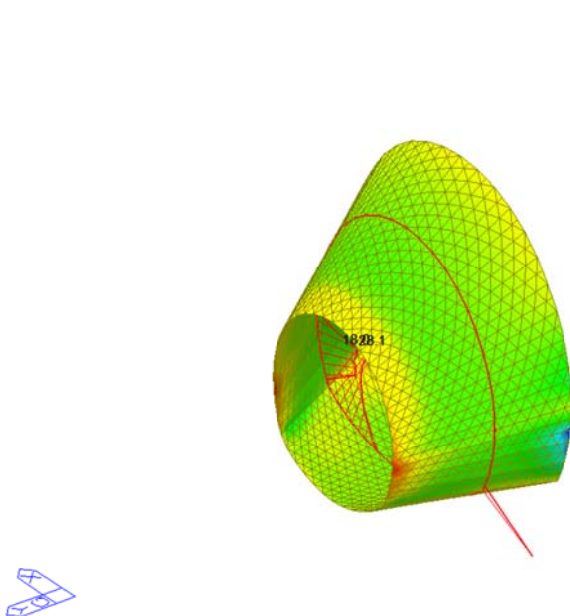


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
254.09	
207.89	
161.70	
115.50	
69.30	
23.11	
0.00	
-69.28	
-115.48	
-161.67	
-207.87	
-254.06	

ST: N11	
Avg Modal Active-	
MAX : 8529	
MIN : 7377	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.694	
Y: 0.325	
Z: 0.500	

Plate force\_Vyy / ST\_N11



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
111.47	
85.83	
60.19	
34.54	
0.00	
-16.74	
-42.39	
-68.03	
-93.68	
-119.32	
-144.96	
-170.61	

ST: N11	
Avg Modal Active-	
MAX : 7438	
MIN : 8644	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.694	
Y: 0.325	
Z: 0.500	

A.5.4.8. Load combination SLU 12

Plate force\_Fxx / ST\_N12

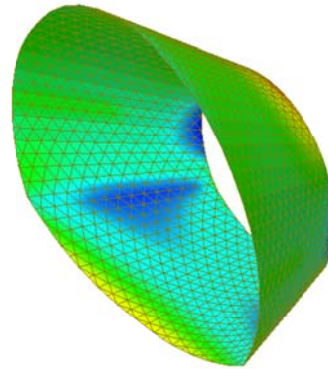
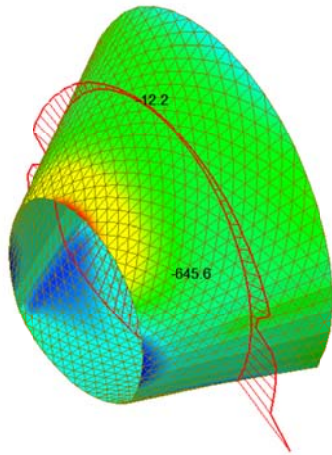


Plate force\_Fyy / ST\_N12

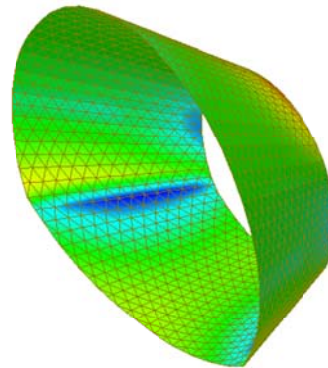
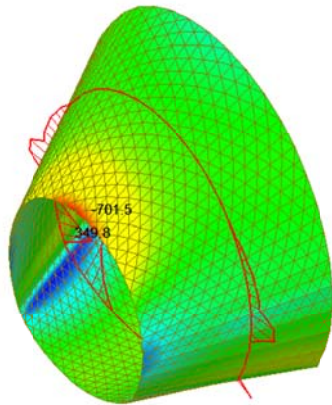




Plate force\_Mxx / ST\_N12

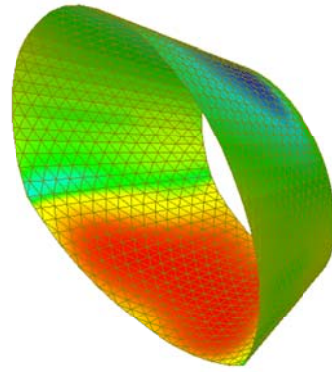
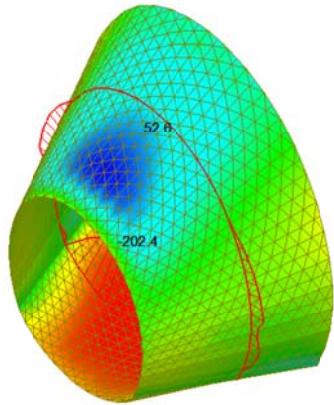


Plate force\_Myy / ST\_N12

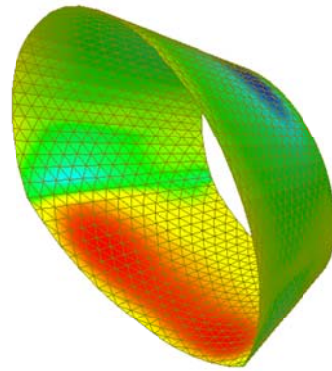
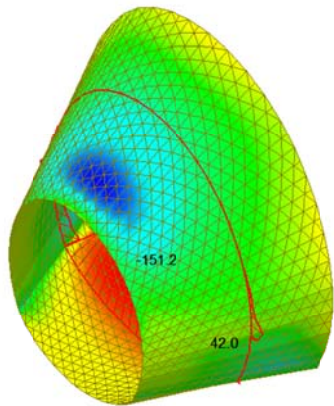
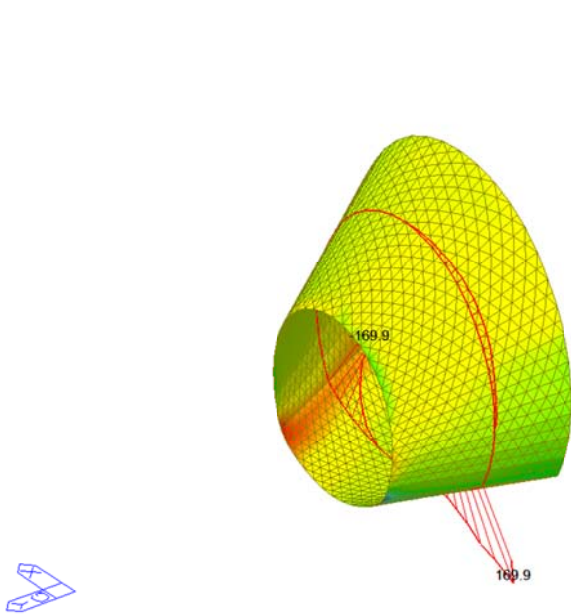


Plate force\_Vxx / ST\_N12

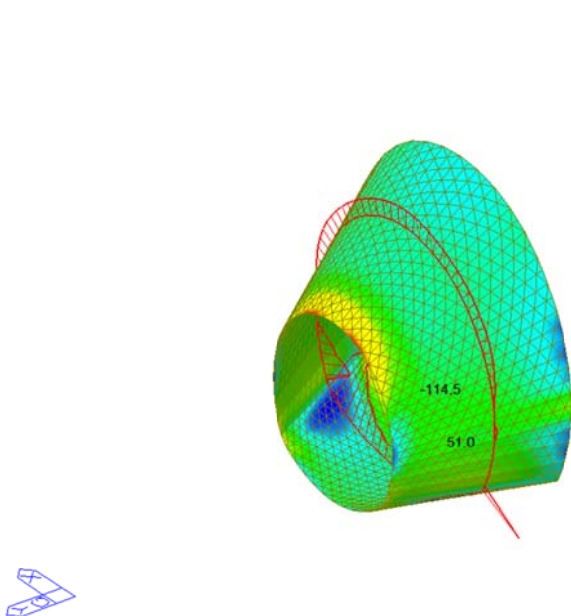


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
256.75	
210.07	
163.39	
116.70	
70.02	
0.00	
-23.35	
-70.03	
-116.71	
-163.40	
-210.08	
-256.76	

ST: N12	
Avg Modal Active-	
MAX : 15127	
MIN : 8470	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.694	
Y: 0.325	
Z: 0.500	

Plate force\_Vyy / ST\_N12



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
215.72	
185.53	
155.34	
125.14	
94.95	
64.76	
34.56	
0.00	
-25.82	
-56.01	
-86.21	
-116.40	

ST: N12	
Avg Modal Active-	
MAX : 7959	
MIN : 7236	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.694	
Y: 0.325	
Z: 0.500	

A.5.4.9. Load combination SLU 21

Plate force\_Fxx / ST\_N21

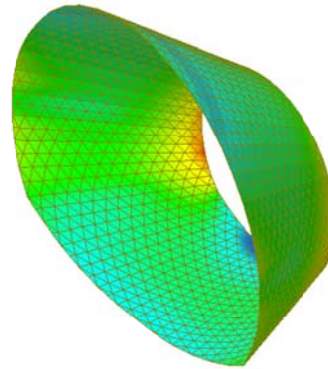
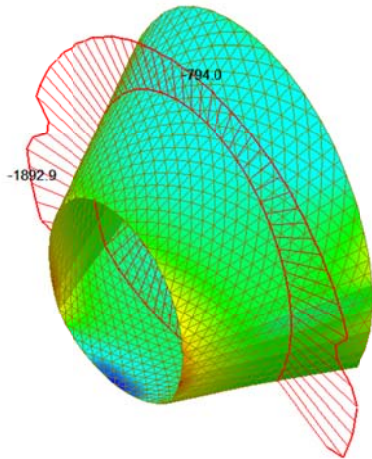


Plate force\_Fyy / ST\_N21

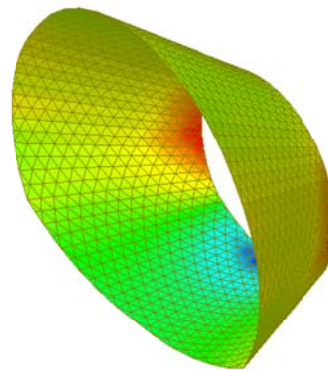
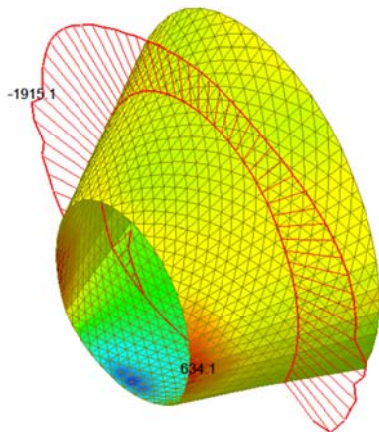
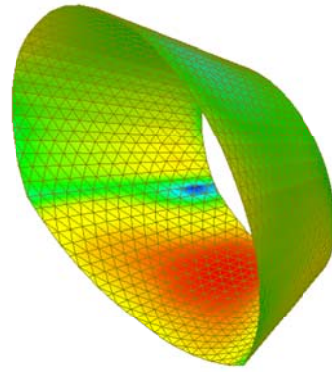
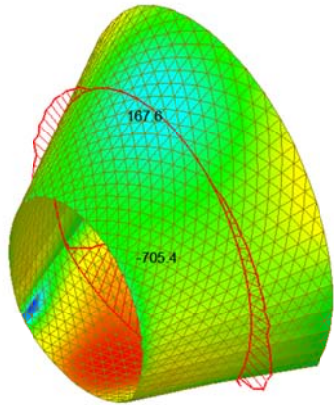


Plate force\_Mxx / ST\_N21



midas Gen  
POST-PROCESSOR  
PLATE FORCE

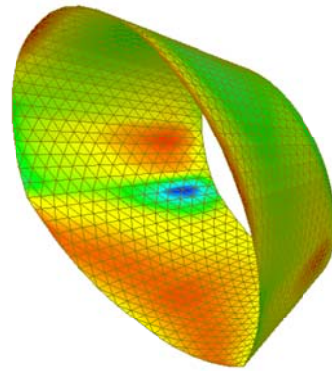
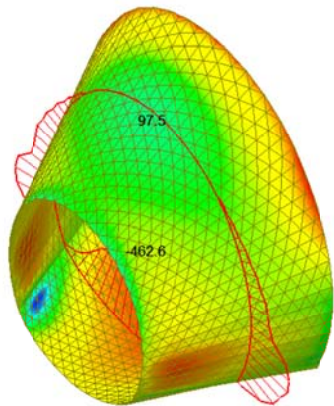
MOMENT-Mxx

207.46
191.08
94.70
0.00
-98.06
-194.45
-290.83
-387.21
-483.59
-579.97
-676.35
-772.73

ST: N21  
Avg Nodal Active-  
MAX : 8444  
MIN : 7009  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

Plate force\_Myy / ST\_N21



midas Gen  
POST-PROCESSOR  
PLATE FORCE

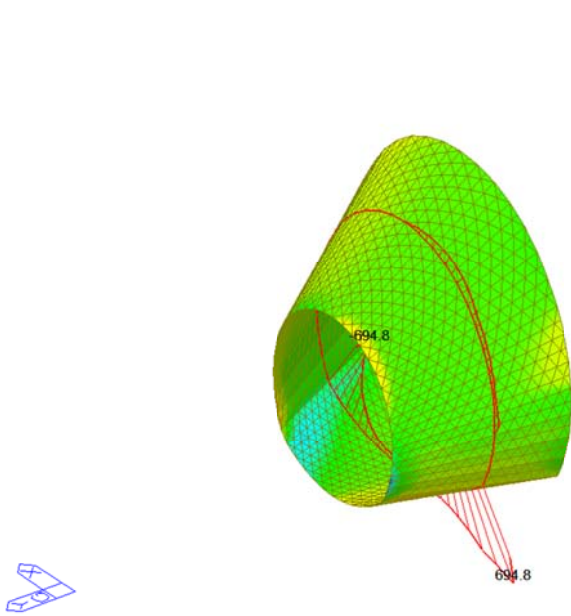
MOMENT-Myy

255.76
182.28
108.81
0.00
-38.14
-111.62
-185.09
-258.57
-332.04
-405.52
-478.99
-552.47

ST: N21  
Avg Nodal Active-  
MAX : 8459  
MIN : 16233  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

Plate force\_Vxx / ST\_N21

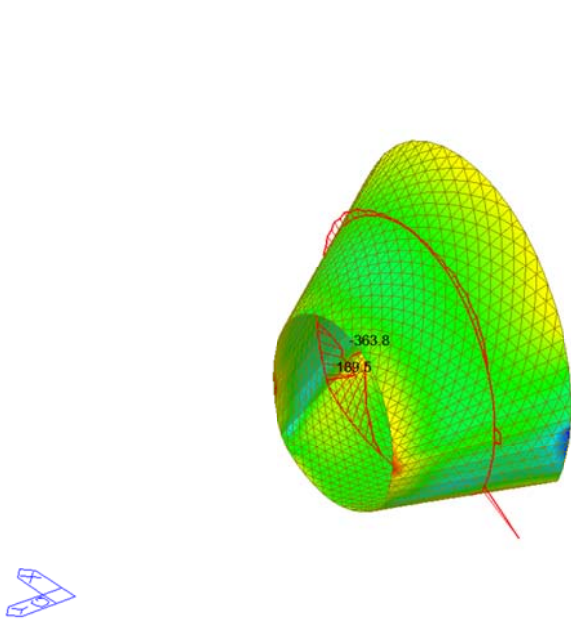


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
1416.40	
1158.87	
901.35	
643.82	
386.29	
128.77	
0.00	
-386.29	
-643.81	
-901.34	
-1158.86	
-1416.39	

ST: N21
Avg Modal Active-
MAX : 8517
MIN : 15944
FILE: FdL-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.694
Y: 0.525
Z: 0.500

Plate force\_Vyy / ST\_N21



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
432.57	
275.13	
117.70	
0.00	
-197.17	
-354.61	
-512.05	
-669.48	
-826.92	
-984.35	
-1141.79	
-1299.23	

ST: N21
Avg Modal Active-
MAX : 7438
MIN : 8644
FILE: FdL-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.694
Y: 0.525
Z: 0.500

A.5.4.10. Load combination SLU 22

Plate force\_Fxx / ST\_N22

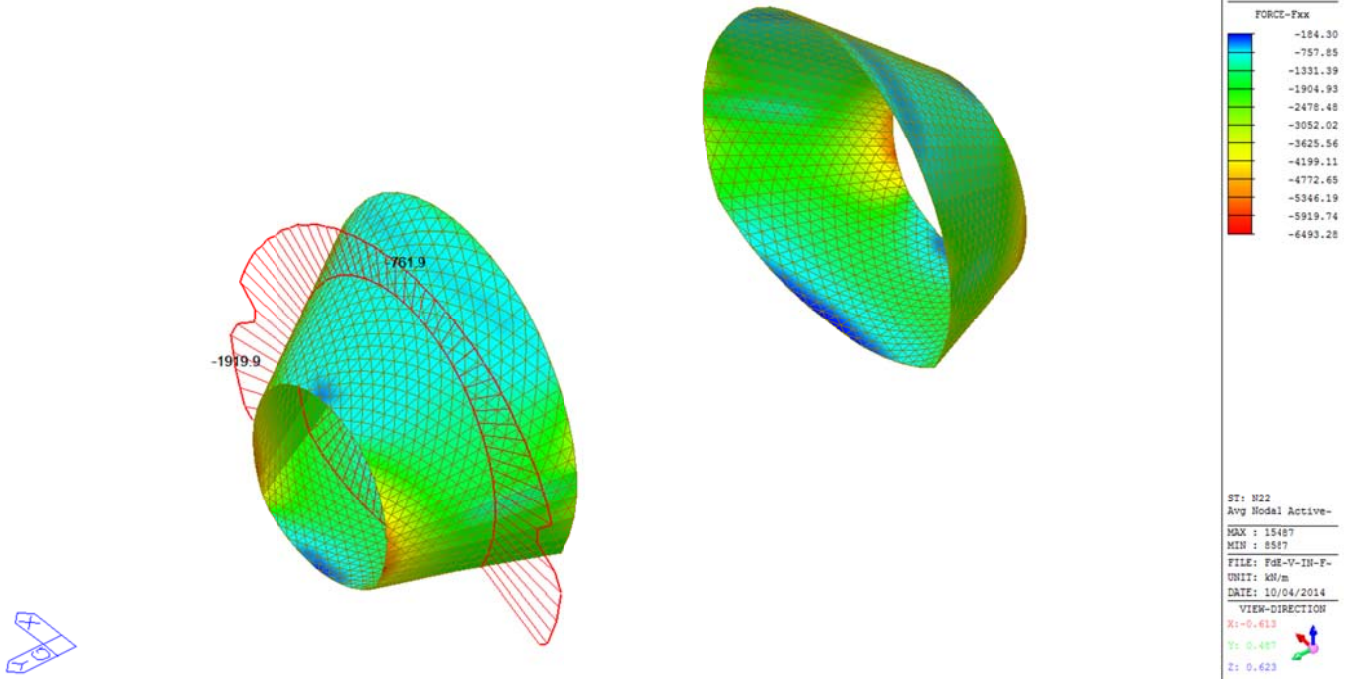


Plate force\_Fyy / ST\_N22

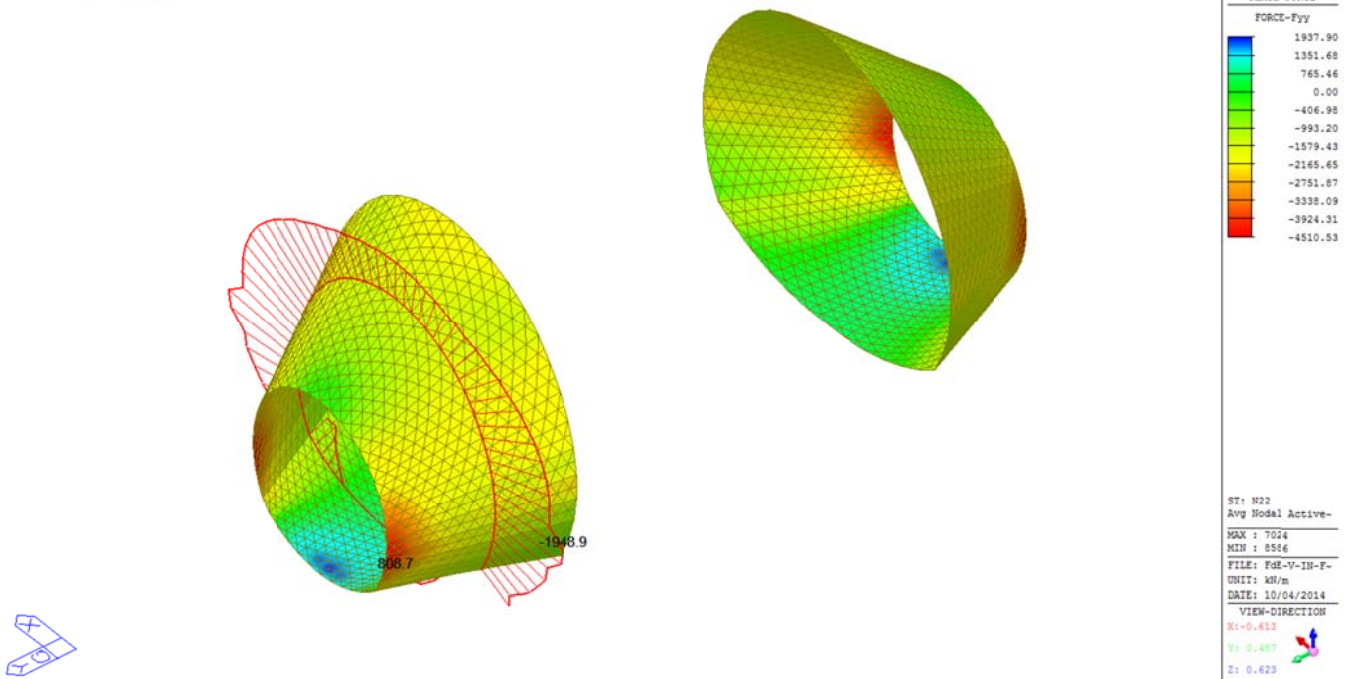
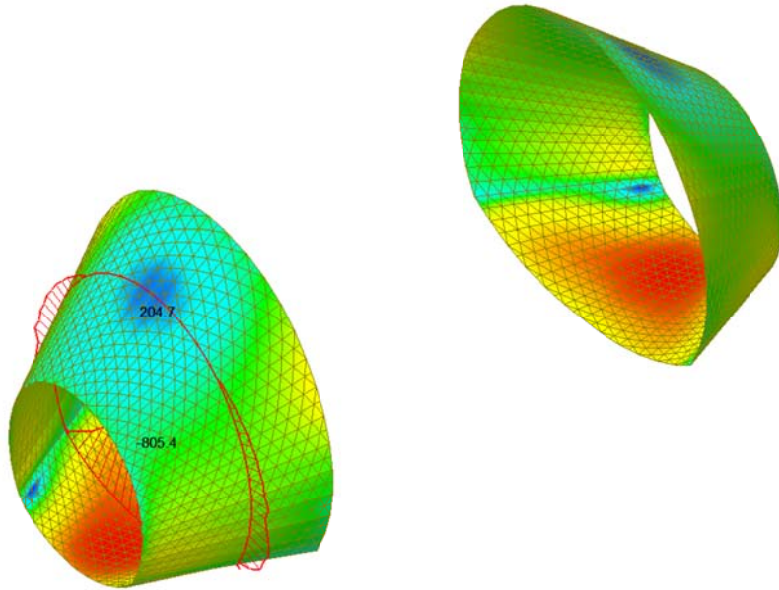


Plate force\_Mxx / ST\_N22



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

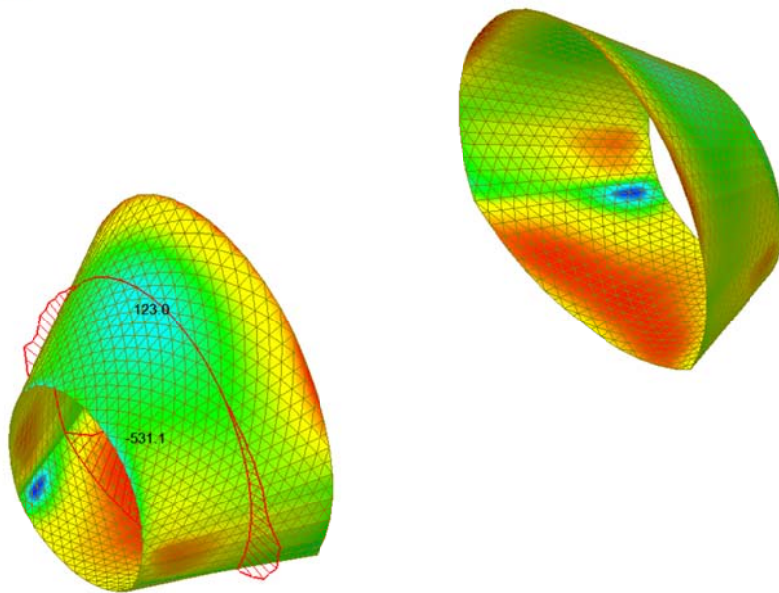
235.70
135.18
0.00
-65.87
-166.40
-266.92
-367.45
-467.97
-568.50
-669.02
-769.55
-870.07

ST: N22  
Avg Nodal Active-  
MAX : 8444  
MIN : 7009  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623



Plate force\_Myy / ST\_N22



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

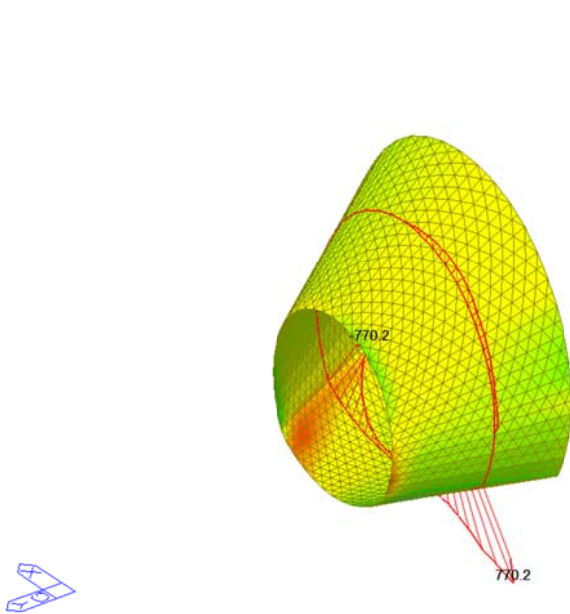
221.06
149.44
77.82
0.00
-65.42
-137.04
-208.66
-280.27
-351.89
-423.51
-495.13
-566.75

ST: N22  
Avg Nodal Active-  
MAX : 8459  
MIN : 15089  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623



Plate force\_Vxx / ST\_N22

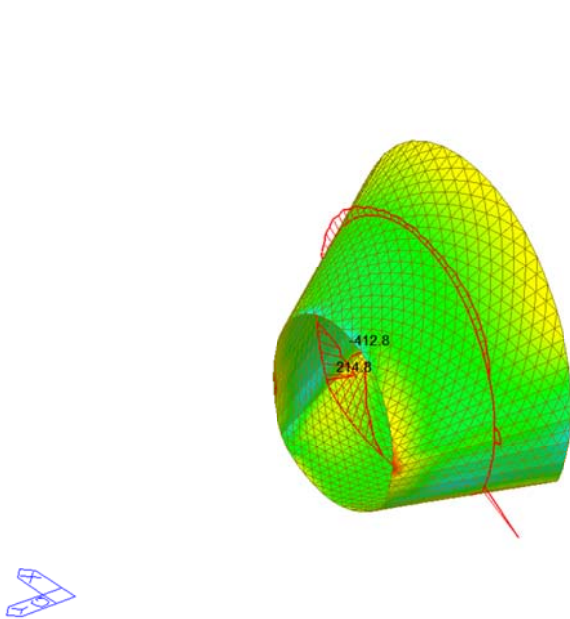


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
1328.76	
1087.17	
845.58	
603.98	
362.39	
0.00	
-120.80	
-362.39	
-603.98	
-845.58	
-1087.17	
-1328.76	

ST: N22	
Avg Modal Active-	
MAX : 8517	
MIN : 15944	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.696	
Y: 0.525	
Z: 0.500	

Plate force\_Vyy / ST\_N22



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
452.01	
297.99	
143.97	
0.00	
-164.07	
-318.09	
-472.11	
-626.13	
-780.15	
-934.17	
-1088.19	
-1242.21	

ST: N22	
Avg Modal Active-	
MAX : 14143	
MIN : 8644	
FILE: FdL-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.696	
Y: 0.525	
Z: 0.500	



A.5.4.11. Section checking: M-N iteration

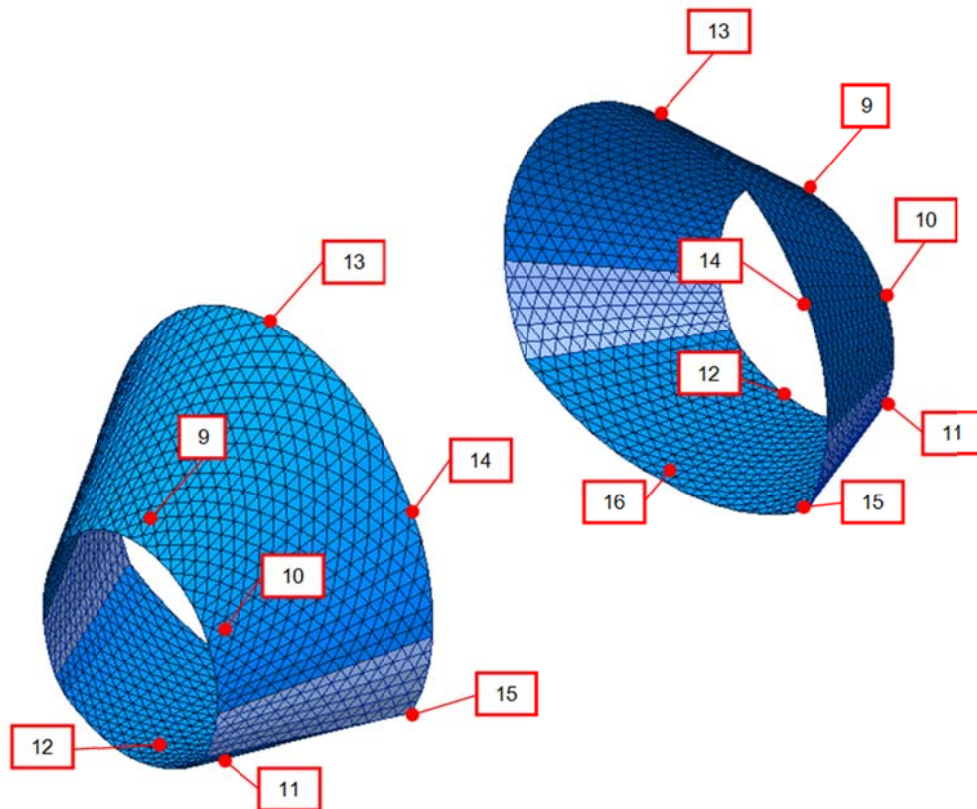


Figure 8 Numbering of sections checked

Spessore anello [cm]		60				∅	60				diametro	90				∅	120				∅	
Sezioni		9				18/15 18/15	10				16/15 16/15	11				16/15 16/15	12				18/15 18/15	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	
SLU	1	-616.5	-56.0	-1.1	0.08	-891.9	-50.5	-13.7	0.11	-826.4	118.2	136.7	0.08	-69.7	-58.6	-18.9	0.03					
	2	549.3	100.2	-5.5	0.73	-177.0	-25.0	60.0	0.03	-696.8	-49.0	-267.7	0.06	-478.6	-228.3	0.7	0.07					
	3	-607.9	-55.4	-1.1	0.08	-893.2	-50.9	-12.9	0.11	-825.2	116.3	131.8	0.08	-75.1	-64.7	-18.9	0.04					
	4	559.0	101.5	-5.6	0.74	-183.5	-26.2	61.2	0.03	-697.4	-51.6	-275.3	0.06	-487.9	-238.0	0.8	0.07					
	5	-1653.3	56.0	-16.5	0.18	-4119.8	-205.3	147.8	0.48	-4554.4	393.3	-771.5	0.37	-969.7	-899.7	-89.2	0.55					
	6	-814.8	213.3	-22.5	0.22	-3680.2	-188.5	218.7	0.43	-4579.6	253.0	-1071.9	0.35	-1473.5	-1140.3	-75.9	0.56					
	11	-217.4	-20.5	-0.6	0.03	-393.7	-24.4	4.2	0.05	-364.5	45.6	40.1	0.03	-34.1	-43.3	-8.2	0.04					
	12	353.6	69.7	-4.2	0.48	-213.0	-23.2	45.3	0.03	-587.3	-26.7	-197.2	0.04	-411.1	-185.3	-0.9	0.06					
	21	-1127.7	73.5	-14.2	0.15	-3199.0	-159.2	129.8	0.41	-3623.2	287.5	-666.5	0.31	-854.8	-758.1	-68.6	0.49					
	22	-802.0	128.9	-16.5	0.16	-3032.1	-156.1	157.0	0.39	-3625.9	235.7	-779.6	0.30	-1040.8	-848.1	-63.6	0.49					

Spessore anello [cm]		60				∅	60				∅	90				∅	120				∅	
Sezioni		13				18/15 18/15	14				18/15 18/15	15				20/15 20/15	16				20/15 20/15	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	
SLU	1	-268.7	-28.2	2.3	0.04	-478.1	45.0	95.0	0.06	-522.0	-47.5	35.0	0.04	-674.0	-29.9	21.3	0.04					
	2	136.1	112.2	10.3	0.44	16.0	-66.8	-39.7	0.21	-468.9	56.3	-190.1	0.04	663.4	-199.7	-32.2	0.65					
	3	-265.5	-28.1	2.4	0.04	-470.7	45.4	94.8	0.06	-525.8	-47.3	33.6	0.04	-677.3	-33.0	21.5	0.04					
	4	136.8	112.3	10.3	0.44	19.8	-66.2	-39.3	0.22	-481.3	58.8	-192.6	0.04	644.1	-204.7	-31.7	0.65					
	5	-1778.9	236.8	36.1	0.28	-2587.7	-113.3	259.2	0.29	-2581.5	-100.8	-465.9	0.18	-1215.6	-587.9	20.2	0.17					
	6	-1494.0	397.6	48.5	0.41	-2251.8	-205.9	146.3	0.30	-2297.9	116.7	-689.2	0.17	-356.2	-805.4	-47.8	0.70					
	11	-74.3	-9.1	1.2	0.01	-184.3	18.0	41.7	0.03	-204.9	6.0	-10.2	0.01	-266.1	-20.6	7.9	0.02					
	12	70.3	80.2	7.9	0.30	-44.6	-48.3	-22.0	0.11	-421.5	35.7	-142.9	0.03	385.8	-163.0	-20.6	0.43					
	21	-1370.2	218.3	30.9	0.27	-1998.1	-105.0	185.8	0.25	-1999.2	76.1	-408.9	0.15	-813.0	-505.3	9.0	0.19					
	22	-1263.0	274.5	35.6	0.32	-1872.4	-144.2	143.2	0.26	-1892.3	85.2	-493.0	0.14	-488.7	-585.2	-24.3	0.40					

• SECTION 9

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	800	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	1.48	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>326.60</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>331.48</b>	<b>kN</b>			
$V_{Rd} =$	<b>331.48</b>	<b>kN</b>	$V_{Ed} =$	<b>22.50</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

• SECTION 10

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.607		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	542	mm	Altezza statica della sezione
$A_s =$	1'340	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00247		Percentuale di armatura
$N_{Ed} =$	3'600	kN	Azione assiale di progetto
$A_c =$	542'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>515.09</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>535.69</b>	<b>kN</b>			
$V_{Rd} =$	<b>535.69</b>	<b>kN</b>	$V_{Ed} =$	<b>218.70</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 11

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.487		Coefficiente
$h =$	900	mm	Altezza geometrica della sezione
$d =$	842	mm	Altezza statica della sezione
$A_s =$	1'340	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00159		Percentuale di armatura
$N_{Ed} =$	4'500	kN	Azione assiale di progetto
$A_c =$	842'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>740.49</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>796.03</b>	<b>kN</b>			
$V_{Rd} =$	<b>796.03</b>	<b>kN</b>	$V_{Ed} =$	<b>1'071.90</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ <b>NO!</b>

Verifica sezione con armatura a taglio

Verifica a taglio-trazione

$V_{Rsd} =$	<b>1'285.54</b>	<b>kN</b>	$V_{Ed} =$	<b>1'071.90</b>	<b>kN</b>	$V_{Rsd} > V_{Ed}$	<b>OK</b>
$f_{yd} =$	375.00	MPa					
$d =$	842	mm					
$\alpha =$	90	°				Inclinazione staffe rispetto all'asse dell'elemento	
$s =$	150	mm					
$A_{sw} =$	679	mm <sup>2</sup>					
$\phi =$	12	mm				Diametro staffe	
n° bracci =	6						

Verifica a taglio-compressione

$V_{Rcd} =$	<b>3'220.65</b>	<b>kN</b>	$V_{Ed} =$	<b>1'071.90</b>	<b>kN</b>	$V_{Rcd} > V_{Ed}$	<b>OK</b>
$b_w =$	1'000	mm					
$d =$	842	mm					
$\sigma_{cp} =$	3.98	MPa					
$f_{cd} =$	20.00	MPa					
$f'_{cd} =$	10.00	MPa					
$\alpha_c =$	0.85						
$\alpha =$	90	°				Inclinazione staffe rispetto all'asse dell'elemento	
$\theta =$	45	°				Inclinazione bielle calcestruzzo rispetto all'asse della sezione	

- SECTION 12

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.419		Coefficiente
$h =$	1'200	mm	Altezza geometrica della sezione
$d =$	1'141	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00149		Percentuale di armatura
$N_{Ed} =$	900	kN	Azione assiale di progetto
$A_c =$	1'141'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.79	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>434.76</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>504.60</b>	kN			
$V_{Rd} =$	<b>504.60</b>	kN	$V_{Ed} =$	<b>89.20</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 13

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	1'400	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	2.59	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>416.60</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>421.48</b>	kN			
$V_{Rd} =$	<b>421.48</b>	kN	$V_{Ed} =$	<b>48.50</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 14

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	2'500	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante
$V_{Rd1} =$	<b>529.93</b>	<b>kN</b>	
$V_{Rd2}(v_{min}) =$	<b>534.81</b>	<b>kN</b>	
$V_{Rd} =$	<b>534.81</b>	<b>kN</b>	$V_{Ed} =$ <b>259.20</b> <b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 15

### VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1

#### Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.488		Coefficiente
$h =$	900	mm	Altezza geometrica della sezione
$d =$	840	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00249		Percentuale di armatura
$N_{Ed} =$	2'300	kN	Azione assiale di progetto
$A_c =$	840'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	2.74	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>619.99</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>637.27</b>	<b>kN</b>			
$V_{Rd} =$	<b>637.27</b>	<b>kN</b>	$V_{Ed} =$	<b>689.20</b>	<b>kN</b>
					$V_{Rd} > V_{Ed}$ <b>NO!</b>

#### Verifica sezione con armatura a taglio

##### Verifica a taglio-trazione

$V_{Rsd} =$	<b>854.99</b>	<b>kN</b>	$V_{Ed} =$	<b>689.20</b>	<b>kN</b>	$V_{Rsd} > V_{Ed}$	<b>OK</b>
$f_{yd} =$	375.00	MPa					
$d =$	840	mm					
$\alpha =$	90	°				Inclinazione staffe rispetto all'asse dell'elemento	
$s =$	150	mm					
$A_{sw} =$	452	mm <sup>2</sup>					
$\phi =$	12	mm				Diametro staffe	
n° bracci =	4						

##### Verifica a taglio-compressione

$V_{Rcd} =$	<b>3'213.00</b>	<b>kN</b>	$V_{Ed} =$	<b>689.20</b>	<b>kN</b>	$V_{Rcd} > V_{Ed}$	<b>OK</b>
$b_w =$	1'000	mm					
$d =$	840	mm					
$\sigma_{cp} =$	2.74	MPa					
$f_{cd} =$	20.00	MPa					
$f'_{cd} =$	10.00	MPa					
$\alpha_c =$	0.85						
$\alpha =$	90	°				Inclinazione staffe rispetto all'asse dell'elemento	
$\theta =$	45	°				Inclinazione bielle calcestruzzo rispetto all'asse della sezione	

- SECTION 16

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.419		Coefficiente
$h =$	1'200	mm	Altezza geometrica della sezione
$d =$	1'140	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00184		Percentuale di armatura
$N_{Ed} =$	350	kN	Azione assiale di progetto
$A_c =$	1'140'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.31	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante
$V_{Rd1} =$	<b>373.93</b>	<b>kN</b>	
$V_{Rd2}(v_{min}) =$	<b>421.85</b>	<b>kN</b>	
$V_{Rd} =$	<b>421.85</b>	<b>kN</b>	$V_{Ed} =$ <b>47.80</b> <b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

• SECTION 9

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	491	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00346		Percentuale di armatura
$N_{Ed} =$	800	kN	Azione assiale di progetto
$A_c =$	491'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	1.63	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$$V_{Rd1} = 317.30 \text{ kN}$$

$$V_{Rd2}(v_{min}) = 317.37 \text{ kN}$$

$$V_{Rd} = 317.37 \text{ kN} \quad V_{Ed} = 16.50 \text{ kN} \quad V_{Rd} > V_{Ed} \text{ VERIFICA SODDISFATTA}$$

• SECTION 10

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	492	mm	Altezza statica della sezione
$A_s =$	1'340	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00272		Percentuale di armatura
$N_{Ed} =$	3'000	kN	Azione assiale di progetto
$A_c =$	492'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$$V_{Rd1} = 476.62 \text{ kN}$$

$$V_{Rd2}(v_{min}) = 491.70 \text{ kN}$$

$$V_{Rd} = 491.70 \text{ kN} \quad V_{Ed} = 157.00 \text{ kN} \quad V_{Rd} > V_{Ed} \text{ VERIFICA SODDISFATTA}$$



- SECTION 11

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.503		Coefficiente
$h =$	850	mm	Altezza geometrica della sezione
$d =$	792	mm	Altezza statica della sezione
$A_s =$	1'340	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00169		Percentuale di armatura
$N_{Ed} =$	3'625	kN	Azione assiale di progetto
$A_c =$	792'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>738.61</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>790.62</b>	kN			
$V_{Rd} =$	<b>790.62</b>	kN	$V_{Ed} =$	<b>779.60</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 12

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.428		Coefficiente
$h =$	1'150	mm	Altezza geometrica della sezione
$d =$	1'091	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00155		Percentuale di armatura
$N_{Ed} =$	800	kN	Azione assiale di progetto
$A_c =$	1'091'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.73	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>412.88</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>476.96</b>	kN			
$V_{Rd} =$	<b>476.96</b>	kN	$V_{Ed} =$	<b>68.60</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 13

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	1'400	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	2.59	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>416.60</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>421.48</b>	kN			
$V_{Rd} =$	<b>421.48</b>	kN	$V_{Ed} =$	<b>48.50</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 14

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	491	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00346		Percentuale di armatura
$N_{Ed} =$	1'900	kN	Azione assiale di progetto
$A_c =$	491'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.87	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>482.30</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>482.37</b>	kN			
$V_{Rd} =$	<b>482.37</b>	kN	$V_{Ed} =$	<b>185.80</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 15

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.503		Coefficiente
$h =$	850	mm	Altezza geometrica della sezione
$d =$	790	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00265		Percentuale di armatura
$N_{Ed} =$	1'800	kN	Azione assiale di progetto
$A_c =$	790'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	2.28	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>536.66</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>549.10</b>	<b>kN</b>			
$V_{Rd} =$	<b>549.10</b>	<b>kN</b>	$V_{Ed} =$	<b>493.00</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 16

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.428		Coefficiente
$h =$	1'150	mm	Altezza geometrica della sezione
$d =$	1'090	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00192		Percentuale di armatura
$N_{Ed} =$	400	kN	Azione assiale di progetto
$A_c =$	1'090'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.37	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>374.05</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>416.70</b>	<b>kN</b>			
$V_{Rd} =$	<b>416.70</b>	<b>kN</b>	$V_{Ed} =$	<b>24.30</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

A.5.4.14. Load combination SLE 1

Plate force\_Fxx / ST\_NSLE-1

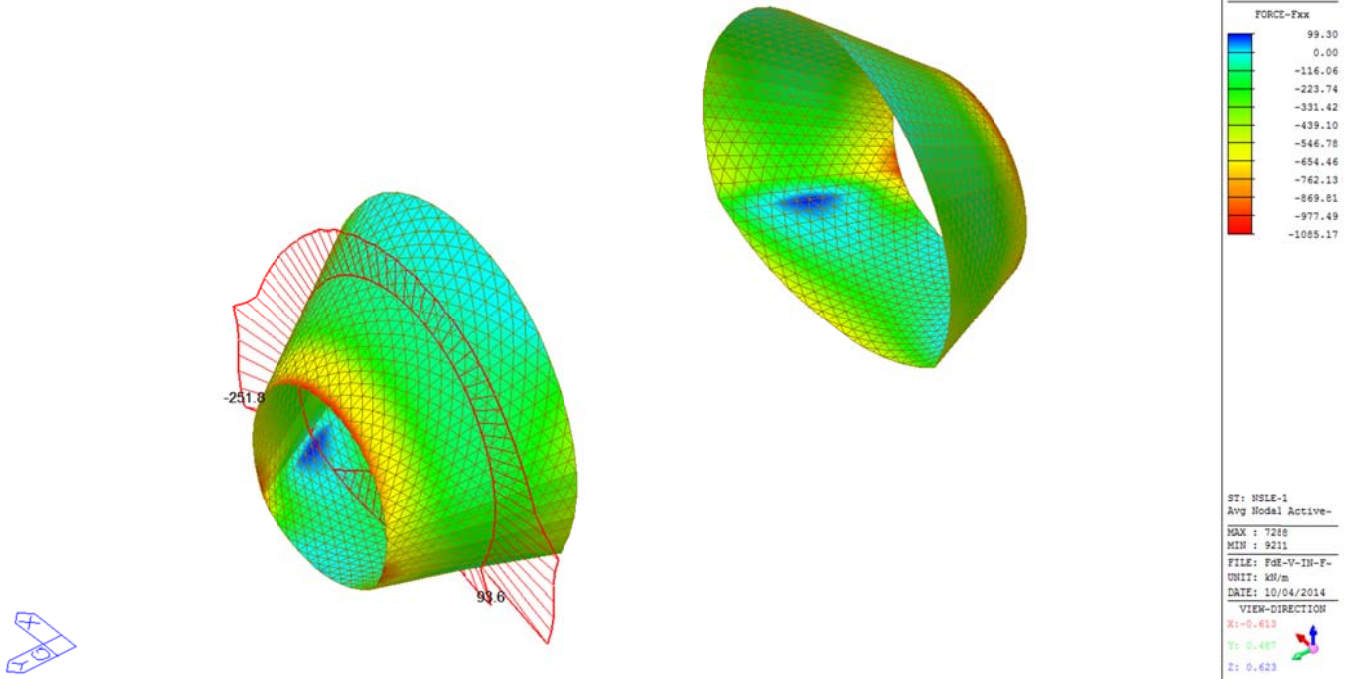


Plate force\_Fyy / ST\_NSLE-1

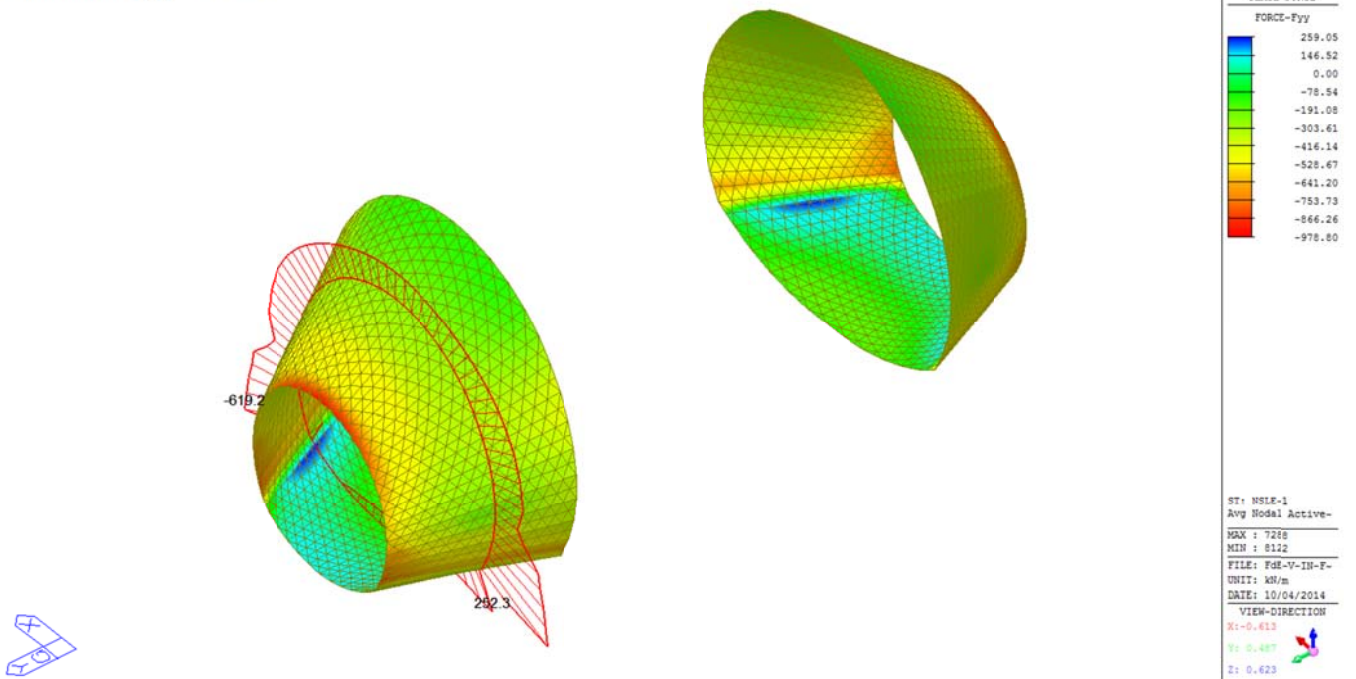


Plate force\_Mxx / ST\_NSLE-1

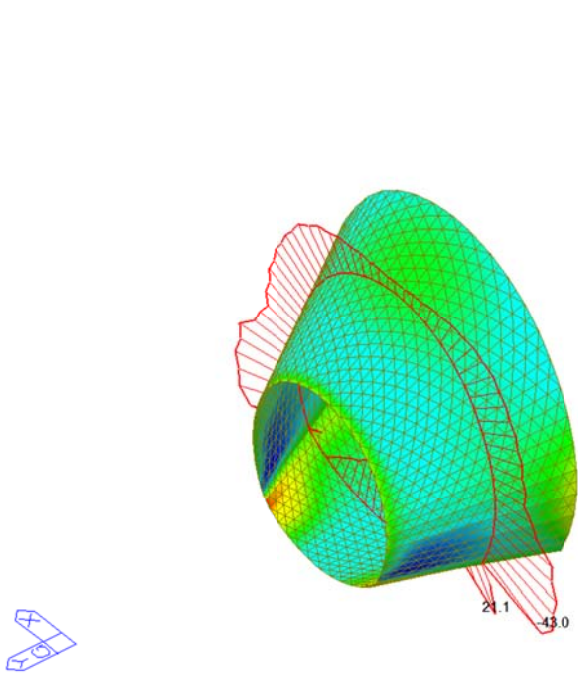
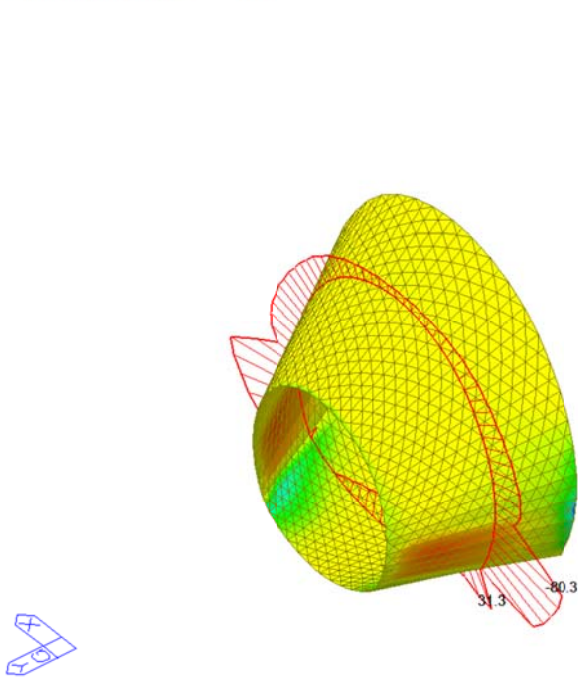


Plate force\_Myy / ST\_NSLE-1



A.5.4.15. Load combination SLE 2

Plate force\_Fxx / ST\_NSLE-2

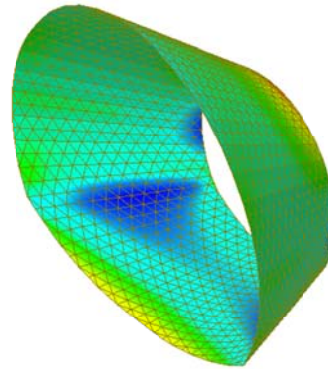
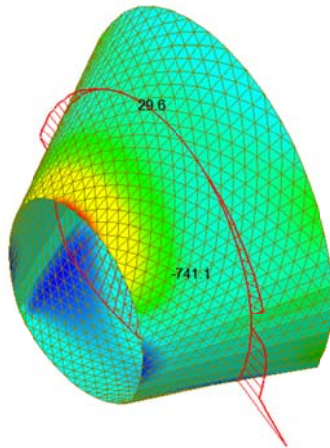


Plate force\_Fyy / ST\_NSLE-2

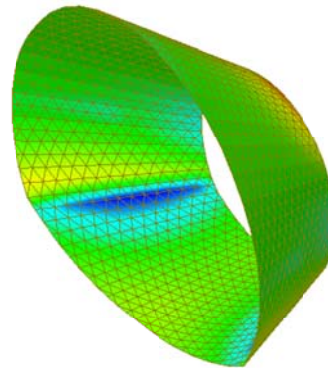
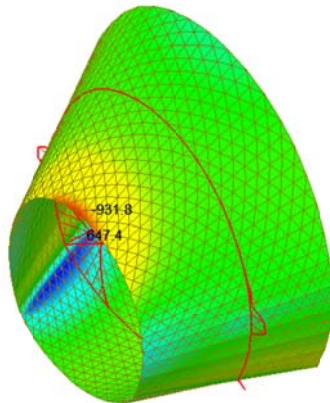


Plate force\_Mxx / ST\_NSLE-2

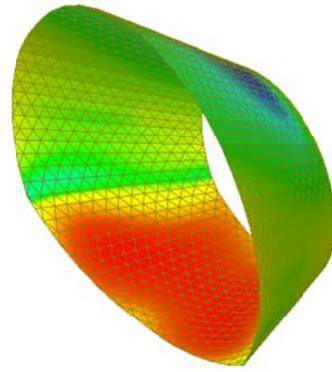
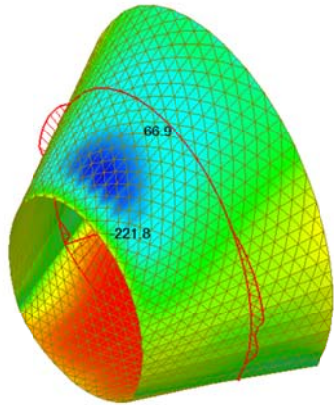
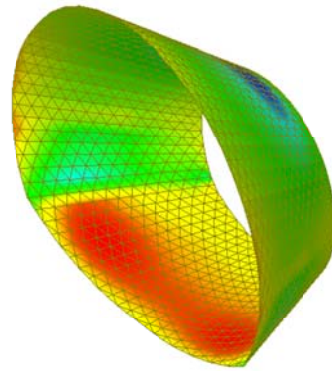
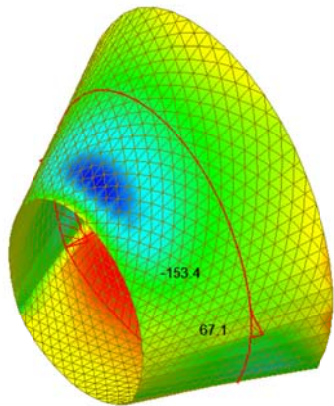


Plate force\_Myy / ST\_NSLE-2



A.5.4.16. Load combination SLE 3

Plate force\_Fxx / ST\_NSLE-3

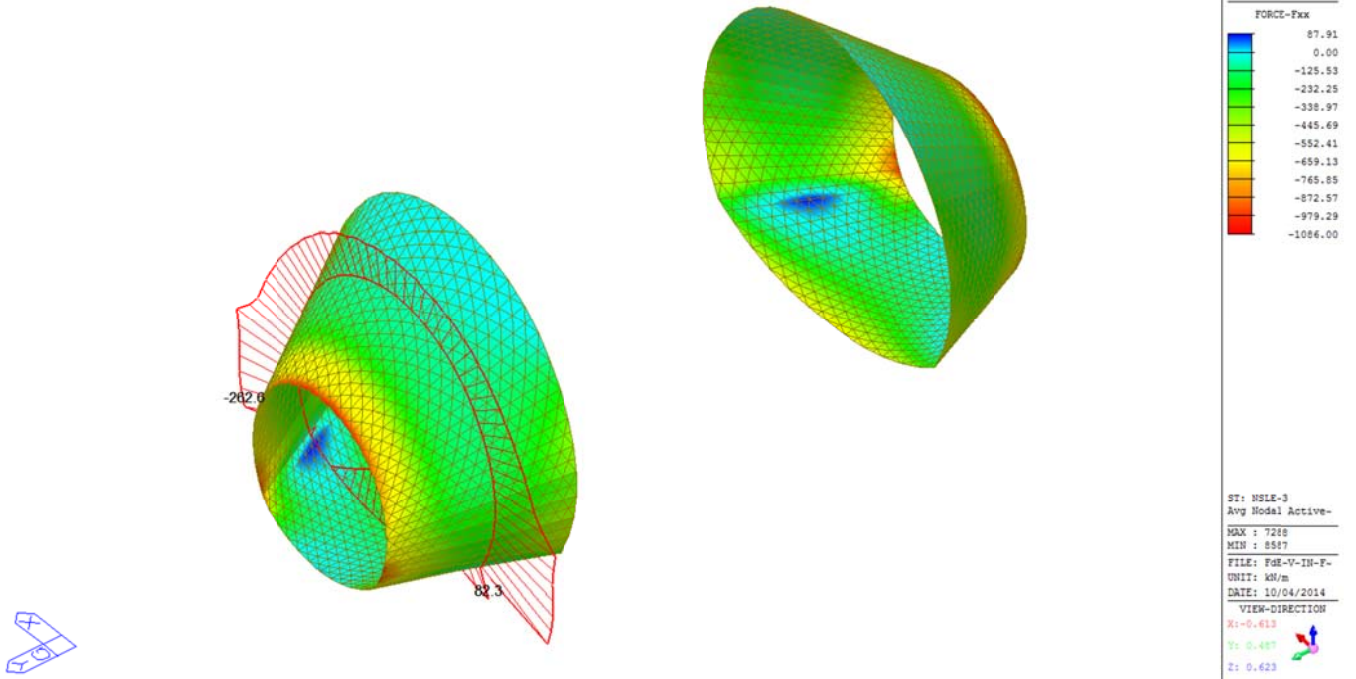


Plate force\_Fyy / ST\_NSLE-3

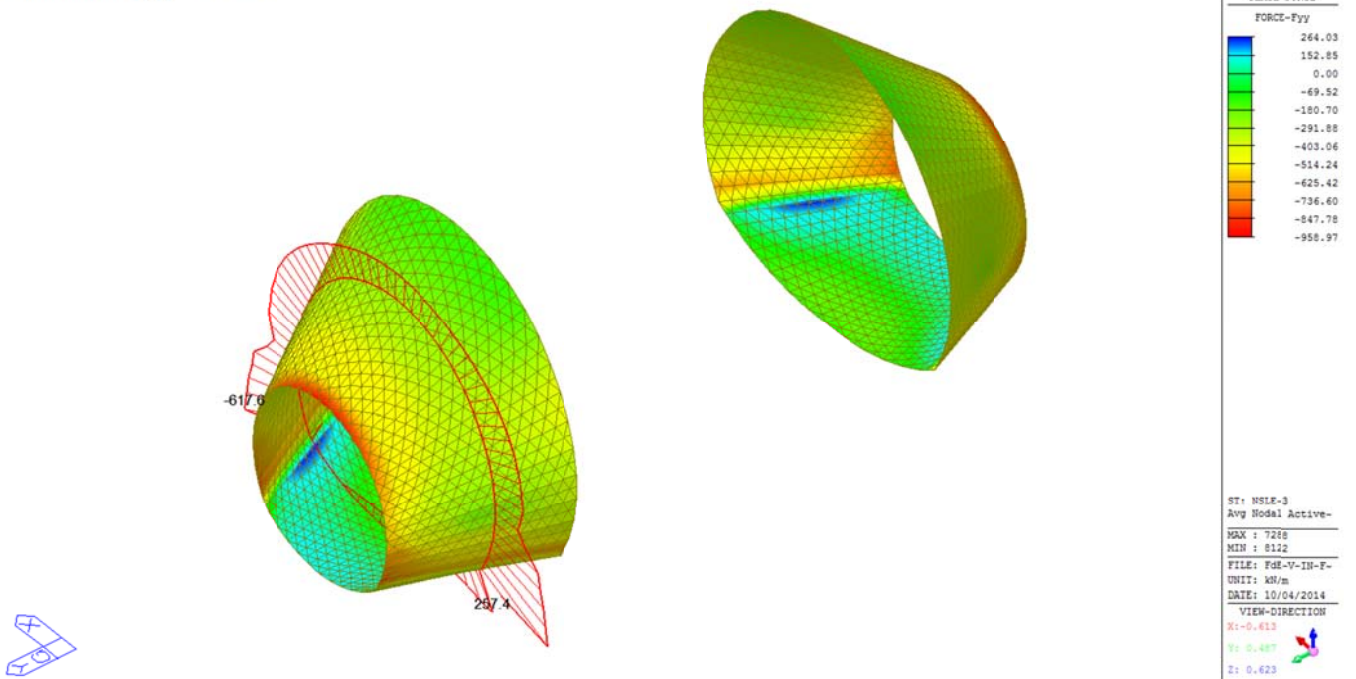
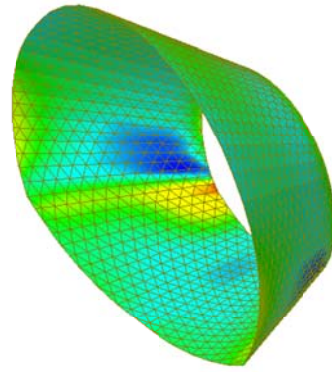
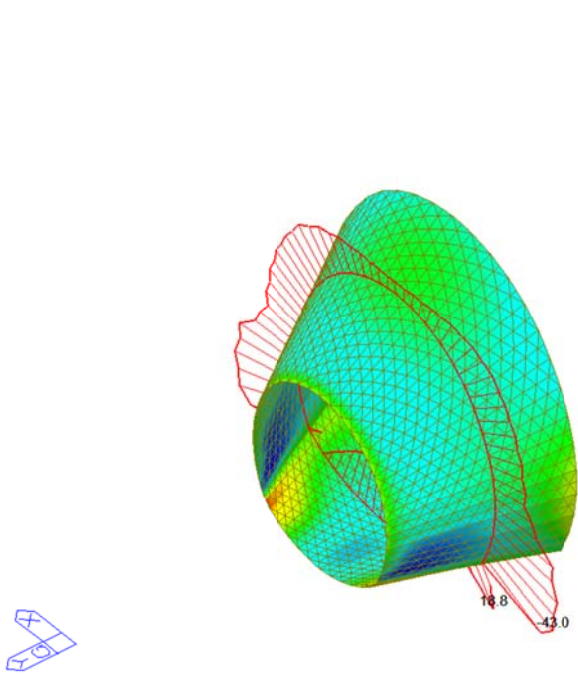




Plate force\_Mxx / ST\_NSLE-3

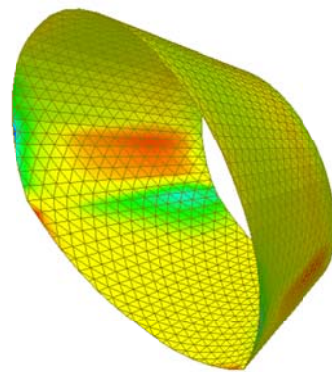
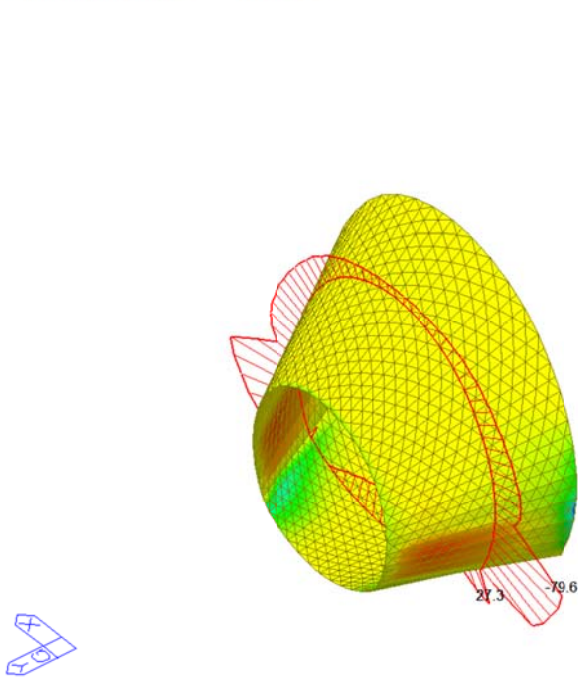


midas Gen POST-PROCESSOR	
PLATE FORCE	
MOMENT-Mxx	
111.16	
94.45	
77.74	
61.04	
44.33	
27.62	
10.92	
0.00	
-22.50	
-39.20	
-55.91	
-72.62	

ST: NSLE-3
Avg Nodal Active-
MAX : 8471
MIN : 8522
FILE: F02-V-IN-F-
UNIT: kN*m/m
DATE: 10/04/2014
VIEW-DIRECTION
X: 0.613
Y: 0.487
Z: 0.623

Plate force\_Myy / ST\_NSLE-3



midas Gen POST-PROCESSOR	
PLATE FORCE	
MOMENT-Myy	
93.12	
72.87	
52.63	
32.38	
12.13	
0.00	
-28.36	
-48.61	
-68.85	
-89.10	
-109.35	
-129.59	

ST: NSLE-3
Avg Nodal Active-
MAX : 7438
MIN : 15774
FILE: F02-V-IN-F-
UNIT: kN*m/m
DATE: 10/04/2014
VIEW-DIRECTION
X: 0.613
Y: 0.487
Z: 0.623

A.5.4.17. Load combination SLE 4

Plate force\_Fxx / ST\_NSLE-4

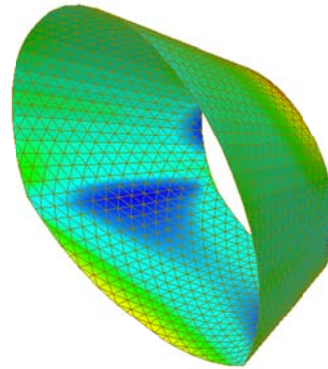
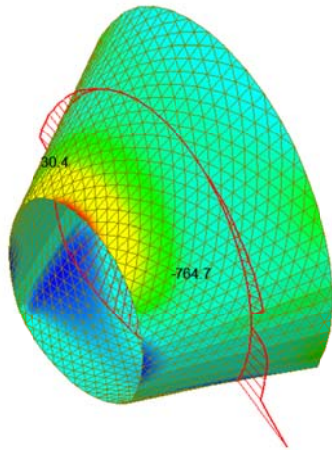


Plate force\_Fyy / ST\_NSLE-4

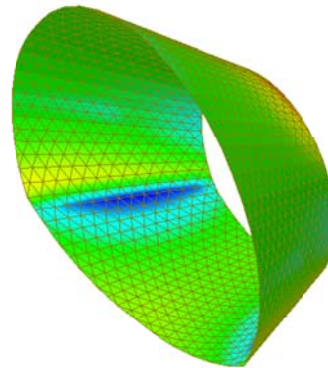
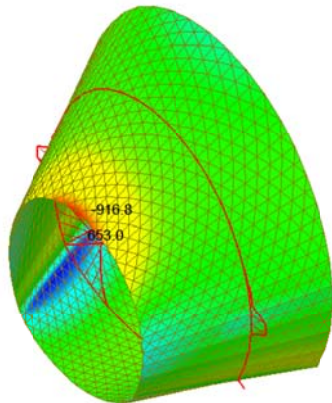


Plate force\_Mxx / ST\_NSLE-4

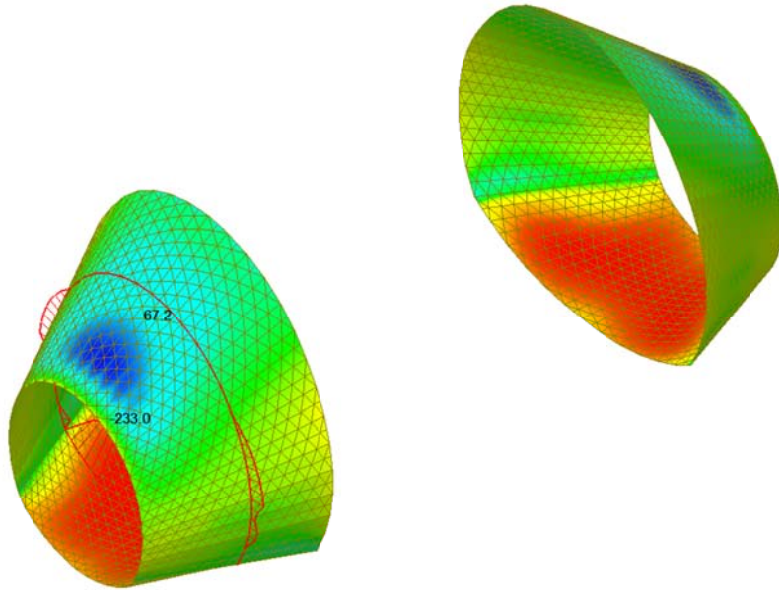
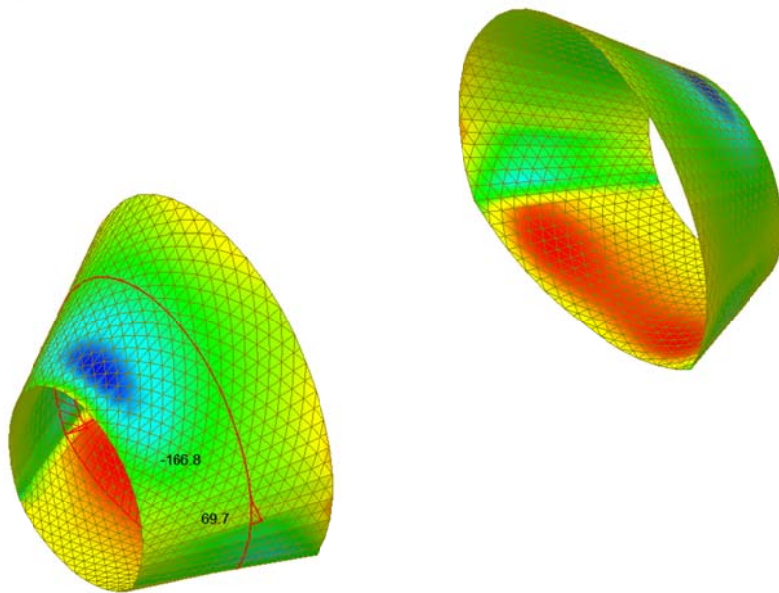


Plate force\_Myy / ST\_NSLE-4



A.5.4.18. Load combination SLE 5

Plate force\_Fxx / ST\_NSLE-5

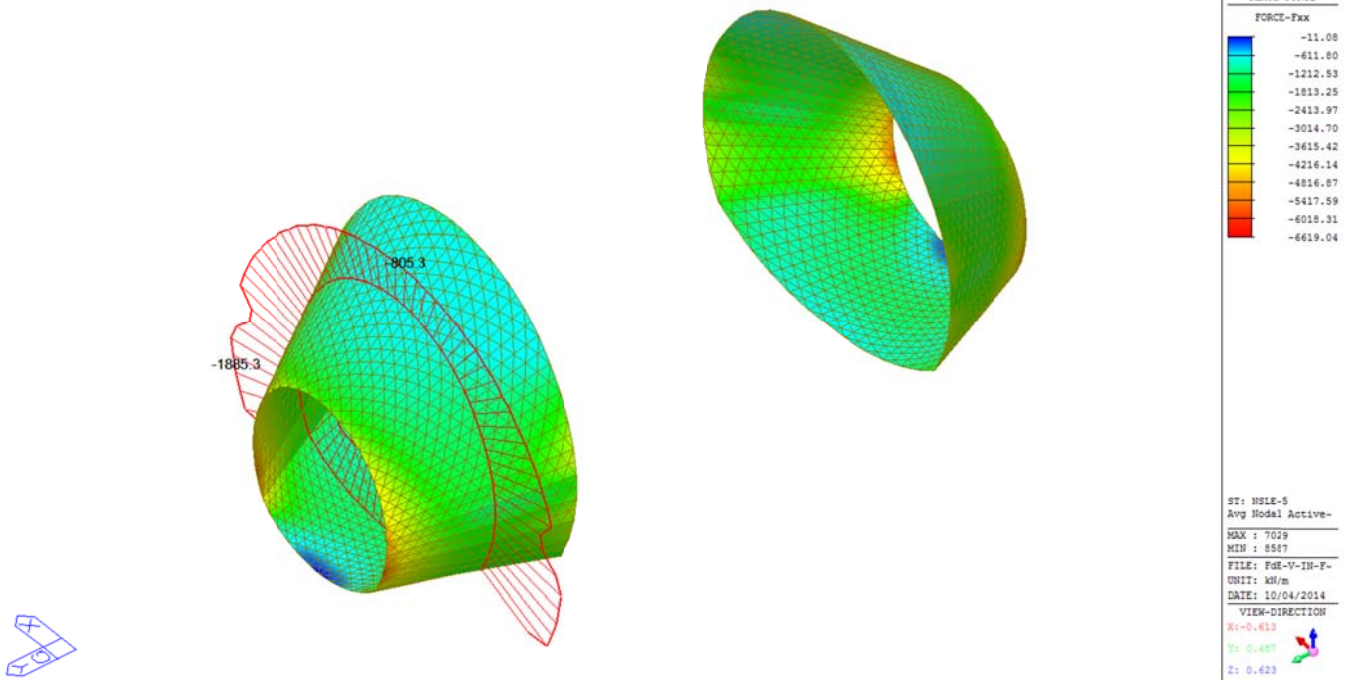


Plate force\_Fyy / ST\_NSLE-5

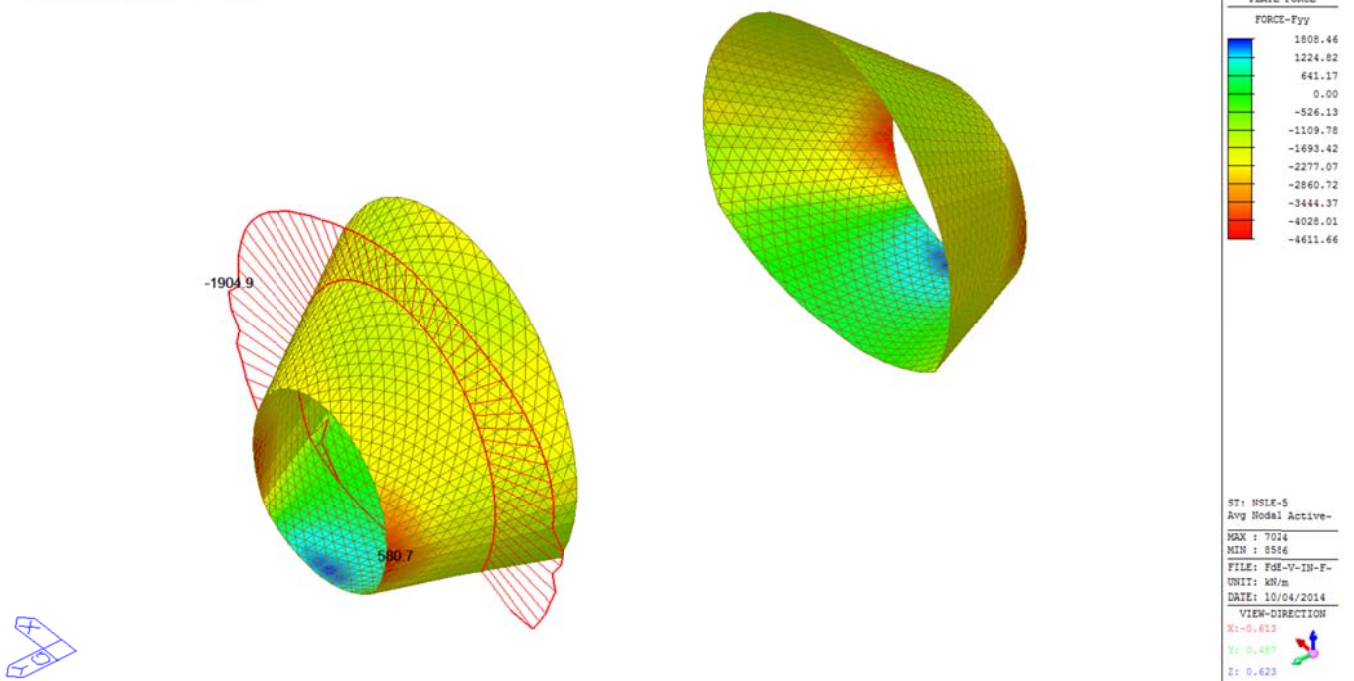
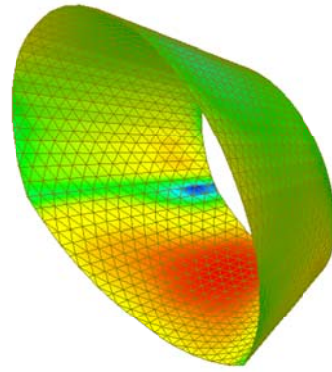
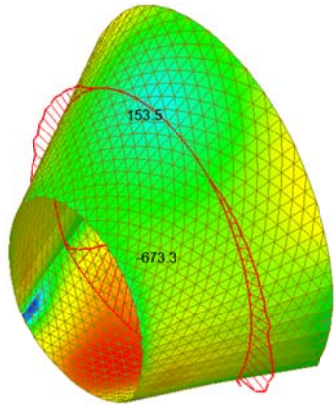


Plate force\_Mxx / ST\_NSLE-5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

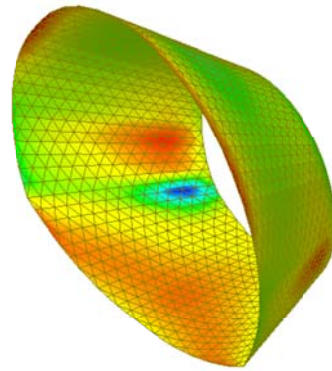
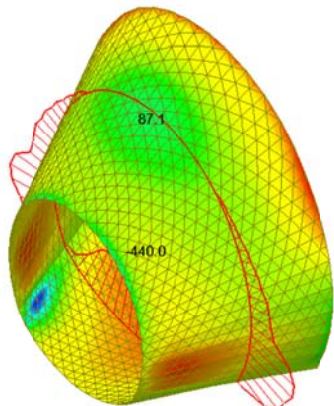
MOMENT-Mxx

304.26
209.18
114.09
0.00
-76.08
-171.17
-266.25
-361.34
-456.42
-551.51
-646.59
-741.68

ST: NSLE-5  
Avg Nodal Active-  
MAX : 8464  
MIN : 7013  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

Plate force\_Myy / ST\_NSLE-5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

266.42
192.20
117.98
43.77
0.00
-104.66
-176.88
-253.10
-327.31
-401.53
-475.74
-549.96

ST: NSLE-5  
Avg Nodal Active-  
MAX : 8459  
MIN : 16233  
FILE: F02-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.613  
Y: 0.487  
Z: 0.623

A.5.4.19. Load combination SLE 6

Plate force\_Fxx / ST\_NSLE-6

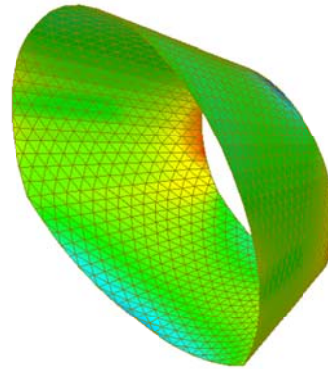
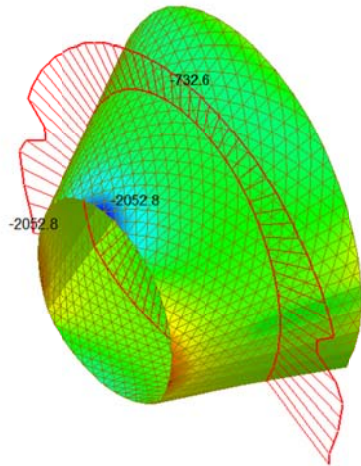


Plate force\_Fyy / ST\_NSLE-6

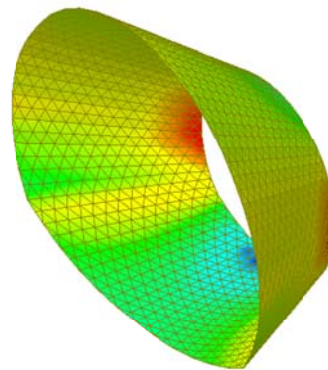
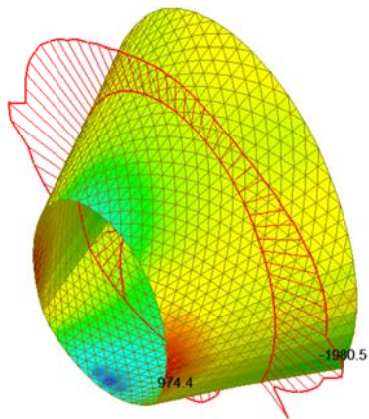


Plate force\_Mxx / ST\_NSLE-6

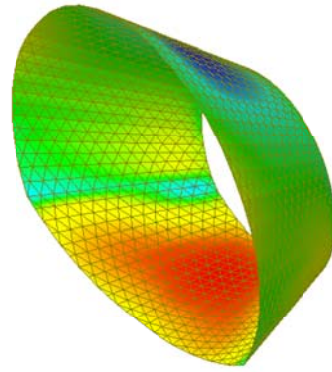
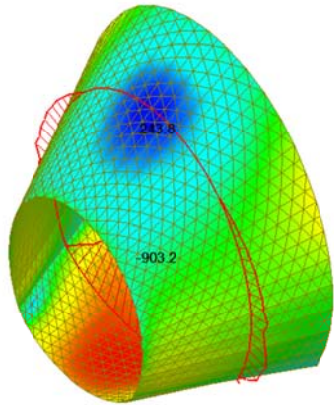
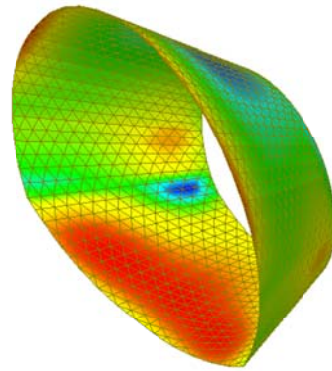
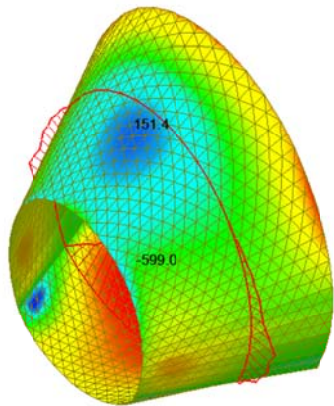


Plate force\_Myy / ST\_NSLE-6



A.5.4.20. Stress checking:

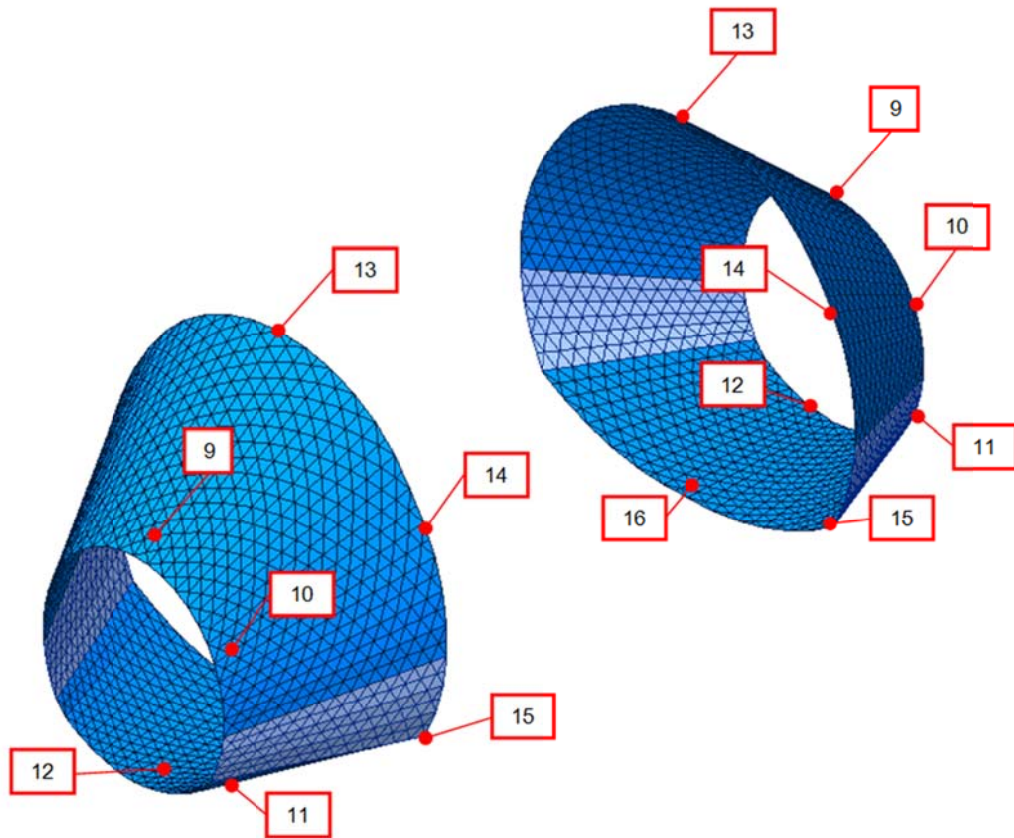


Figure 9 Numbering of sections checked

Spessore anello [cm]	60				Ø	60				Ø	90				Ø	120				Ø	
Sezioni	9				18/15 18/15	10				16/15 16/15	11				16/15 16/15	12				18/15 18/15	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	
SLE	1	-409.3	-36.9	-0.8	0.00	-608.5	-34.5	-8.3	0.00	-570.1	79.6	88.9	0.00	-57.8	-43.9	-12.9	0.00				
	2	558.8	95.4	-5.0	0.02	-83.8	-20.8	56.5	0.00	-596.6	-54.2	-255.0	0.00	-422.3	-196.7	2.4	0.00				
	3	-400.9	-36.2	-0.8	0.00	-609.7	-35.0	-7.6	0.00	-568.4	77.6	84.0	0.00	-62.7	-50.0	-12.8	0.00				
	4	572.0	97.0	-5.1	0.02	-90.3	-22.3	58.0	0.00	-592.1	-58.1	-265.6	0.00	-431.6	-209.9	2.5	0.00				
	5	-1255.1	53.9	-13.5	0.00	-3249.9	-161.8	121.6	0.00	-3618.7	304.3	-630.8	0.00	-794.8	-729.5	-70.1	0.02				
	6	-579.4	185.7	-18.6	0.01	-2869.5	-149.8	182.8	0.00	-3634.3	184.6	-888.2	0.00	-1225.0	-935.2	-58.8	0.02				

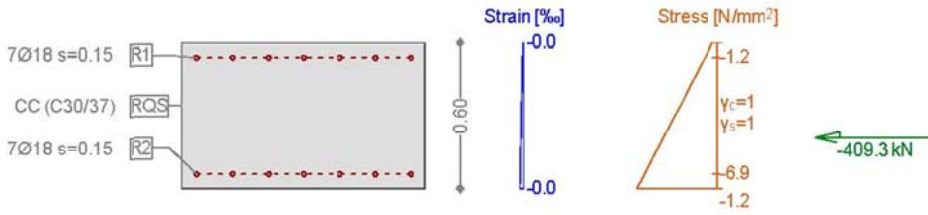
Spessore anello [cm]	60				Ø	60				Ø	90				Ø	120				Ø	
Sezioni	13				18/15 18/15	14				18/15 18/15	15				20/15 20/15	16				20/15 20/15	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	
SLE	1	-176.7	-18.3	1.6	0.00	-324.5	29.9	64.3	0.00	-360.6	-32.5	21.6	0.00	-454.4	-24.1	14.2	0.00				
	2	141.1	104.1	9.3	0.01	54.4	-69.7	-47.3	0.01	-403.4	8.6	-178.0	0.00	725.0	-177.7	-32.9	0.02				
	3	-173.4	-18.2	1.6	0.00	-317.3	30.4	64.1	0.00	-364.9	-32.0	19.9	0.00	-458.3	-27.0	14.4	0.00				
	4	141.7	104.2	9.3	0.01	60.6	-68.7	-46.7	0.01	-418.3	52.8	-180.3	0.00	694.1	-182.3	-32.2	0.02				
	5	-1404.5	198.1	29.4	0.00	-2039.2	-95.0	199.3	0.00	-2034.1	72.5	-382.7	0.00	-915.1	-479.2	13.7	0.01				
	6	-1161.5	332.2	39.9	0.08	-1754.1	-178.1	102.5	0.00	-1843.3	95.3	-574.8	0.00	254.6	-664.4	-44.5	0.02				



• SECTION 9

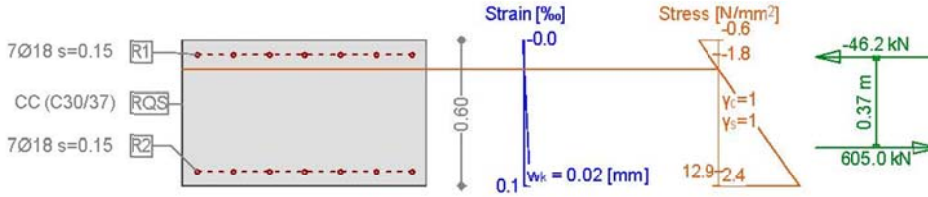
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-409.3$ ;  $M_y=-36.9$ ;

Scale 1 :30.0



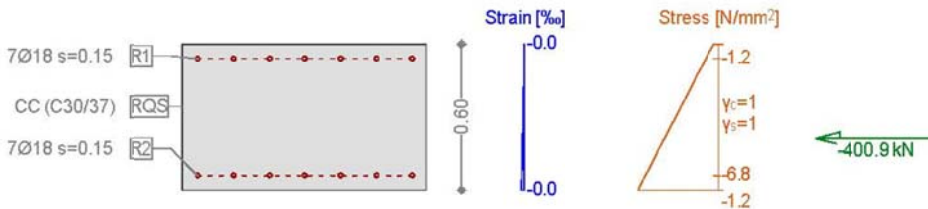
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=558.8$ ;  $M_y=95.4$ ;

Scale 1 :30.0



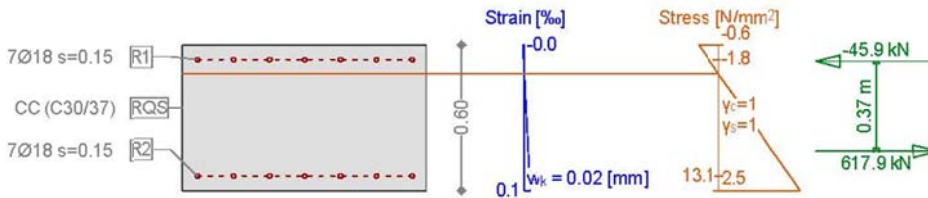
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-400.9$ ;  $M_y=-36.2$ ;

Scale 1 :30.0



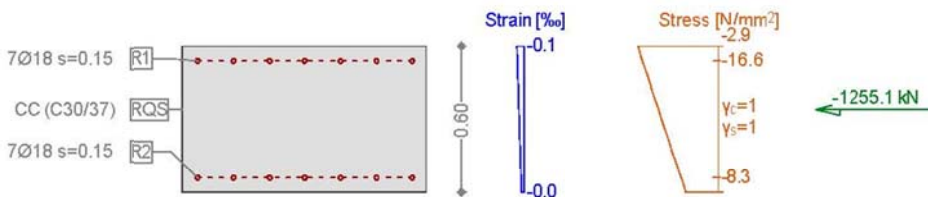
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=572.0$ ;  $M_y=97.0$ ;

Scale 1 :30.0



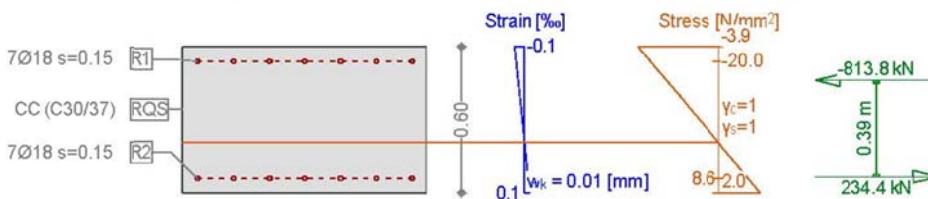
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1255.1$ ;  $M_y=53.9$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-579.4$ ;  $M_y=185.7$ ;

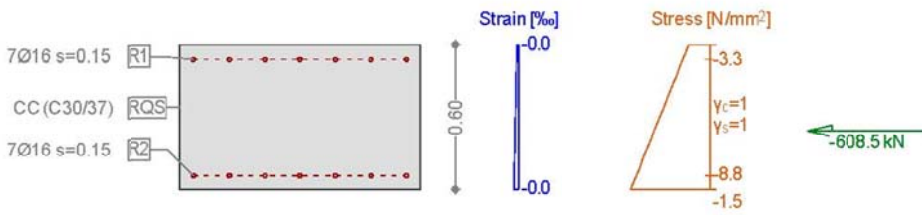
Scale 1 :30.0



• SECTION 10

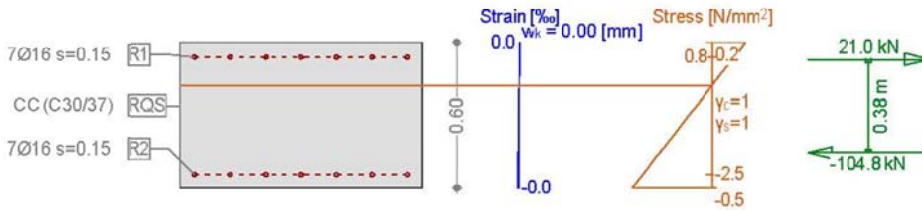
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-608.5$ ;  $M_y=-34.5$ ;

Scale 1 :30.0



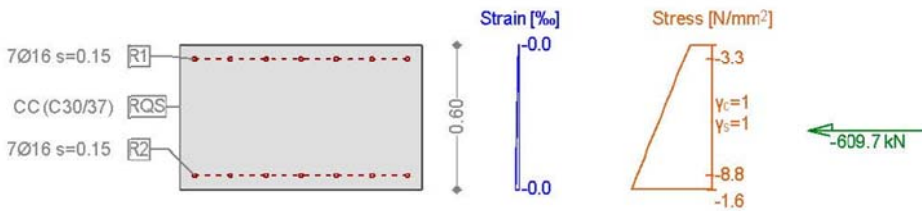
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-83.8$ ;  $M_y=-20.8$ ;

Scale 1 :30.0



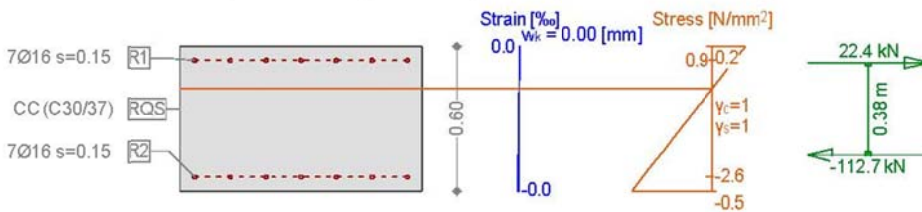
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-609.7$ ;  $M_y=-35.0$ ;

Scale 1 :30.0



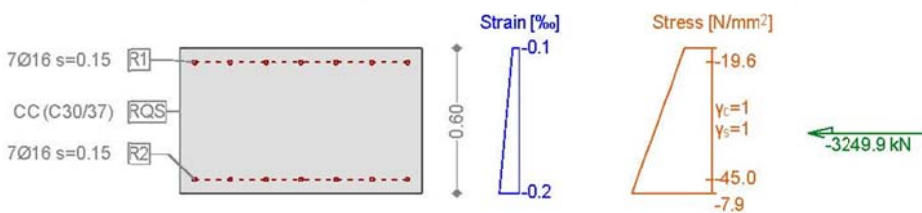
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-90.3$ ;  $M_y=-22.3$ ;

Scale 1 :30.0



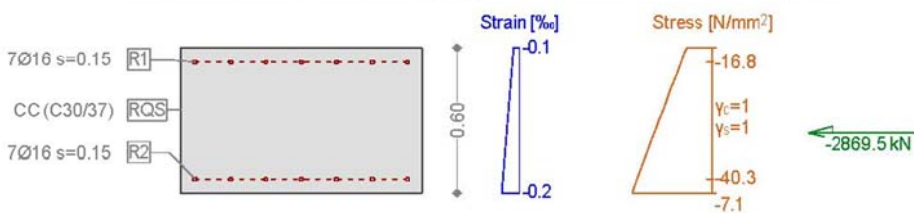
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3249.9$ ;  $M_y=-161.8$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-2869.5$ ;  $M_y=-149.8$ ;

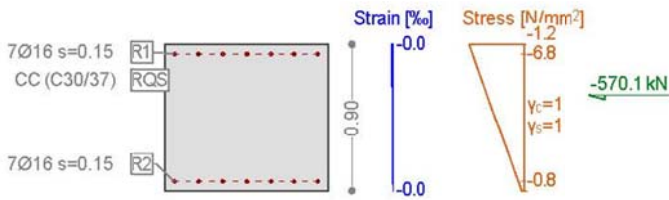
Scale 1 :30.0



- SECTION 11

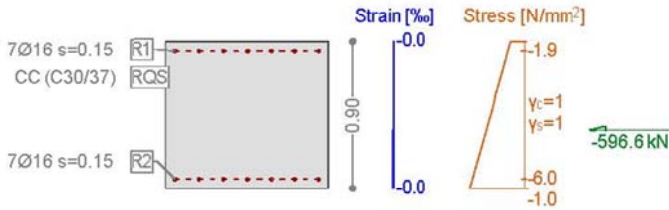
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-570.1$ ;  $M_y=79.6$ ;

Scale 1 : 45.0



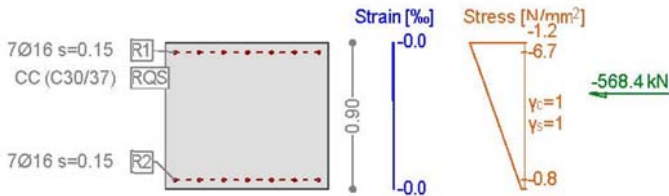
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-596.6$ ;  $M_y=-54.2$ ;

Scale 1 : 45.0



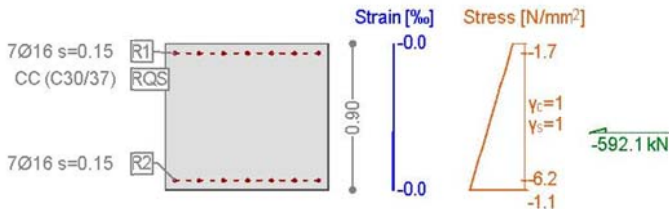
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-568.4$ ;  $M_y=77.6$ ;

Scale 1 : 45.0



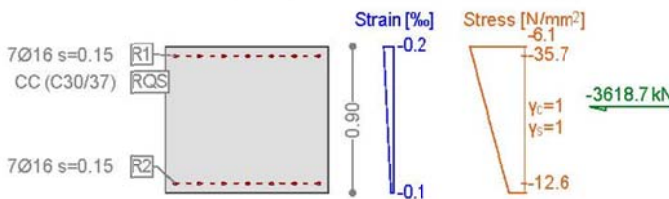
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-592.1$ ;  $M_y=-58.1$ ;

Scale 1 : 45.0



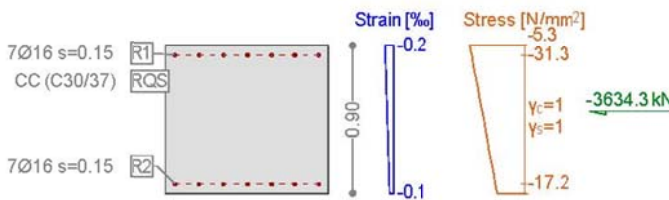
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3618.7$ ;  $M_y=304.3$ ;

Scale 1 : 45.0



Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3634.3$ ;  $M_y=184.6$ ;

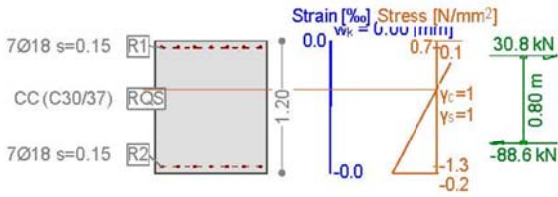
Scale 1 : 45.0



- SECTION 12

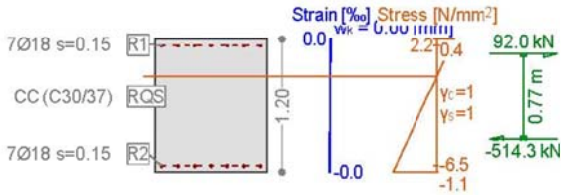
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-57.8; M_y=-43.9;$

Scale 1 :65.0



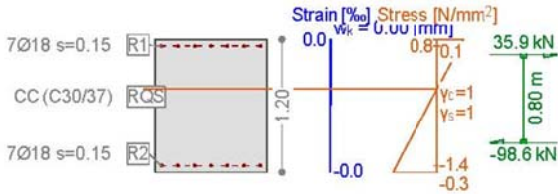
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-422.3; M_y=-196.7;$

Scale 1 :65.0



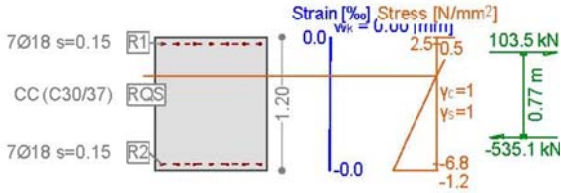
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-62.7; M_y=-50.0;$

Scale 1 :65.0



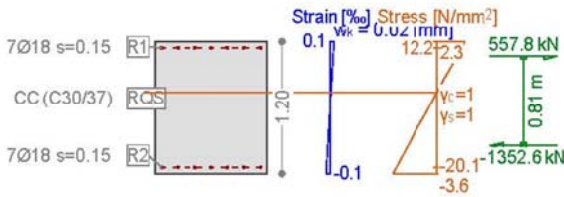
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-431.6; M_y=-209.9;$

Scale 1 :65.0



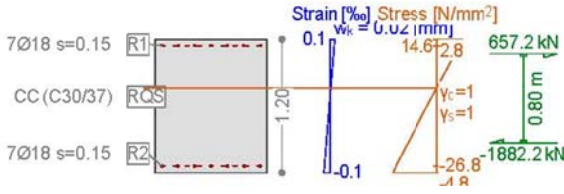
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-794.8; M_y=-729.5;$

Scale 1 :65.0



Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1225.0; M_y=-935.2;$

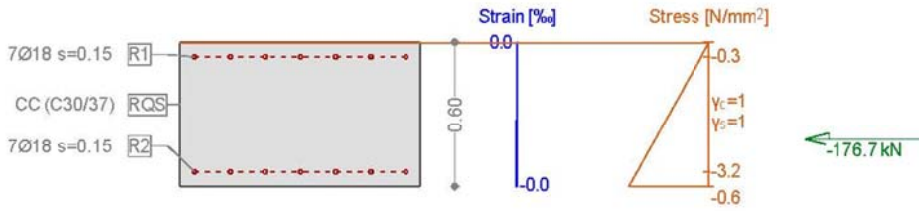
Scale 1 :65.0



• SECTION 13

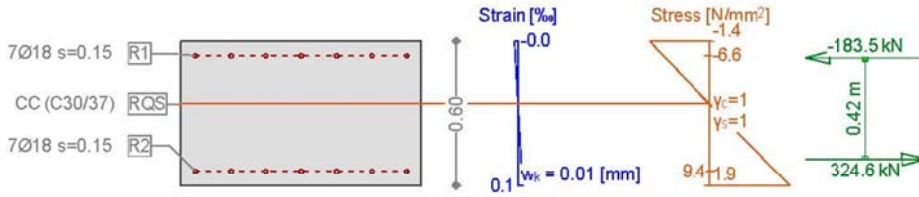
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-176.7$ ;  $M_y=-18.3$ ;

Scale 1 :30.0



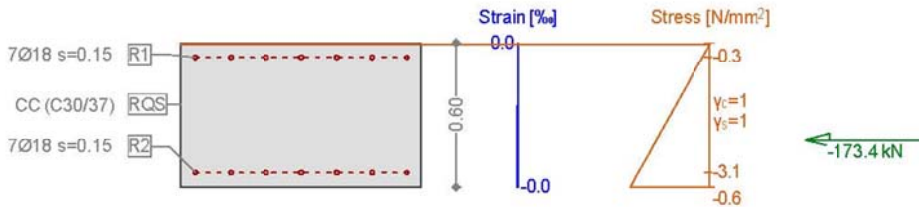
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=141.1$ ;  $M_y=104.1$ ;

Scale 1 :30.0



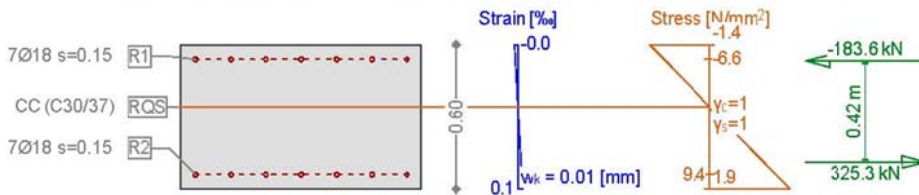
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-173.4$ ;  $M_y=-18.2$ ;

Scale 1 :30.0



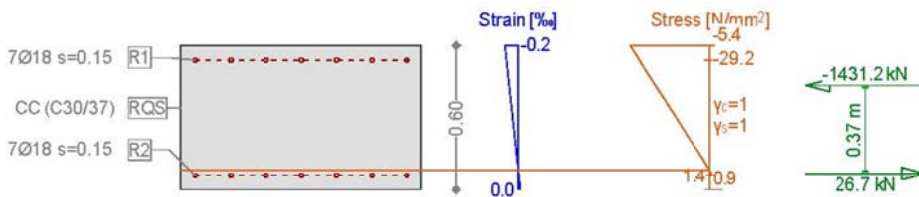
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=141.7$ ;  $M_y=104.2$ ;

Scale 1 :30.0



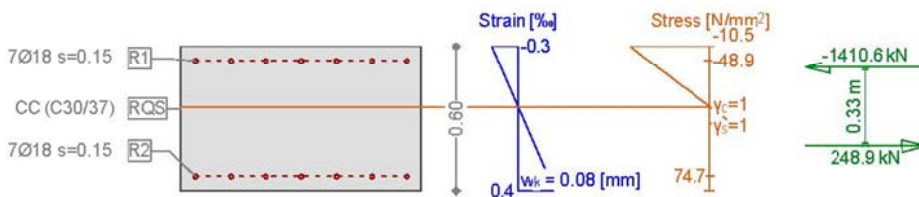
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1404.5$ ;  $M_y=198.1$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1161.5$ ;  $M_y=332.2$ ;

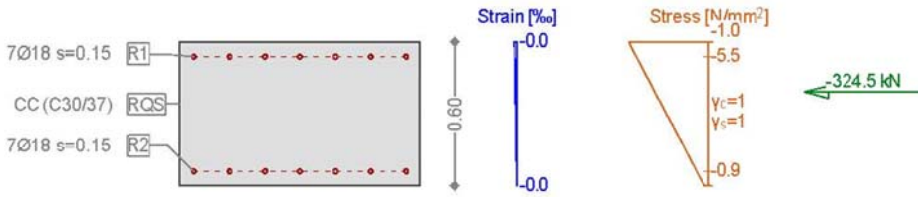
Scale 1 :30.0



• SECTION 14

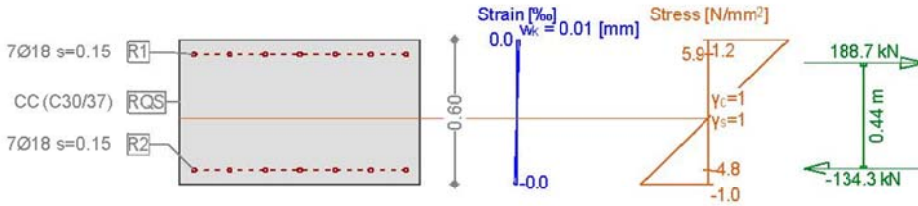
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-324.5$ ;  $M_y=29.9$ ;

Scale 1 :30.0



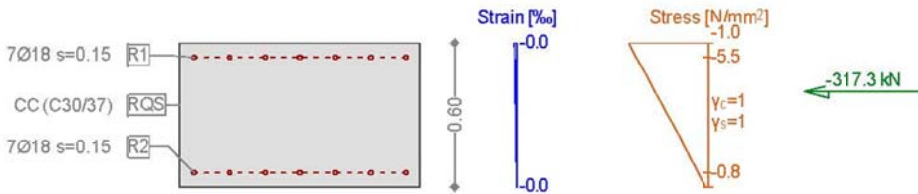
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=54.4$ ;  $M_y=-69.7$ ;

Scale 1 :30.0



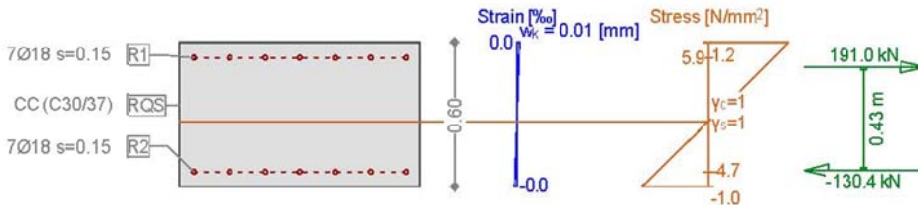
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-317.3$ ;  $M_y=30.4$ ;

Scale 1 :30.0



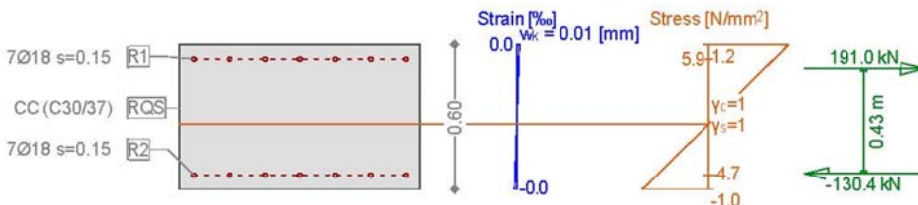
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=60.6$ ;  $M_y=-68.7$ ;

Scale 1 :30.0



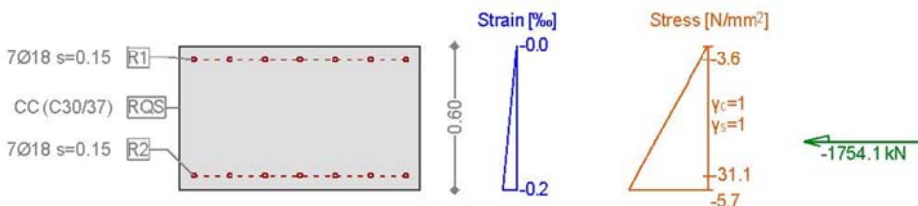
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=60.6$ ;  $M_y=-68.7$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1754.1$ ;  $M_y=-178.1$ ;

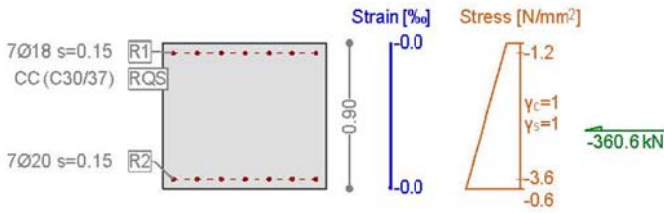
Scale 1 :30.0



- SECTION 15

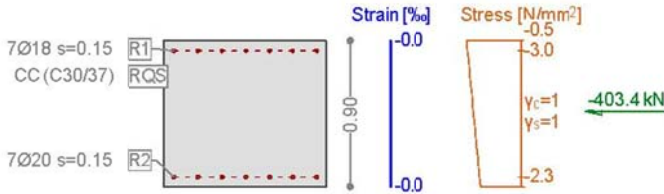
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-360.6$ ;  $M_y=-32.5$ ;

Scale 1 :45.0



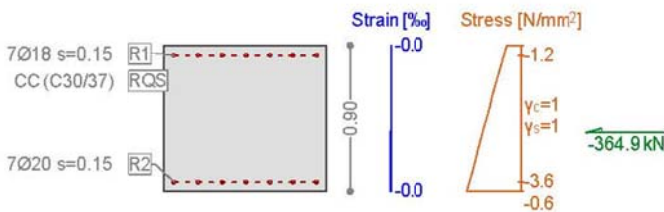
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-403.4$ ;  $M_y=8.6$ ;

Scale 1 :45.0



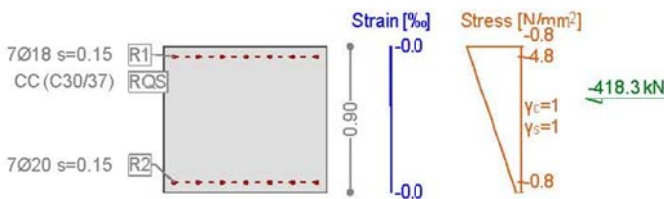
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-364.9$ ;  $M_y=-32.0$ ;

Scale 1 :45.0



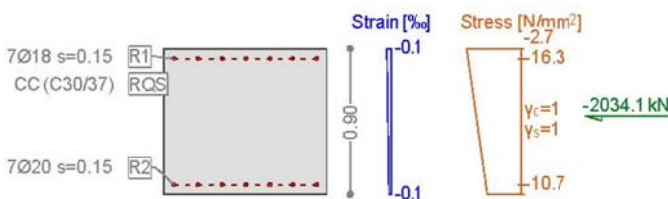
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-418.3$ ;  $M_y=52.8$ ;

Scale 1 :45.0



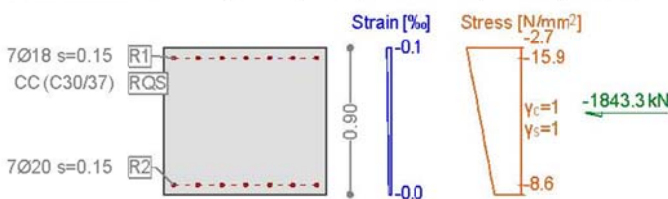
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-2034.1$ ;  $M_y=72.5$ ;

Scale 1 :45.0



Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1843.3$ ;  $M_y=95.3$ ;

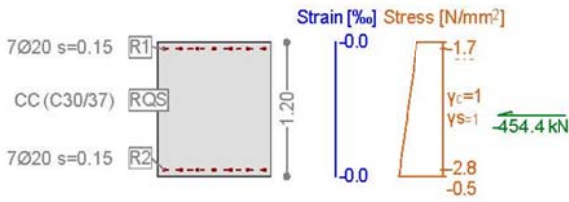
Scale 1 :45.0



- SECTION 16

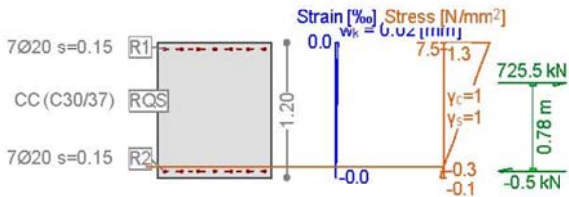
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-454.4;M_y=-24.1$ ;

Scale 1 :65.0



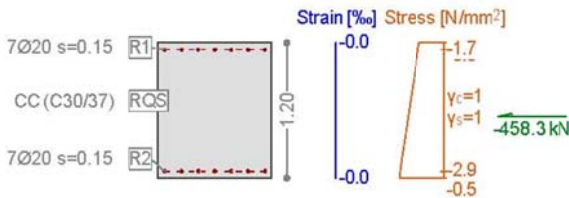
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=725.0;M_y=-177.7$ ;

Scale 1 :65.0



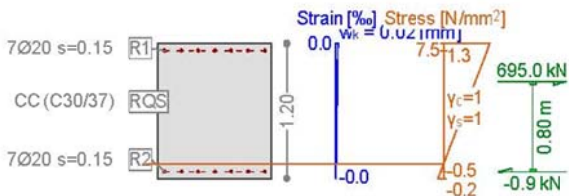
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-458.3;M_y=-27.0$ ;

Scale 1 :65.0



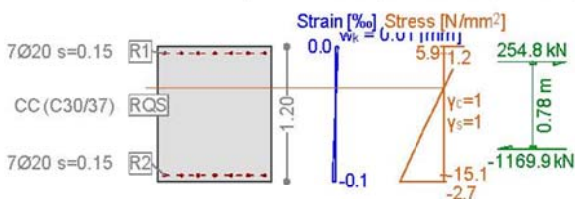
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=694.1;M_y=-182.3$ ;

Scale 1 :65.0



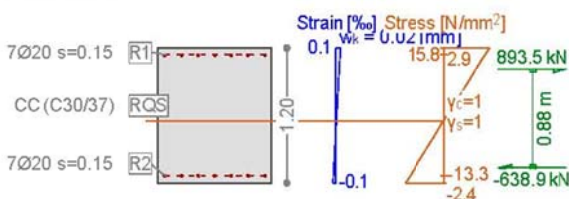
Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-915.1;M_y=-479.2$ ;

Scale 1 :65.0



Cross-section 1200X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=254.6;M_y=-664.4$ ;

Scale 1 :65.0





## A.5.5. Output and check result for cross section FdE-Va-IN-FdE-CcTa

### A.5.5.1. Load combination SLU 1

Plate force\_Fxx / ST\_N1

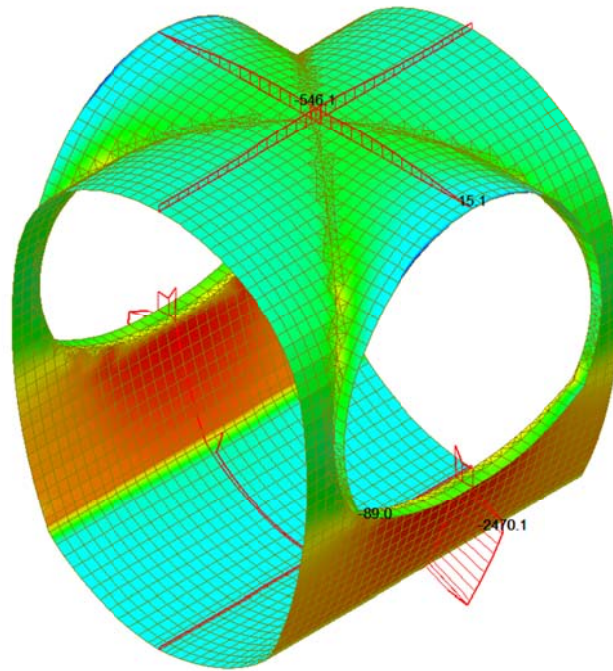


Plate force\_Fyy / ST\_N1

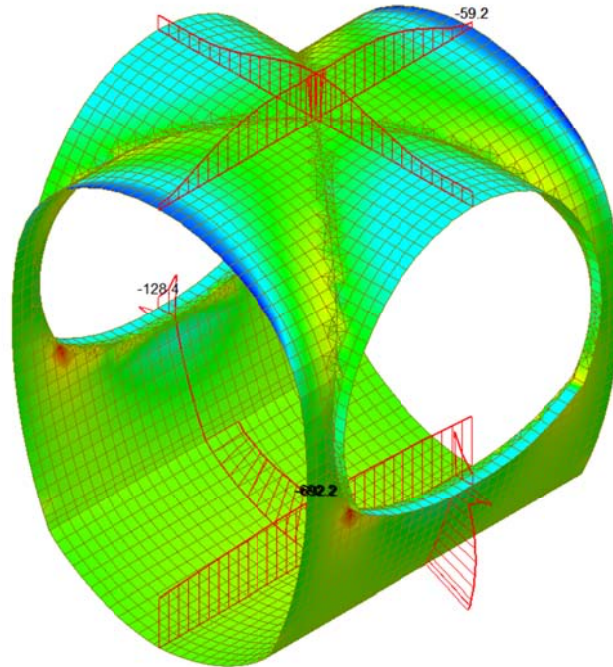
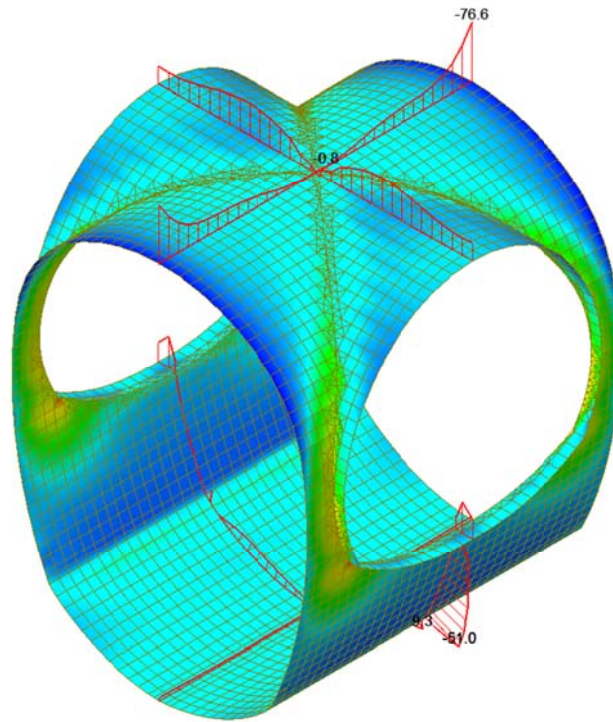


Plate force\_Mxx / ST\_N1



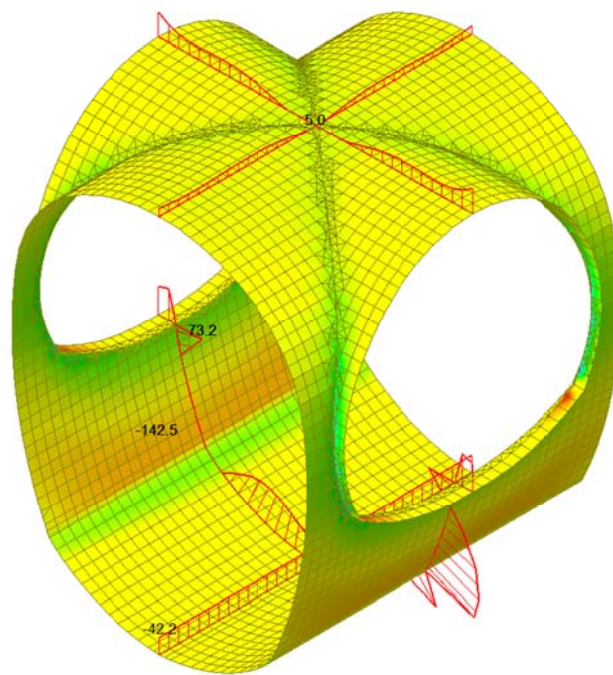
midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

287.91
254.26
220.62
186.98
153.34
119.70
86.06
52.41
18.77
0.00
-48.51
-82.15

ST: N1  
Avg Nodal Active-  
MAX : 21409  
MIN : 20328  
FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_N1



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

293.02
238.36
183.70
129.04
74.39
0.00
-34.93
-89.59
-144.25
-198.91
-253.57
-308.23

ST: N1  
Avg Nodal Active-  
MAX : 20774  
MIN : 20773  
FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Vxx / ST\_N1

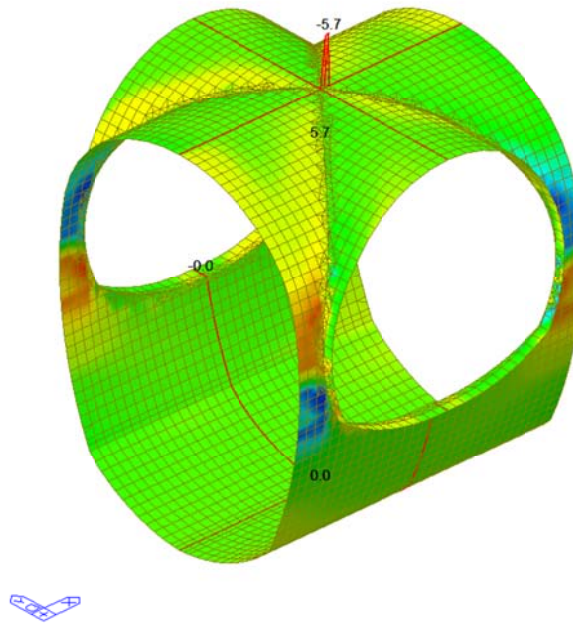
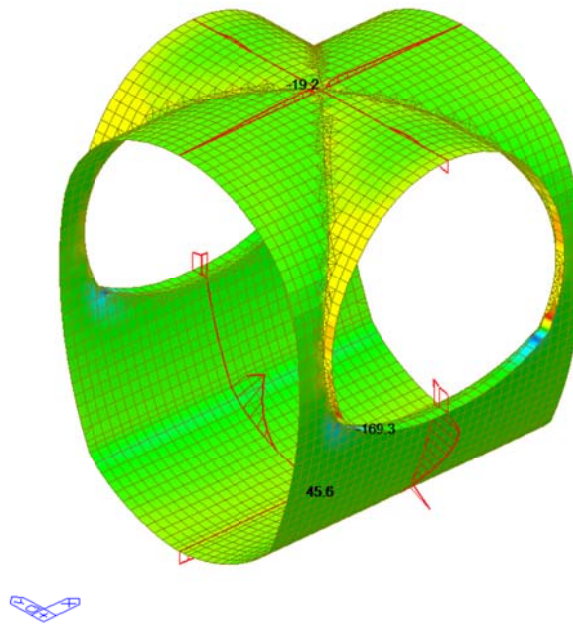
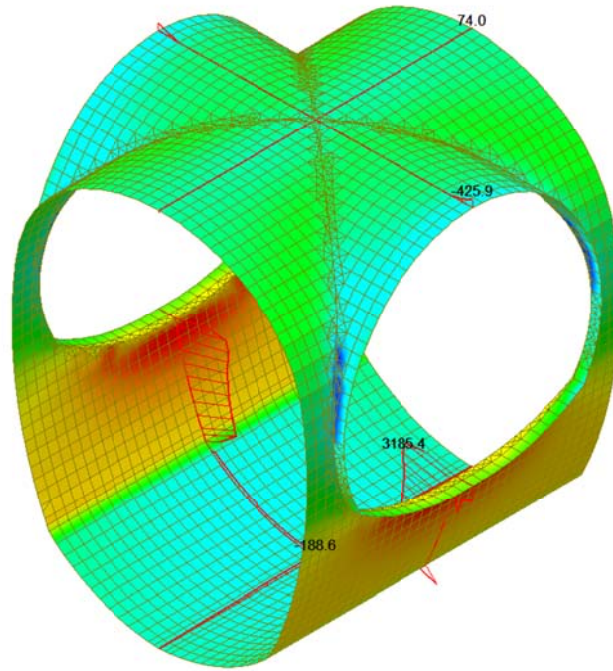


Plate force\_Vyy / ST\_N1



A.5.5.2. Load combination SLU 2

Plate force\_Fxx / ST\_N2



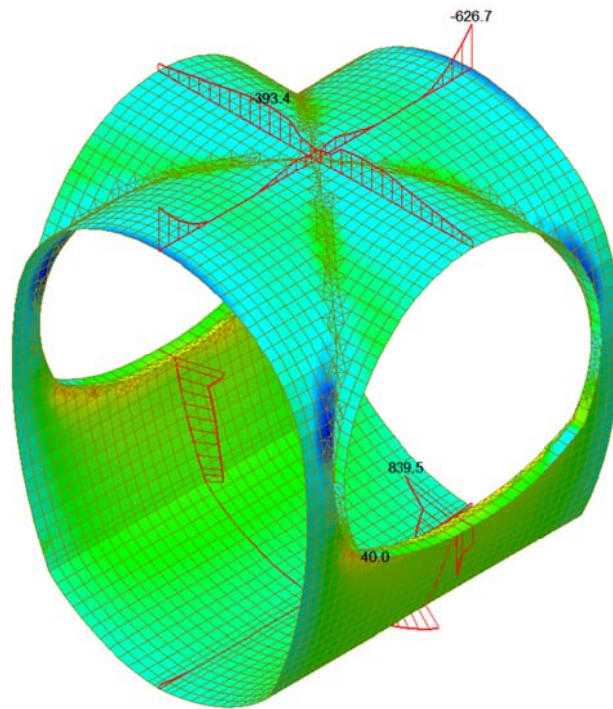
midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fxx	
3185.39	
2791.53	
2397.67	
2003.82	
1609.96	
1216.11	
822.25	
428.40	
0.00	
-359.31	
-753.17	
-1147.03	

ST: N2
Avg Nodal Active-
MAX : 21615
MIN : 23194
FILE: FdE-V-IN-F-
UNIT: kN/m
DATE: 10/24/2014
VIEW-DIRECTION
X: -0.584
Y: 0.574
Z: 0.574



Plate force\_Fyy / ST\_N2



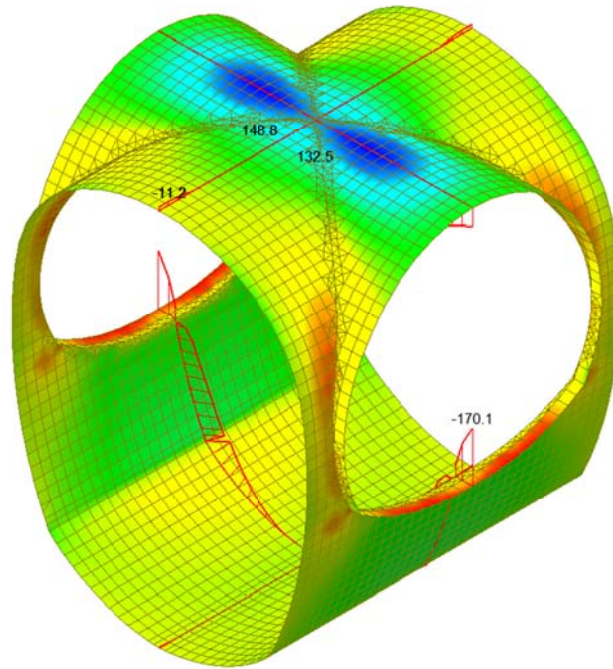
midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fyy	
1919.67	
1667.00	
1414.33	
1161.67	
909.00	
656.33	
403.66	
150.99	
0.00	
-354.34	
-607.01	
-859.68	

ST: N2
Avg Nodal Active-
MAX : 23568
MIN : 21081
FILE: FdE-V-IN-F-
UNIT: kN/m
DATE: 10/24/2014
VIEW-DIRECTION
X: -0.584
Y: 0.574
Z: 0.574



Plate force\_Mxx / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

148.79
116.57
84.35
52.14
19.92
0.00
-44.51
-76.73
-108.95
-141.16
-173.38
-205.59

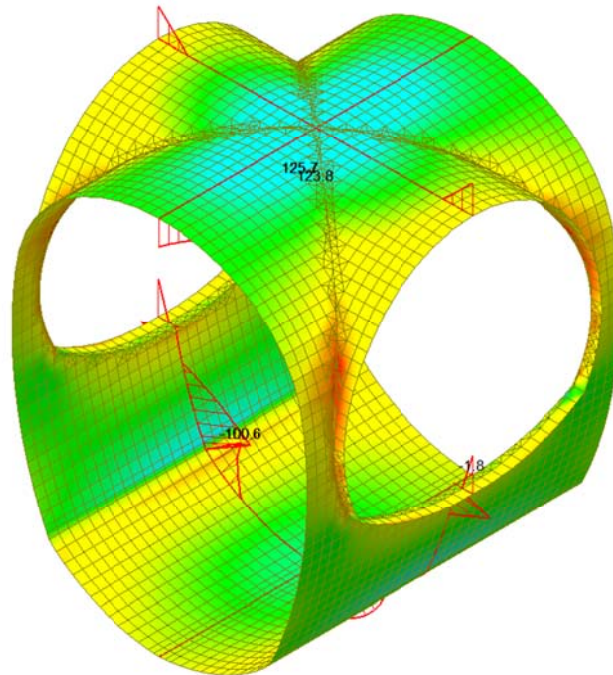
ST: N2  
Avg Nodal Active-

MAX : 19926  
MIN : 22093

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_N2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

152.98
121.54
90.11
58.67
27.24
0.00
-35.63
-67.07
-98.50
-129.94
-161.37
-192.81

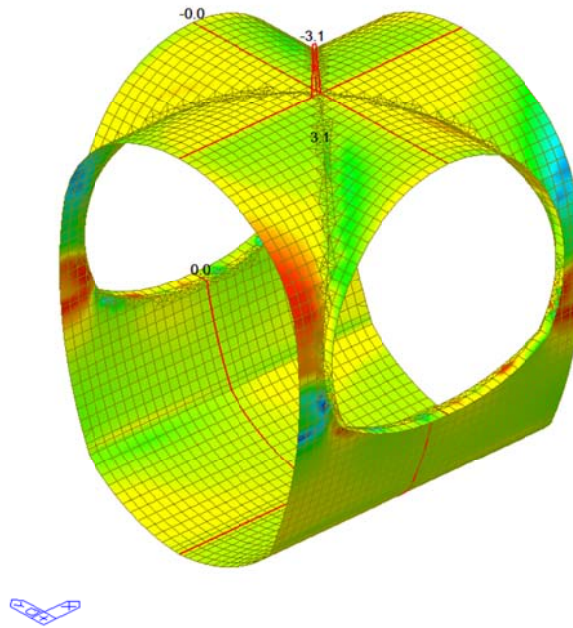
ST: N2  
Avg Nodal Active-

MAX : 19932  
MIN : 20792

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Vxx / ST\_N2

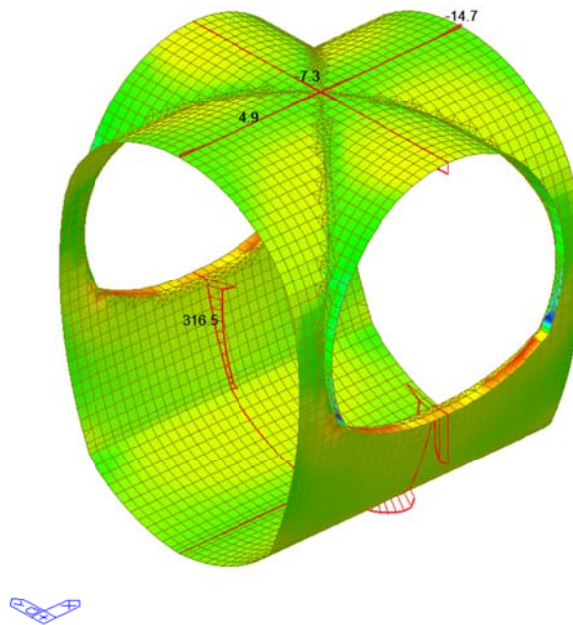


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
	166.84
	136.50
	106.16
	75.82
	45.49
	0.00
	-15.19
	-45.53
	-75.86
	-106.20
	-136.54
	-166.88

ST: N2	Avg Modal Active-
MAX : 22789	
MIN : 20177	
FILE: F02-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.582	
Y: 0.635	
Z: 0.508	

Plate force\_Vyy / ST\_N2



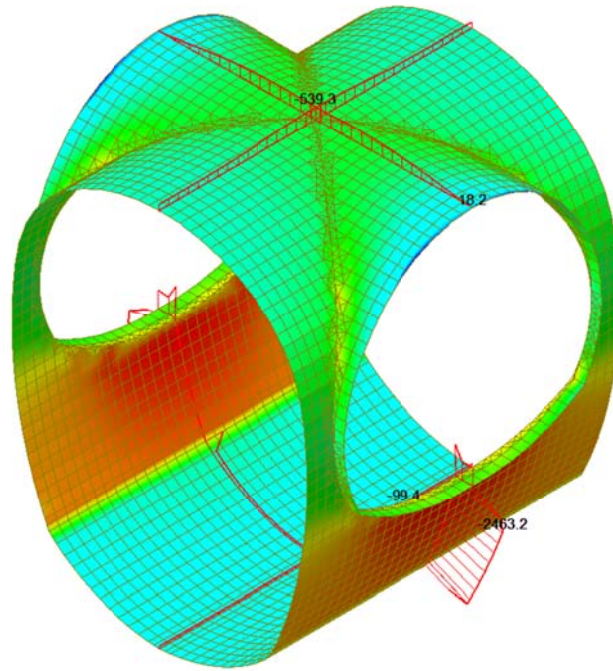
midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
	403.85
	330.95
	258.06
	185.16
	112.27
	39.37
	0.00
	-106.42
	-179.31
	-252.20
	-325.10
	-397.99

ST: N2	Avg Modal Active-
MAX : 19374	
MIN : 20774	
FILE: F02-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.582	
Y: 0.635	
Z: 0.508	

A.5.5.3. Load combination SLU 3

Plate force\_Fxx / ST\_N3

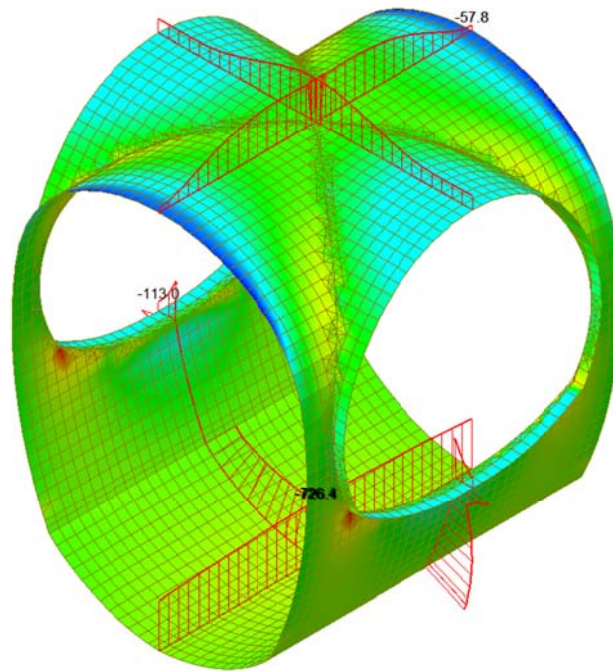


midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fxx	
42.23	
0.00	
-413.31	
-641.08	
-868.85	
-1096.62	
-1324.39	
-1552.16	
-1779.93	
-2007.70	
-2235.47	
-2463.24	

ST: N3	
Avg Nodal Active-	
MAX : 23217	
MIN : 21615	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/24/2014	
VIEW-DIRECTION	
X: -0.584	
Y: 0.574	
Z: 0.574	

Plate force\_Fyy / ST\_N3

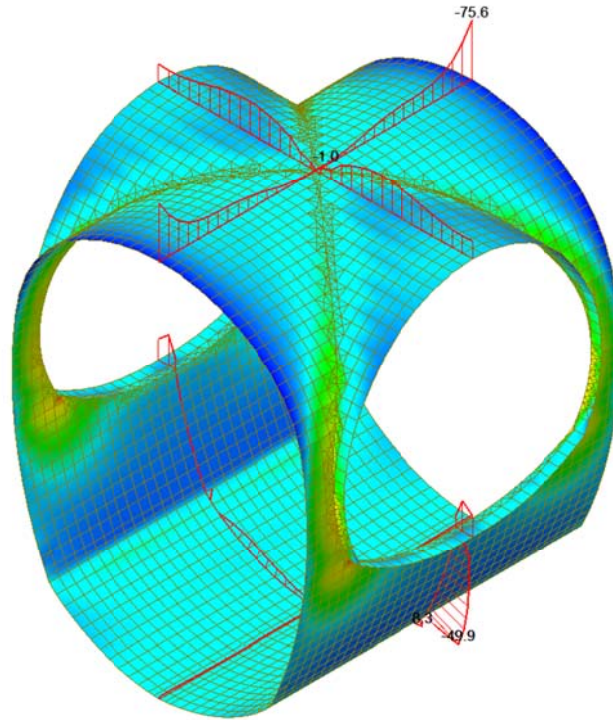


midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fyy	
-13.61	
-165.34	
-317.07	
-468.79	
-620.52	
-772.25	
-923.97	
-1075.70	
-1227.43	
-1379.16	
-1530.88	
-1682.61	

ST: N3	
Avg Nodal Active-	
MAX : 20312	
MIN : 17610	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/24/2014	
VIEW-DIRECTION	
X: -0.584	
Y: 0.574	
Z: 0.574	

Plate force\_Mxx / ST\_N3



midas Gen  
POST-PROCESSOR  
PLATE FORCE

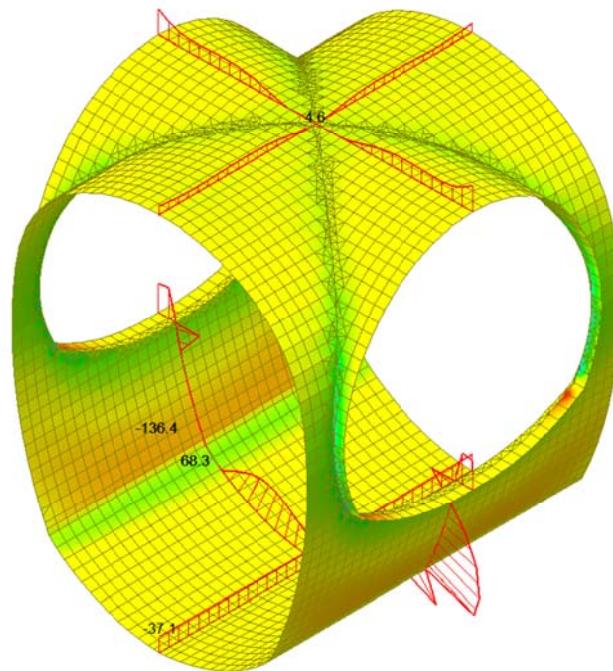
MOMENT-Mxx

281.61
248.58
215.56
182.54
149.52
116.50
83.47
50.45
17.43
0.00
-48.61
-81.63

ST: N3  
Avg Nodal Active-  
MAX : 21409  
MIN : 20328  
FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574



Plate force\_Myy / ST\_N3



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

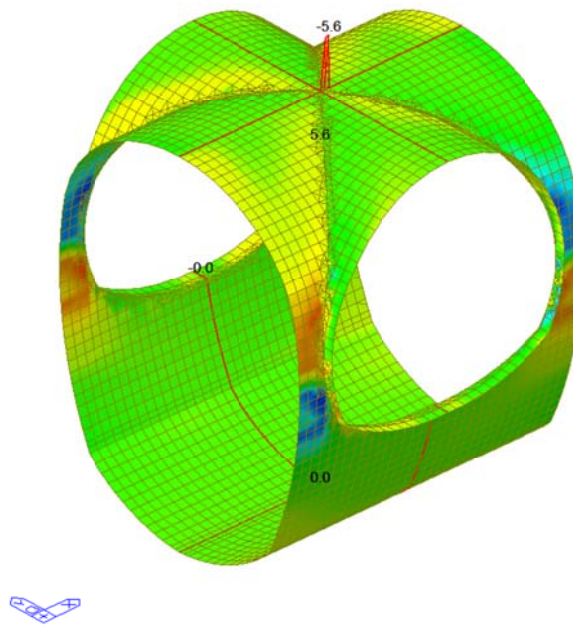
289.23
235.77
182.30
128.83
75.36
0.00
-31.58
-85.05
-138.52
-191.98
-245.45
-298.92

ST: N3  
Avg Nodal Active-  
MAX : 20774  
MIN : 20773  
FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574





Plate force\_Vxx / ST\_N3

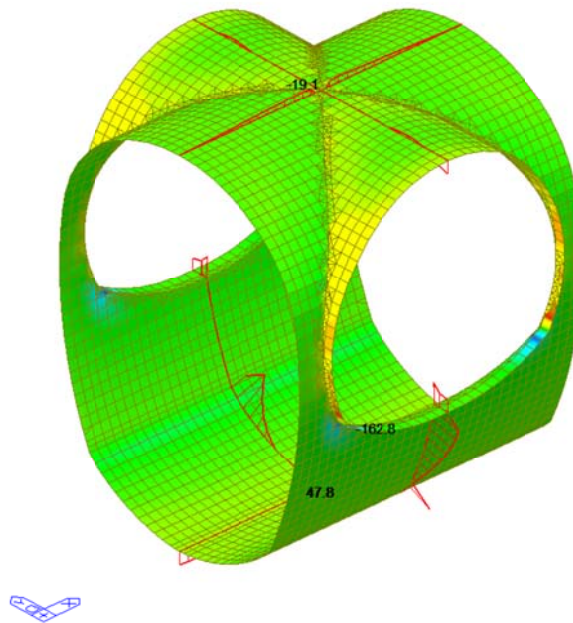


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
260.90	
213.46	
166.03	
118.59	
71.15	
23.72	
0.00	
-71.15	
-118.59	
-166.02	
-213.46	
-260.90	

ST: N3
Avg Modal Active-
MAX : 20.40
MIN : 22.52
FILE: FdE-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.582
Y: 0.635
Z: 0.508

Plate force\_Vyy / ST\_N3



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
516.45	
424.57	
332.68	
240.80	
148.91	
57.02	
0.00	
-126.75	
-218.64	
-310.52	
-402.41	
-494.29	

ST: N3
Avg Modal Active-
MAX : 20774
MIN : 21.38
FILE: FdE-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.582
Y: 0.635
Z: 0.508

A.5.5.4. Load combination SLU 4

Plate force\_Fxx / ST\_N4

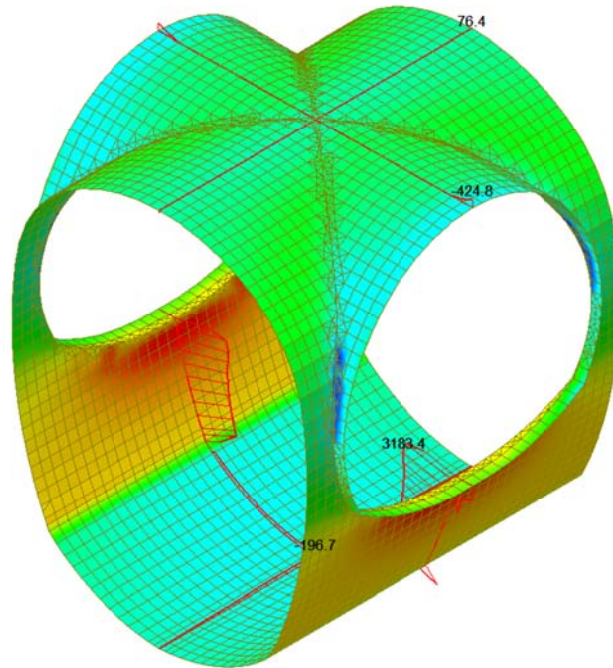


Plate force\_Fyy / ST\_N4

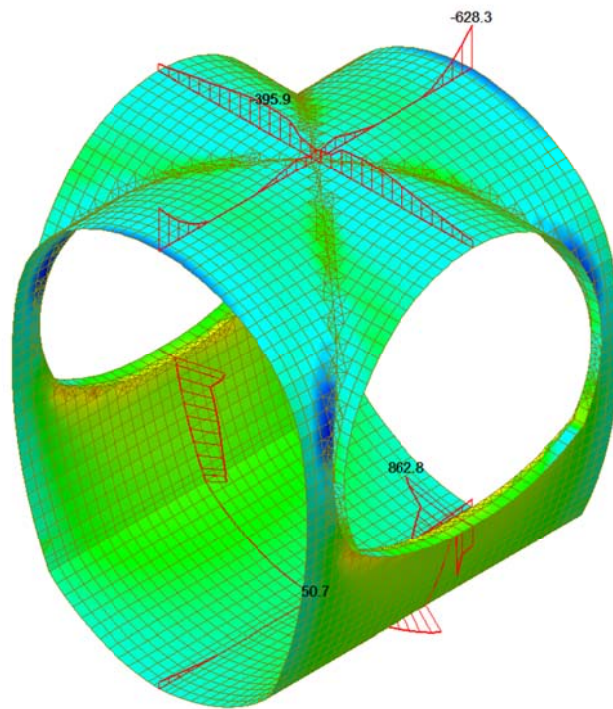
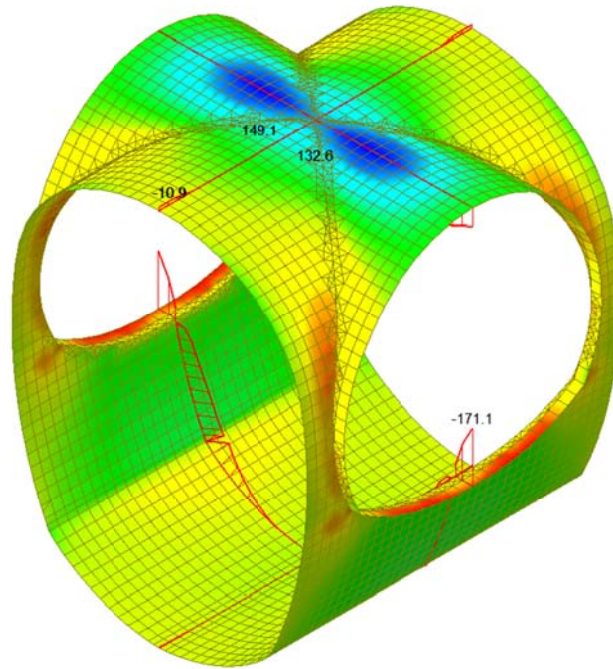


Plate force\_Mxx / ST\_N4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

149.12
116.80
84.47
52.15
19.83
0.00
-44.82
-77.14
-109.47
-141.79
-174.11
-206.44

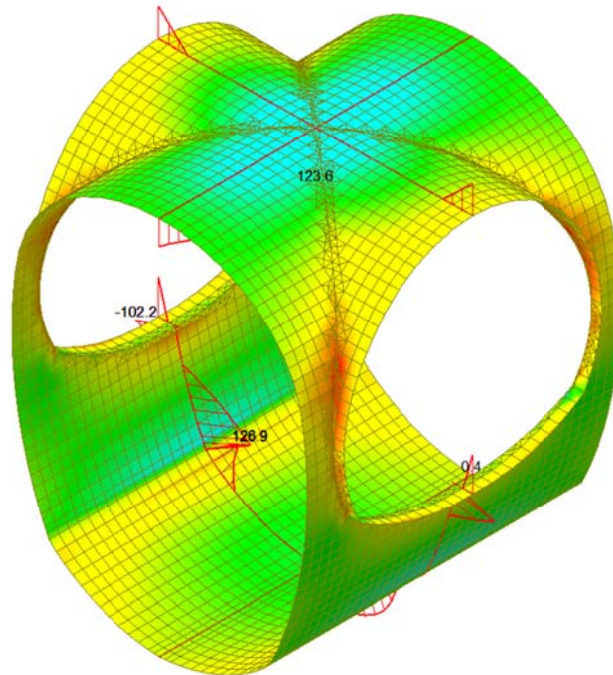
ST: N4  
Avg Nodal Active-

MAX : 19926  
MIN : 22093

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_N4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

158.93
127.07
95.21
63.36
31.50
0.00
-32.22
-64.07
-95.93
-127.79
-159.64
-191.50

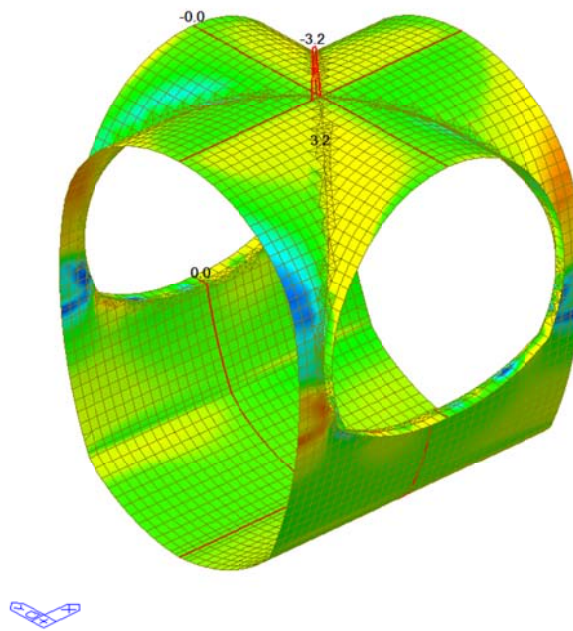
ST: N4  
Avg Nodal Active-

MAX : 19932  
MIN : 20792

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Vxx / ST\_N4

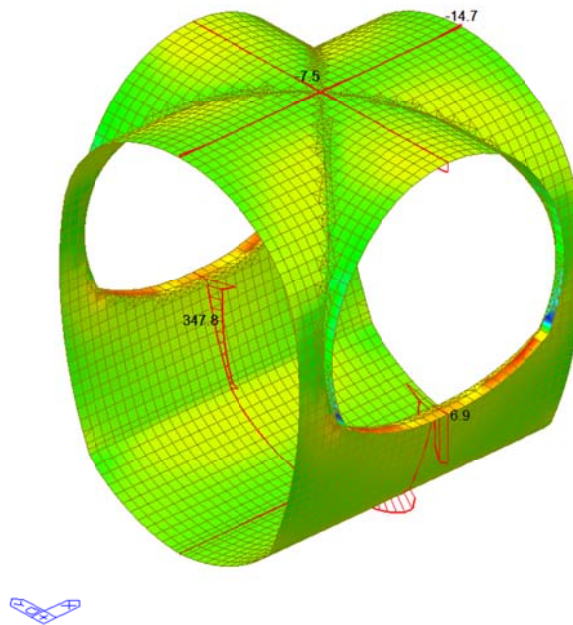


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
179.97	
147.25	
114.53	
81.81	
49.08	
16.36	
0.00	
-49.08	
-81.80	
-114.52	
-147.24	
-179.96	

ST: N4
Avg Modal Active-
MAX : 19428
MIN : 22090
FILE: F02-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.582
Y: 0.635
Z: 0.508

Plate force\_Vyy / ST\_N4



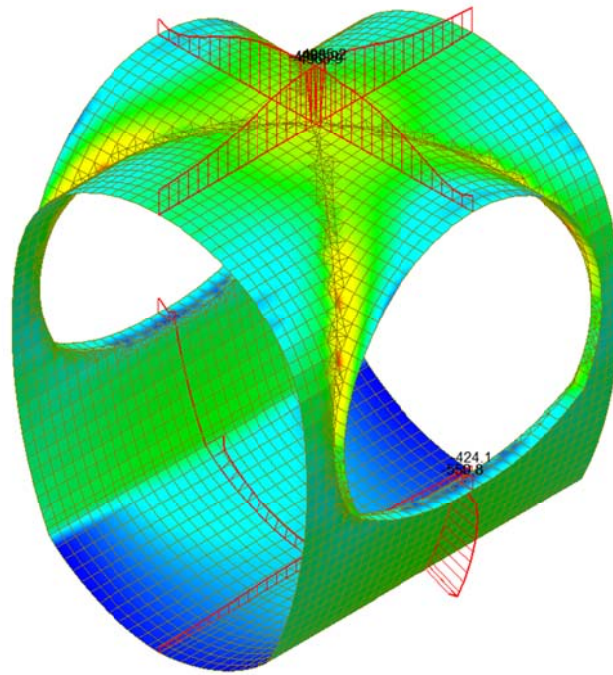
midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
430.56	
354.49	
278.42	
202.35	
126.28	
50.20	
0.00	
-101.94	
-178.01	
-254.09	
-330.16	
-406.23	

ST: N4
Avg Modal Active-
MAX : 19374
MIN : 20774
FILE: F02-V-IN-F-
UNIT: kN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.582
Y: 0.635
Z: 0.508

A.5.5.5. Load combination SLU 5

Plate force\_Fxx / ST\_N5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

FORCE-Fxx

Blue	-321.90
Light Blue	-1270.95
Green	-2220.00
Yellow-Green	-3169.04
Yellow	-4118.09
Orange	-5067.13
Red-Orange	-6016.16
Red	-6965.23
Dark Red	-7914.27
Dark Red	-8863.32
Dark Red	-9812.36
Dark Red	-10761.41

---

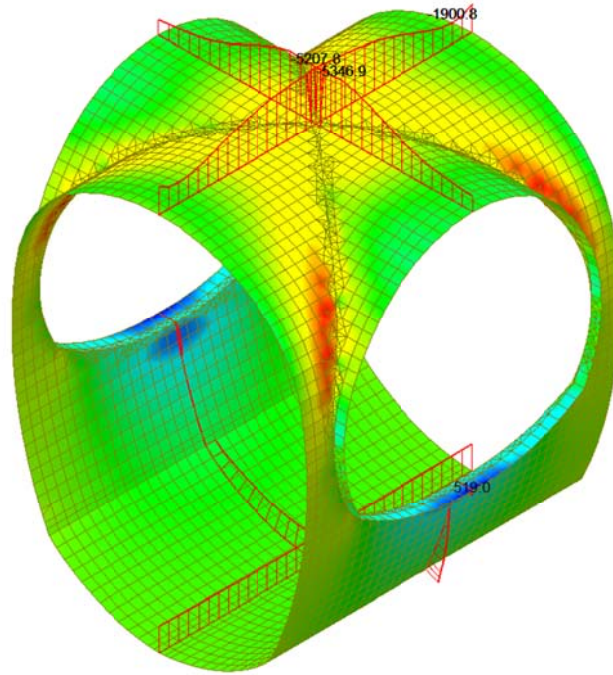
ST: N5  
Avg Nodal Active-

MAX : 20594  
MIN : 20782

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/24/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Fyy / ST\_N5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

FORCE-Fyy

Blue	519.99
Light Blue	0.00
Green	-1081.19
Yellow-Green	-1881.28
Yellow	-2681.37
Orange	-3481.46
Red-Orange	-4281.55
Red	-5081.64
Dark Red	-5881.74
Dark Red	-6681.83
Dark Red	-7481.92
Dark Red	-8282.01

---

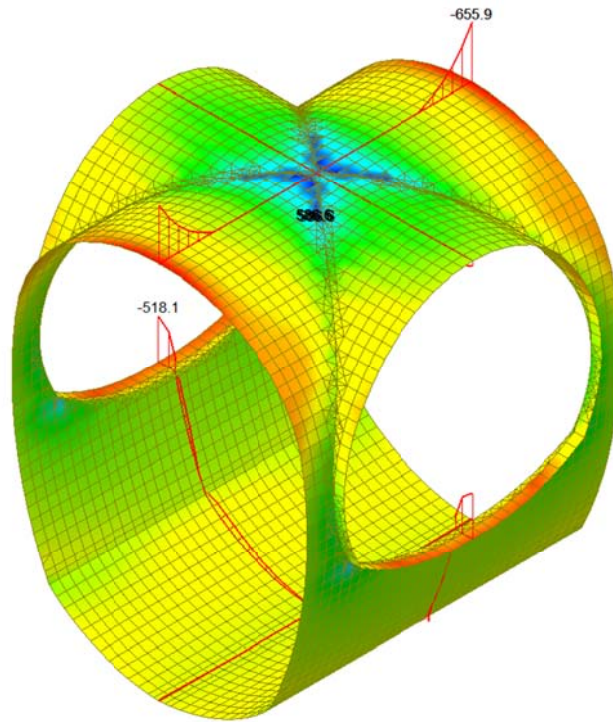
ST: N5  
Avg Nodal Active-

MAX : 22097  
MIN : 20391

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/24/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Mxx / ST\_N5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

626.56
509.97
393.38
276.79
160.20
0.00
-72.97
-189.56
-306.15
-422.74
-539.33
-655.92

ST: N5  
Avg Nodal Active-

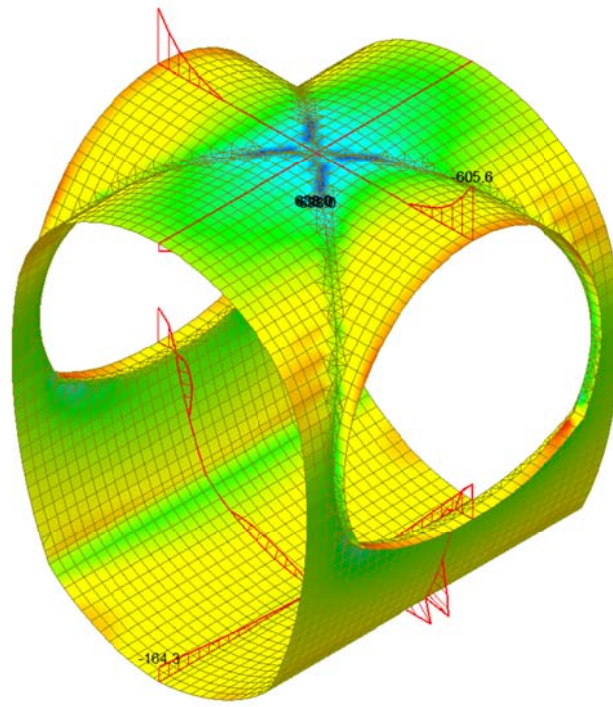
MAX : 21411  
MIN : 16662

FILE: P0E-V-TH-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.384  
Y: 0.574  
Z: 0.574



Plate force\_Myy / ST\_N5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

695.03
556.26
417.49
278.72
139.95
0.00
-137.59
-276.36
-415.13
-553.90
-692.66
-831.43

ST: N5  
Avg Nodal Active-

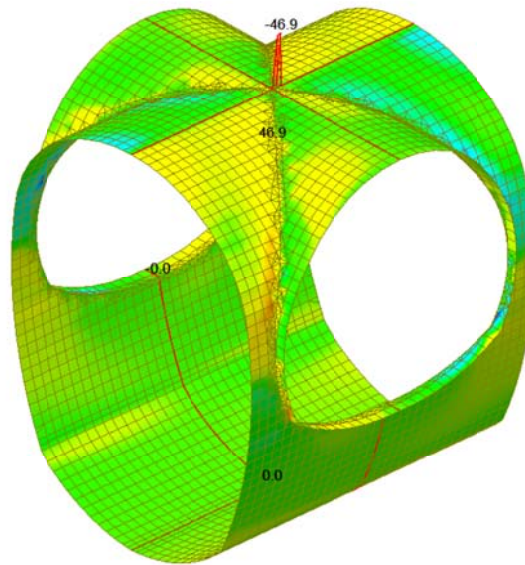
MAX : 23620  
MIN : 20773

FILE: P0E-V-TH-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.384  
Y: 0.574  
Z: 0.574



Plate force\_Vxx / ST\_N5

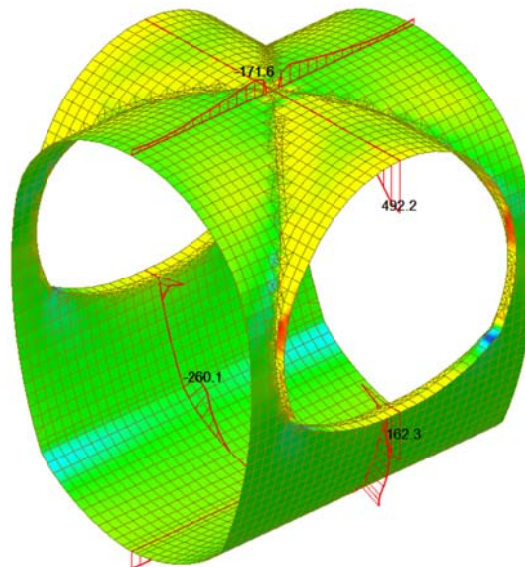


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
811.87	
664.25	
516.64	
369.03	
221.42	
73.81	
0.00	
-221.41	
-369.03	
-516.64	
-664.25	
-811.86	

ST: N5	
Avg Modal Active-	
MAX : 19460	
MIN : 21980	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.582	
Y: 0.635	
Z: 0.508	

Plate force\_Vyy / ST\_N5



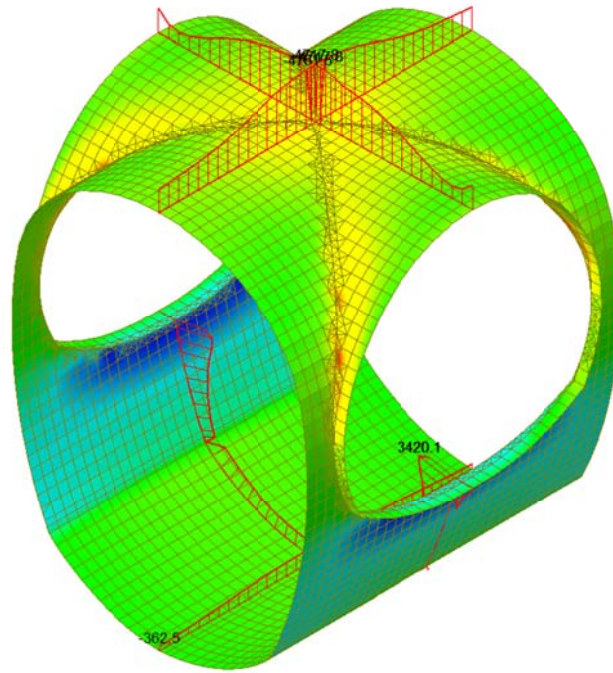
midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
1306.79	
1091.22	
875.64	
660.07	
444.50	
228.92	
0.00	
-202.22	
-417.79	
-633.37	
-848.94	
-1064.51	

ST: N5	
Avg Modal Active-	
MAX : 20777	
MIN : 21138	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.582	
Y: 0.635	
Z: 0.508	

A.5.5.6. Load combination SLU 6

Plate force\_Fxx / ST\_N6



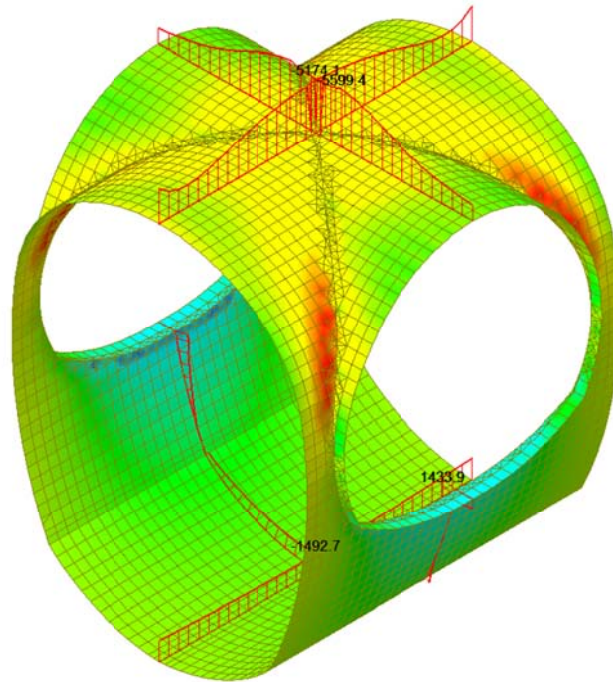
midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fxx	
3567.67	
2170.47	
773.27	
0.00	
-2021.13	
-3418.33	
-4815.53	
-6212.73	
-7609.93	
-9007.13	
-10404.33	
-11801.53	

ST: N6	
Avg Nodal Active-	
MAX : 22371	
MIN : 20792	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/24/2014	
VIEW-DIRECTION	
X: -0.584	
Y: 0.574	
Z: 0.574	



Plate force\_Fyy / ST\_N6



midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fyy	
2266.30	
1280.18	
0.00	
-692.05	
-1678.17	
-2664.29	
-3650.41	
-4636.52	
-5622.64	
-6608.76	
-7594.87	
-8580.99	

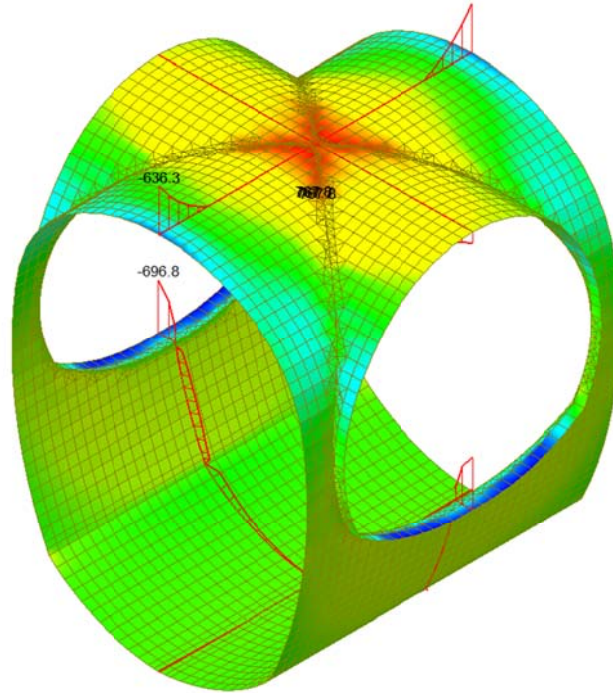
  

ST: N6	
Avg Nodal Active-	
MAX : 23568	
MIN : 22797	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/24/2014	
VIEW-DIRECTION	
X: -0.584	
Y: 0.574	
Z: 0.574	





Plate force\_Mxx / ST\_N6



midas Gen  
POST-PROCESSOR  
PLATE FORCE

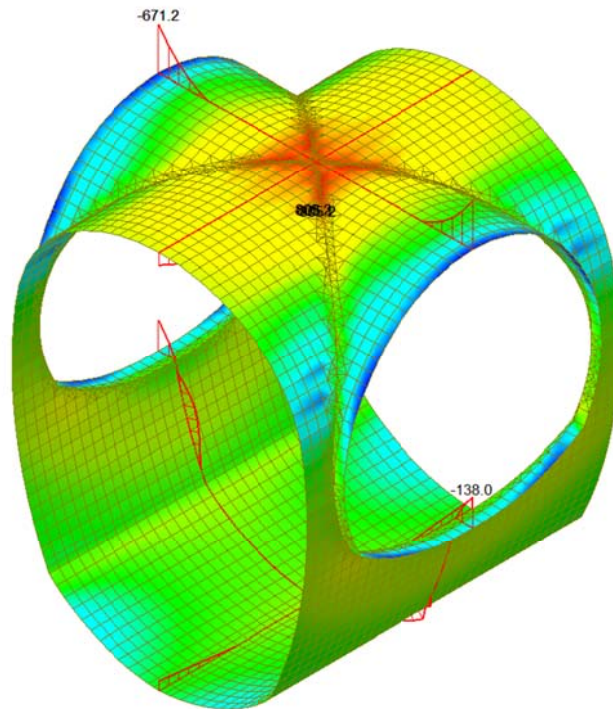
MOMENT-Mxx

799.08
658.10
517.12
376.14
235.15
94.17
0.00
-187.80
-328.78
-469.76
-610.74
-751.73

ST: N6  
Avg Nodal Active-  
MAX : 22617  
MIN : 22092  
FILE: PGE-V-IN-F-  
UNIT: N/mm  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574



Plate force\_Myy / ST\_N6



midas Gen  
POST-PROCESSOR  
PLATE FORCE

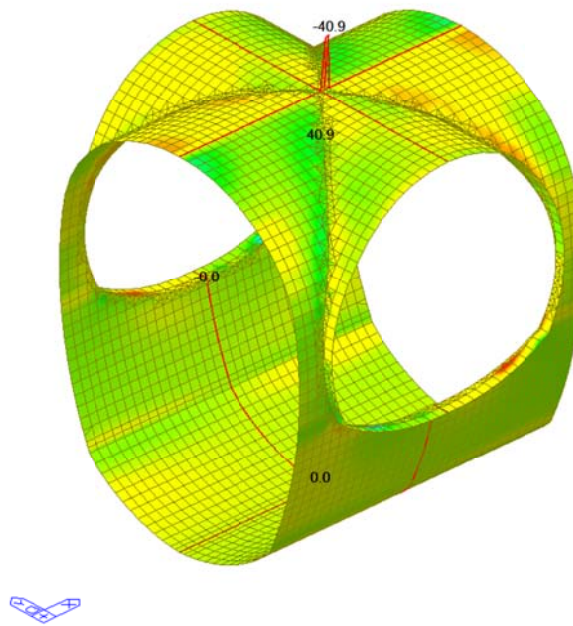
MOMENT-Myy

847.31
706.49
565.68
424.86
284.05
143.23
0.00
-138.40
-279.22
-420.03
-560.85
-701.66

ST: N6  
Avg Nodal Active-  
MAX : 21208  
MIN : 23196  
FILE: PGE-V-IN-F-  
UNIT: N/mm  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574



Plate force\_Vxx / ST\_N6



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vxx

810.21
662.76
515.31
367.85
220.40
0.00
-74.50
-221.96
-369.41
-516.86
-664.31
-811.77

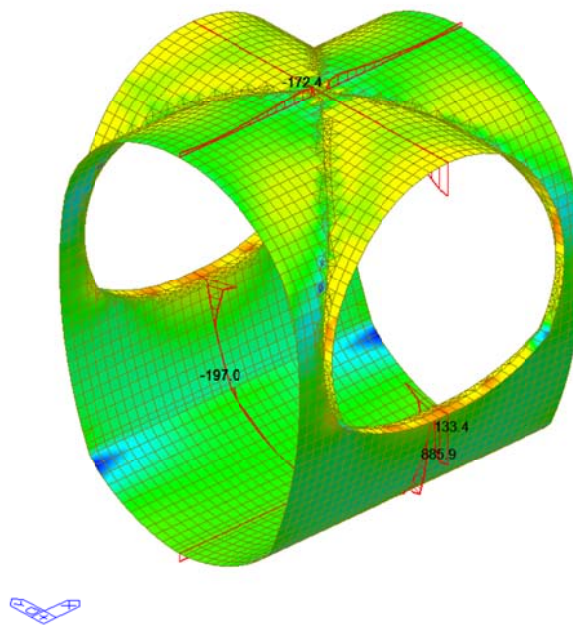
ST: N6  
Avg Modal Active-

MAX : 23285  
MIN : 20183

FILE: FdL-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X: -0.582  
Y: 0.635  
Z: 0.508

Plate force\_Vyy / ST\_N6



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vyy

1001.31
853.63
705.94
558.26
410.58
262.89
115.21
0.00
-180.16
-327.84
-475.53
-623.21

ST: N6  
Avg Modal Active-

MAX : 23300  
MIN : 18025

FILE: FdL-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X: -0.582  
Y: 0.635  
Z: 0.508

Plate force\_Fxx / ST\_N11

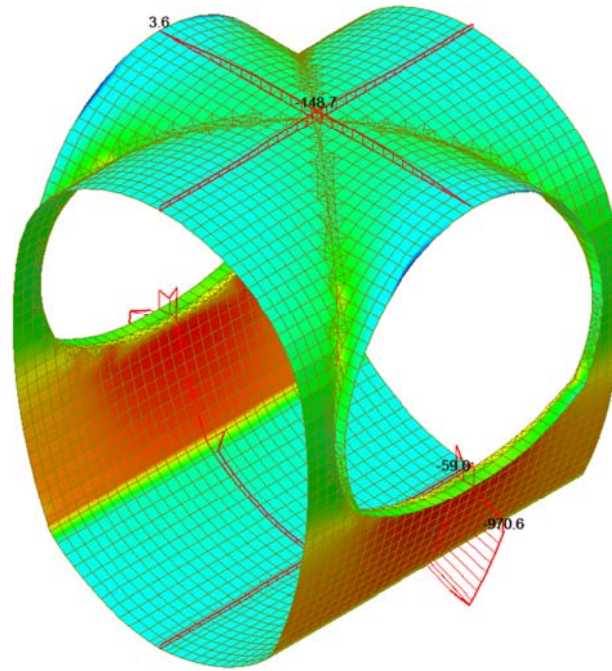


Plate force\_Fyy / ST\_N11

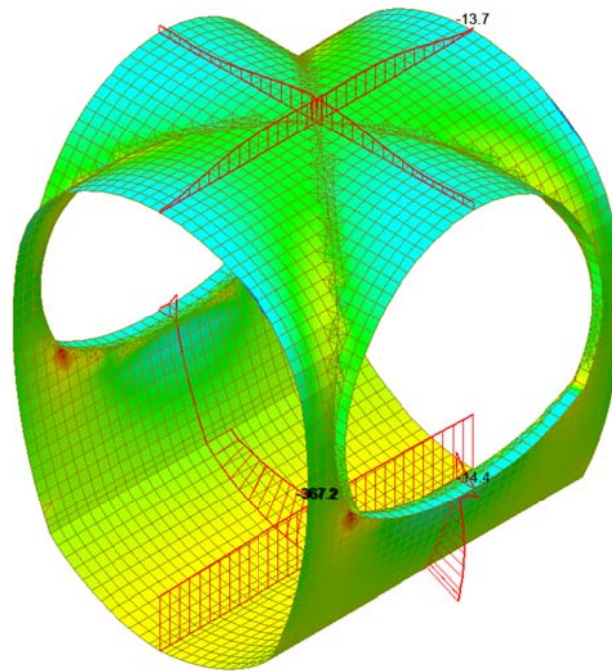
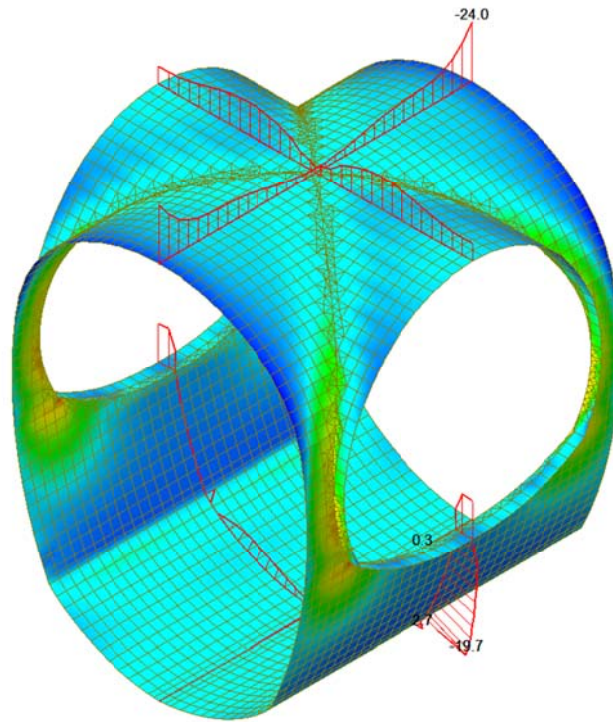


Plate force\_Mxx / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

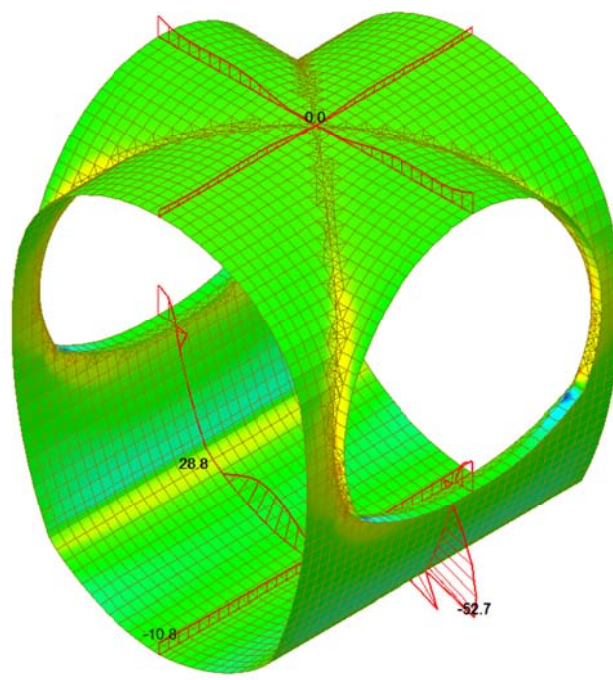
106.88
94.35
81.83
69.30
56.77
44.24
31.71
19.18
6.65
0.00
-18.40
-30.93

ST: N11  
Avg Nodal Active-  
MAX : 21409  
MIN : 21547

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

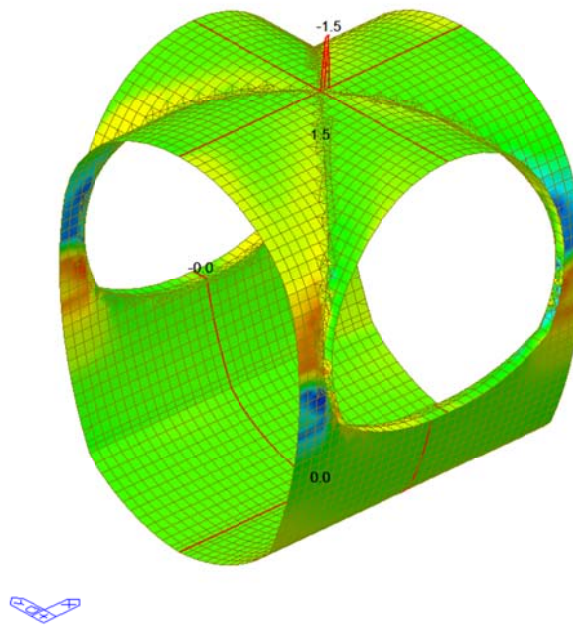
116.16
95.52
74.89
54.25
33.61
12.97
0.00
-28.30
-48.94
-69.58
-90.22
-110.85

ST: N11  
Avg Nodal Active-  
MAX : 20774  
MIN : 20773

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Vxx / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vxx

115.99
94.91
73.82
52.73
31.64
10.55
0.00
-31.63
-52.72
-73.81
-94.90
-115.99

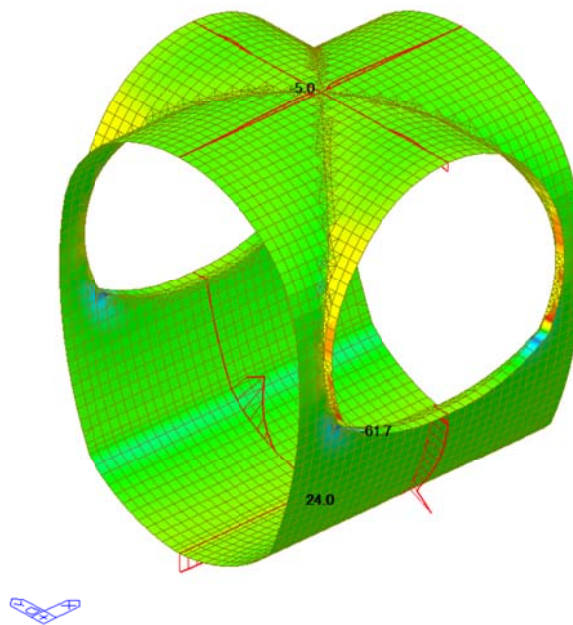
ST: N11  
Avg Modal Active-

MAX : 20.40  
MIN : 21.46

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X: -0.582  
Y: +0.635  
Z: 0.508

Plate force\_Vyy / ST\_N11



midas Gen  
POST-PROCESSOR  
PLATE FORCE

SHEAR-Vyy

205.71
170.61
135.50
100.40
65.30
30.19
0.00
-40.02
-75.12
-110.22
-145.33
-180.43

ST: N11  
Avg Modal Active-

MAX : 20774  
MIN : 21138

FILE: FdE-V-IN-F-  
UNIT: kN/m  
DATE: 10/06/2014

VIEW-DIRECTION  
X: -0.582  
Y: +0.635  
Z: 0.508

Plate force\_Fxx / ST\_N12

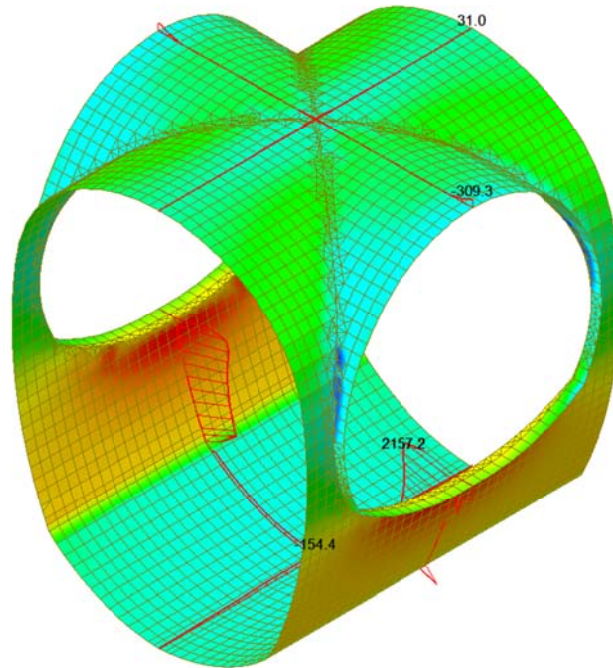


Plate force\_Fyy / ST\_N12

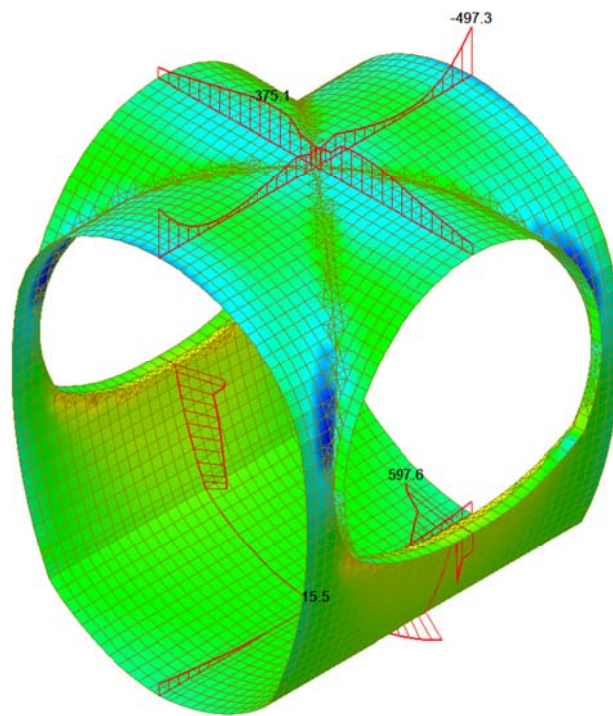
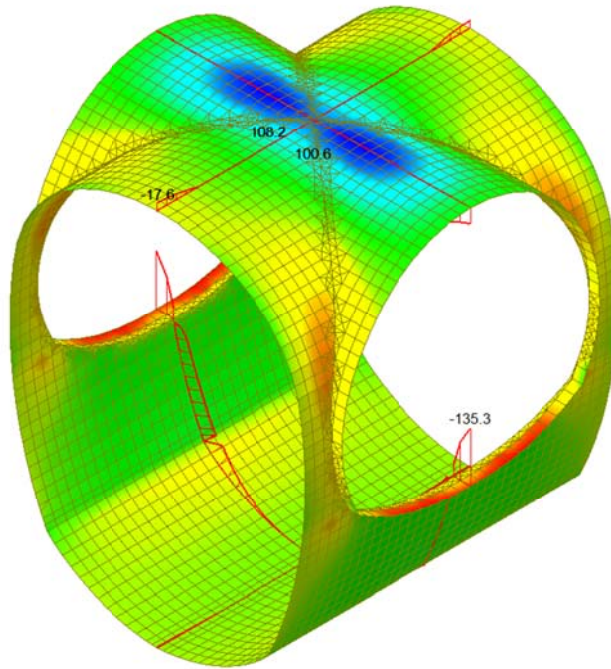


Plate force\_Mxx / ST\_N12



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

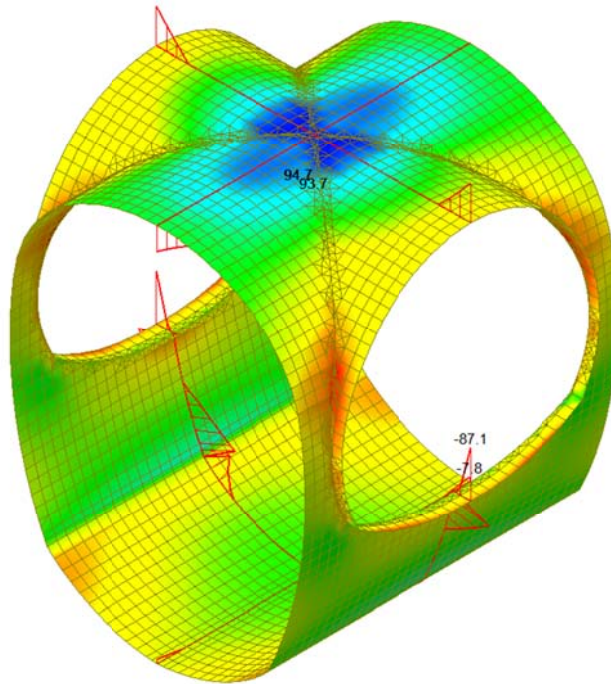
108.21
83.97
59.73
35.49
0.00
-12.99
-37.23
-61.47
-85.71
-109.95
-134.19
-158.43

ST: N12  
Avg Nodal Active-  
MAX : 19316  
MIN : 22093

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_N12



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

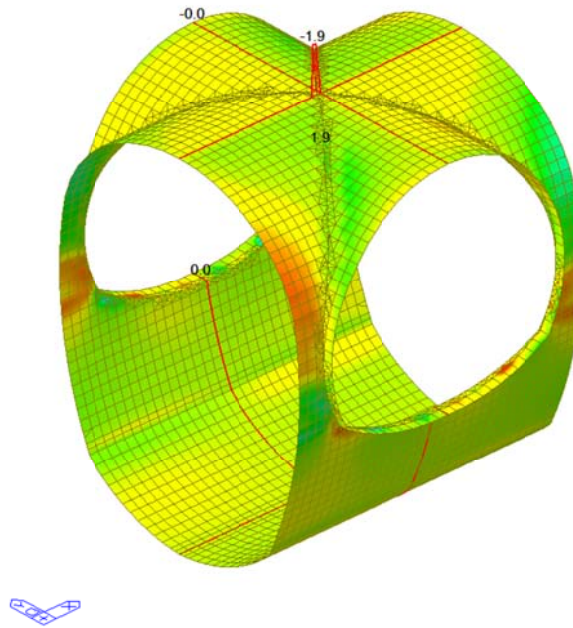
95.11
74.91
54.72
34.53
14.33
0.00
-26.05
-46.25
-66.44
-86.63
-106.83
-127.02

ST: N12  
Avg Nodal Active-  
MAX : 22164  
MIN : 20792

FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Vxx / ST\_N12

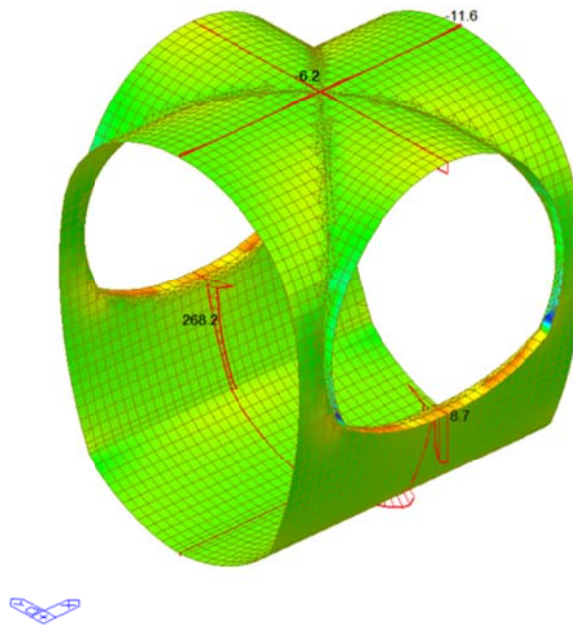


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
140.96	
115.33	
89.70	
64.07	
38.44	
0.00	
-12.82	
-38.45	
-64.08	
-89.71	
-115.34	
-140.97	

ST: N12	
Avg Modal Active-	
MAX : 19428	
MIN : 20184	
FILE: F02-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.582	
Y: 0.635	
Z: 0.508	

Plate force\_Vyy / ST\_N12



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
320.97	
268.91	
216.86	
164.81	
112.76	
60.70	
0.00	
-43.40	
-95.45	
-147.51	
-199.56	
-251.61	

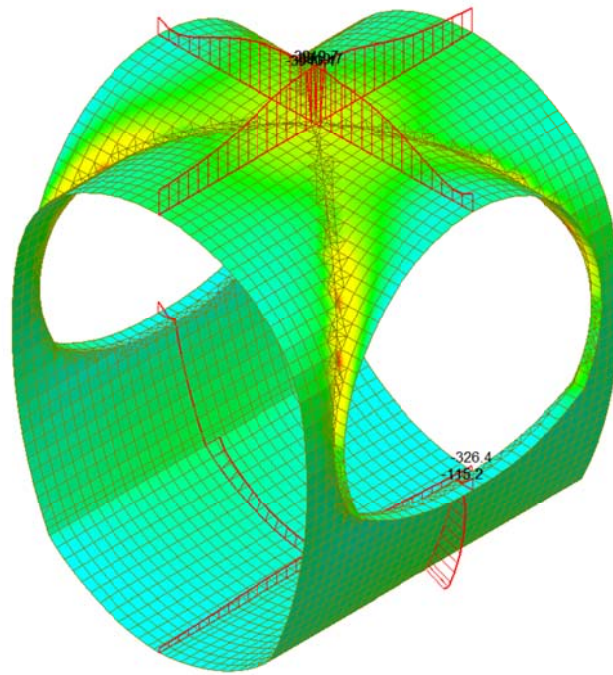
  

ST: N12	
Avg Modal Active-	
MAX : 21388	
MIN : 20774	
FILE: F02-V-IN-F-	
UNIT: kN/m	
DATE: 10/06/2014	
VIEW-DIRECTION	
X: -0.582	
Y: 0.635	
Z: 0.508	



A.5.5.9. Load combination SLU 21

Plate force\_Fxx / ST\_N21



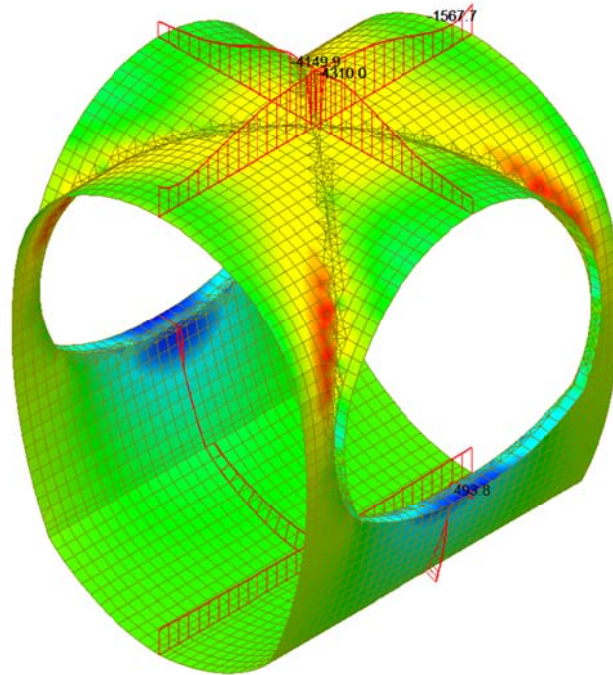
midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fxx	
112.81	
0.00	
-1501.30	
-2308.35	
-3115.41	
-3922.46	
-4729.52	
-5536.57	
-6343.63	
-7150.68	
-7957.74	
-8764.80	

ST: N21	
Avg Nodal Active-	
MAX : 22393	
MIN : 20792	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/24/2014	
VIEW-DIRECTION	
X: -0.584	
Y: 0.574	
Z: 0.574	



Plate force\_Fyy / ST\_N21



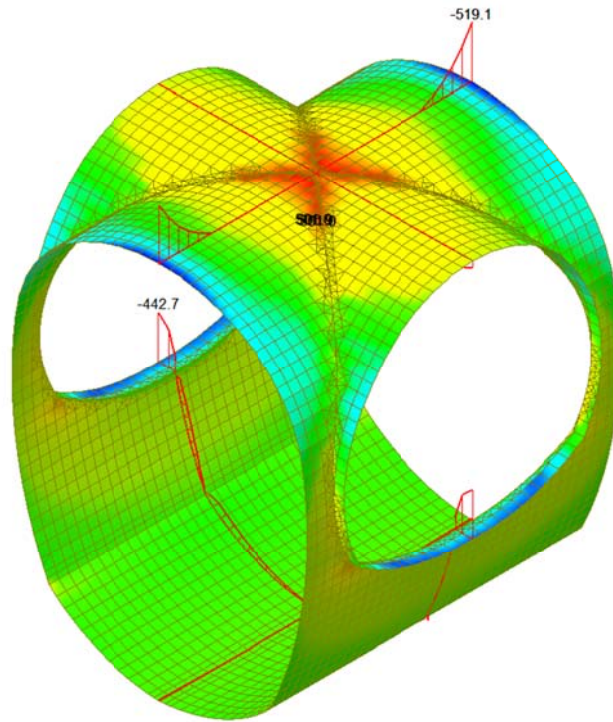
midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fyy	
496.86	
0.00	
-798.01	
-1445.44	
-2092.88	
-2740.31	
-3387.74	
-4035.18	
-4682.61	
-5330.04	
-5977.48	
-6624.91	

ST: N21	
Avg Nodal Active-	
MAX : 23302	
MIN : 20391	
FILE: FdE-V-IN-F-	
UNIT: kN/m	
DATE: 10/24/2014	
VIEW-DIRECTION	
X: -0.584	
Y: 0.574	
Z: 0.574	



Plate force\_Mxx / ST\_N21



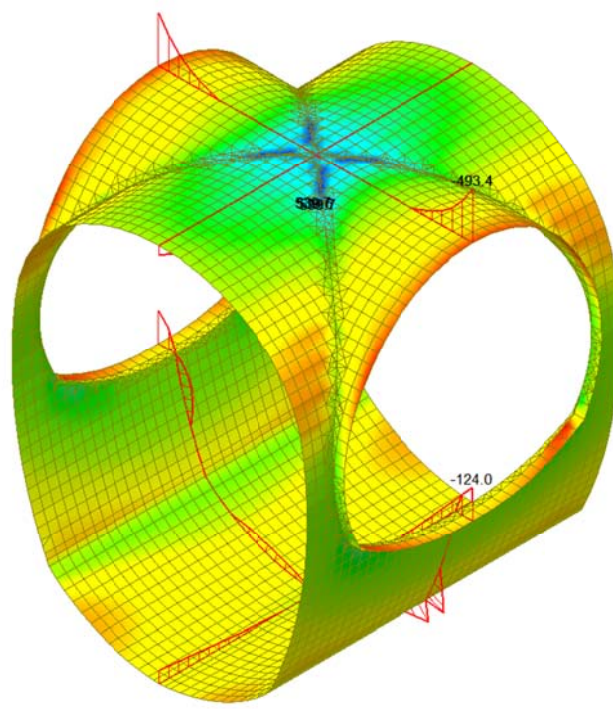
midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

531.39
435.89
340.39
244.89
149.38
53.88
0.00
-137.12
-232.63
-328.13
-423.63
-519.13

ST: N21  
Avg Nodal Active-  
MAX : 21411  
MIN : 16662  
FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_N21



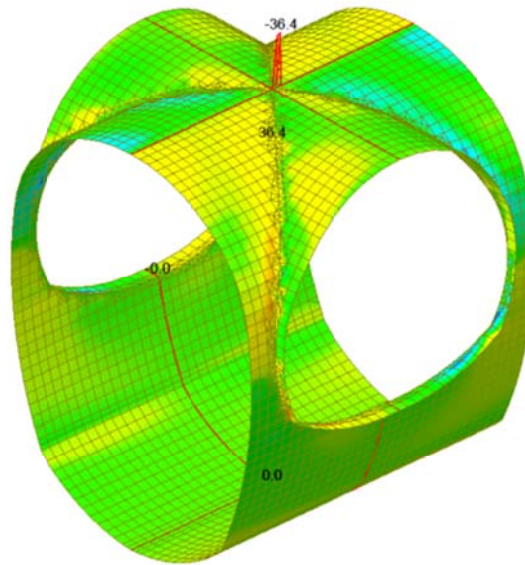
midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

582.56
474.83
367.10
259.38
151.65
0.00
-63.81
-171.54
-279.26
-386.99
-494.72
-602.45

ST: N21  
Avg Nodal Active-  
MAX : 23620  
MIN : 20773  
FILE: F0E-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Vxx / ST\_N21

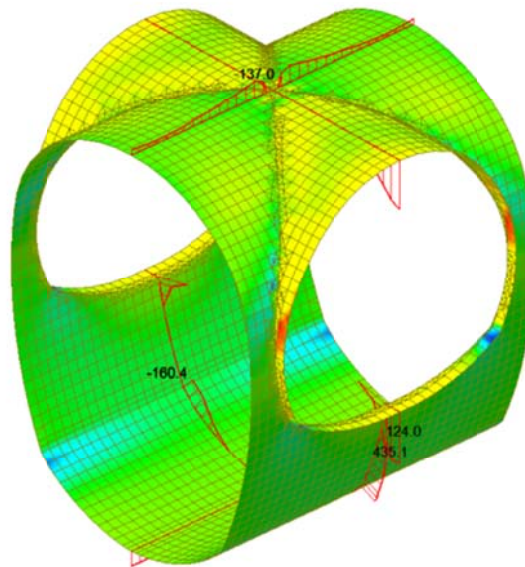


midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vxx	
615.03	
503.20	
391.38	
279.56	
167.74	
55.91	
0.00	
-167.73	
-279.55	
-391.38	
-503.20	
-615.02	

ST: N21
Avg Modal Active-
MAX : 19460
MIN : 21950
FILE: Fat-V-TH-F-
UNIT: KN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.582
Y: 0.635
Z: 0.508

Plate force\_Vyy / ST\_N21



midas Gen POST-PROCESSOR	
PLATE FORCE	
SHEAR-Vyy	
971.24	
819.87	
668.50	
517.12	
365.75	
214.38	
0.00	
-88.36	
-239.74	
-391.11	
-542.48	
-693.85	

ST: N21
Avg Modal Active-
MAX : 20777
MIN : 21138
FILE: Fat-V-TH-F-
UNIT: KN/m
DATE: 10/06/2014
VIEW-DIRECTION
X: -0.582
Y: 0.635
Z: 0.508

A.5.5.10. Load combination SLU 22

Plate force\_Fxx / ST\_N22

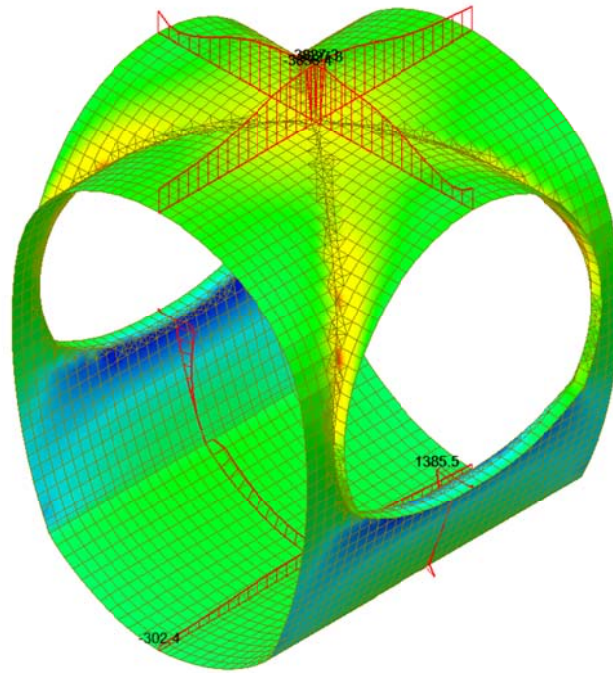


Plate force\_Fyy / ST\_N22

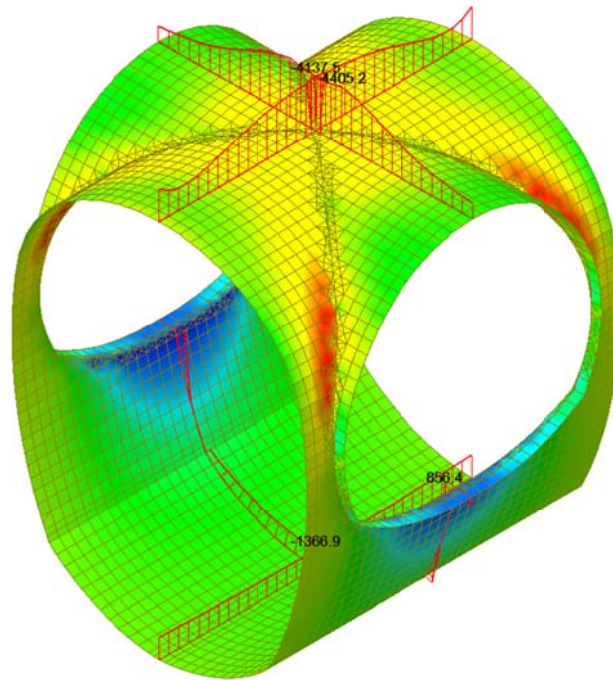


Plate force\_Mxx / ST\_N22

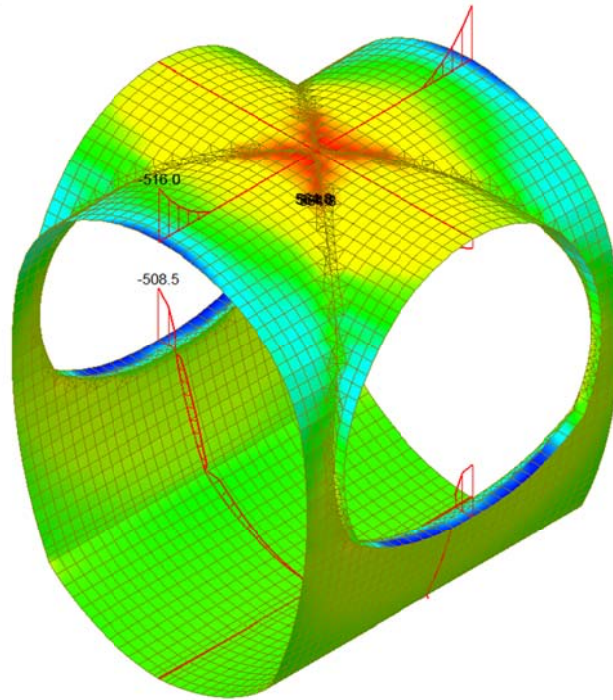


Plate force\_Myy / ST\_N22

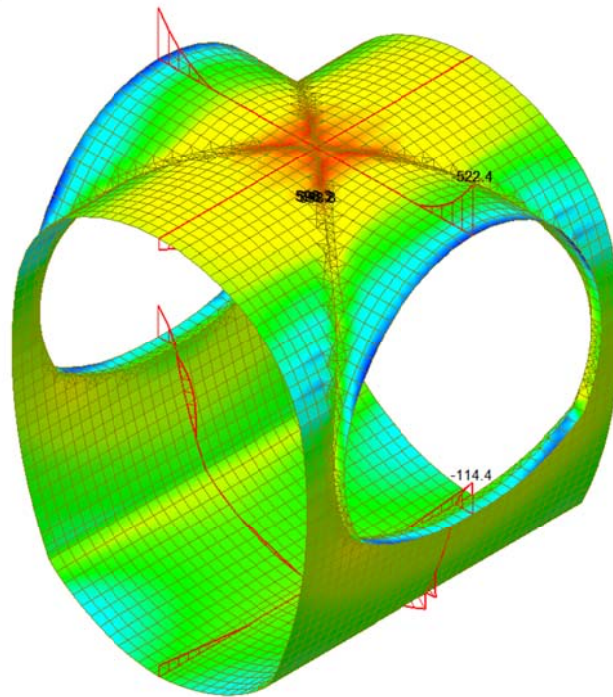


Plate force\_Vxx / ST\_N22

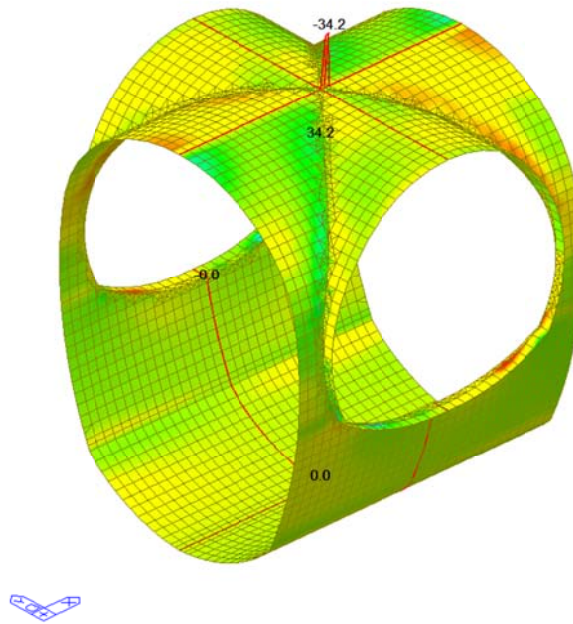
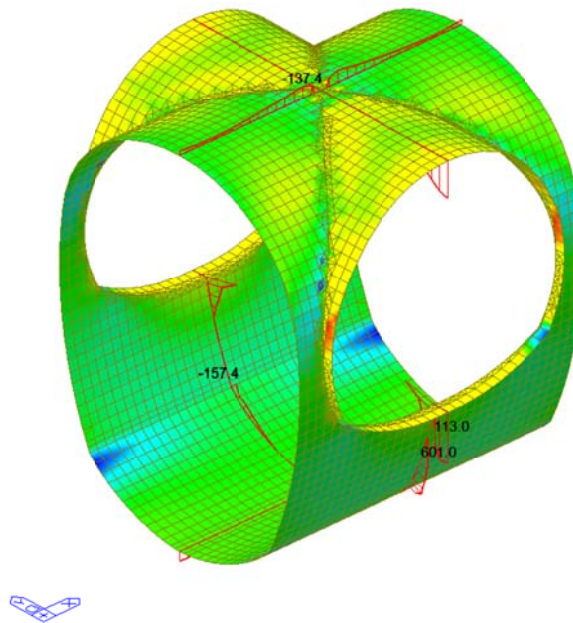


Plate force\_Vyy / ST\_N22



A.5.5.11. Section checking: M-N iteration

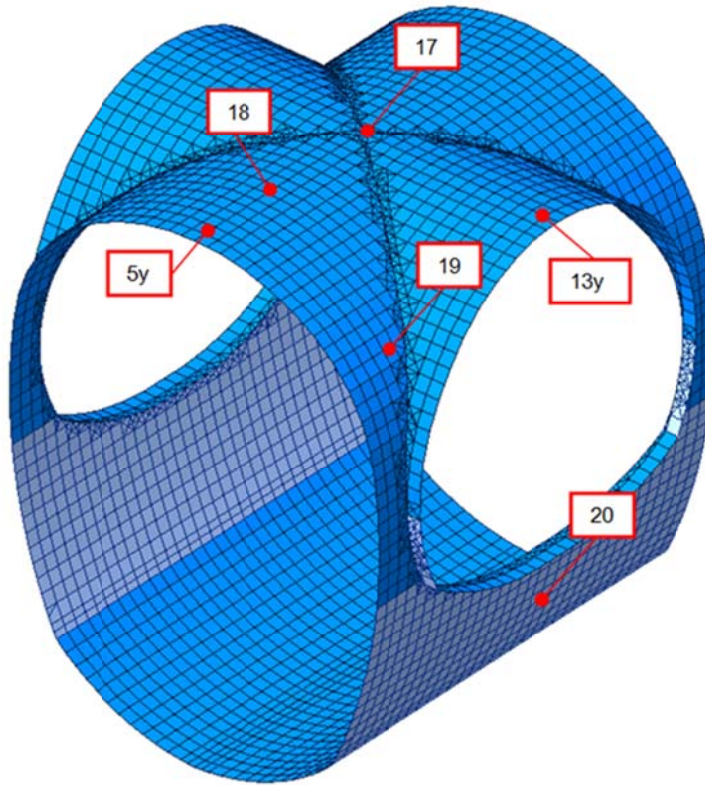


Figure 10 Numbering of sections checked

Spessore anello [cm]		60				Ø	60				Ø	60				Ø	90				Ø	
Sezioni		17x				18/15 18/15	18x				18 18	19				18/15 18/15	20				2X 26/10 2X 26/10	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	Nx (kN)	Mx (kNm)	Vx (kN)	F.S. (M-N)	
SLU	1	-547.4	-7.4	-5.6	0.05	-336.3	-19.9	-3.6	0.04	-700.5	109.1	182.1	0.12	-2404.5	-24.9	-5.2	0.13					
	2	50.3	134.1	3.1	0.44	61.4	45.4	-30.9	0.18	220.8	-164.9	-110.8	0.67	3185.7	58.3	19.2	0.69					
	3	-540.2	-7.4	-5.5	0.05	-329.2	-20.3	-3.5	0.04	-694.0	109.4	182.1	0.12	-2398.3	-26.4	-4.0	0.13					
	4	53.9	134.2	3.2	0.45	66.0	44.9	-30.7	0.19	221.4	-164.2	-109.9	0.66	3183.4	52.7	21.7	0.69					
	5	-4985.3	586.6	-46.3	0.74	-3201.6	131.4	-174.6	0.35	-4558.2	-171.9	607.1	0.49	-2631.8	84.9	48.3	0.13					
	6	-4761.6	767.8	-40.4	0.84	-3050.1	207.3	-213.2	0.37	-4362.1	-363.9	451.7	0.56	3567.7	174.4	76.7	0.83					
	11	-149.1	-3.7	-1.5	0.02	-84.5	-8.4	-1.1	0.01	-262.7	42.9	71.8	0.05	-943.7	-11.7	2.1	0.05					
	12	-65.7	101.2	1.9	0.26	18.6	29.4	-23.6	0.10	-139.9	-114.5	-65.1	0.24	2088.3	36.9	14.2	0.45					
	21	-3940.5	501.0	-36.0	0.69	-2530.9	119.5	-146.1	0.31	-3601.1	-169.4	456.2	0.44	-1172.5	85.1	43.8	0.07					
	22	-3856.5	564.9	-33.8	0.73	-2474.0	143.9	-160.6	0.32	-3527.7	-245.6	398.0	0.48	1076.1	109.6	54.4	0.28					

Spessore anello [cm]		60				Ø	60				Ø	60				Ø	60				Ø	
Sezioni		5y				20/15 20/15	13y				16/15 16/15	17y				16/15 16/15	18y				20/15 20/15	
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Ny (kN)	My (kNm)	Vy (kN)	F.S. (M-N)	Ny (kN)	My (kNm)	Vy (kN)	F.S. (M-N)	Ny (kN)	My (kNm)	Vy (kN)	F.S. (M-N)	Ny (kN)	My (kNm)	Vy (kN)	F.S. (M-N)	Ny (kN)	My (kNm)	Vy (kN)	F.S. (M-N)	
SLU	1	-146.3	20.6	20.6	0.03	-180.7	-29.7	-6.6	0.03	-546.3	5.0	14.0	0.05	-470.7	-17.3	-10.8	0.05					
	2	-486.0	-16.0	-16.0	0.08	-217.7	23.0	70.4	0.03	-175.6	123.8	-8.4	0.30	38.6	117.0	8.3	0.48					
	3	-144.2	20.4	20.4	0.03	-179.7	-29.7	-6.6	0.03	-541.8	4.6	13.7	0.05	-468.0	-17.6	-10.7	0.05					
	4	-486.9	-16.1	-16.1	0.08	-219.4	23.1	70.6	0.03	-176.4	123.6	-8.6	0.30	37.7	116.6	8.3	0.48					
	5	-2564.1	160.6	160.6	0.30	-1974.8	-176.3	230.0	0.27	-5244.9	638.1	116.4	0.81	-3829.6	418.6	-72.5	0.56					
	6	-3060.7	147.1	147.1	0.39	-2195.7	-156.8	321.0	0.28	-5244.8	805.2	100.8	0.93	-3573.3	584.0	67.9	0.66					
	11	-43.3	6.0	6.0	0.01	-41.9	-11.4	-2.4	0.01	-149.3	-1.0	3.8	0.01	-131.9	-5.9	-2.8	0.02					
	12	-391.5	-10.3	-10.3	0.06	-199.0	12.7	46.3	0.02	-220.5	93.7	-5.2	0.16	-46.9	84.5	6.6	0.27					
	21	-2131.8	125.9	125.9	0.28	-1614.2	-136.1	199.4	0.24	-4185.2	539.7	90.3	0.76	-3011.0	364.2	-56.0	0.49					
	22	-2318.4	120.9	120.9	0.32	-1697.6	-132.9	233.7	0.25	-4185.5	598.3	84.4	0.81	-2914.7	422.2	52.1	0.53					

- SECTION 5y

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.609		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	540	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00388		Percentuale di armatura
$N_{Ed} =$	2'400	kN	Azione assiale di progetto
$A_c =$	540'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$$V_{Rd1} = 544.17 \text{ kN}$$

$$V_{Rd2}(v_{min}) = 533.93 \text{ kN}$$

$$V_{Rd} = 544.17 \text{ kN} \quad V_{Ed} = 160.60 \text{ kN} \quad V_{Rd} > V_{Ed} \text{ VERIFICA SODDISFATTA}$$

- SECTION 13y

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.607		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	542	mm	Altezza statica della sezione
$A_s =$	1'340	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00247		Percentuale di armatura
$N_{Ed} =$	2'100	kN	Azione assiale di progetto
$A_c =$	542'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.87	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$$V_{Rd1} = 506.16 \text{ kN}$$

$$V_{Rd2}(v_{min}) = 526.76 \text{ kN}$$

$$V_{Rd} = 526.76 \text{ kN} \quad V_{Ed} = 321.00 \text{ kN} \quad V_{Rd} > V_{Ed} \text{ VERIFICA SODDISFATTA}$$



- SECTION 17

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	4'000	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>529.93</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>534.81</b>	kN			
$V_{Rd} =$	<b>534.81</b>	kN	$V_{Ed} =$	<b>46.30</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 18

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	3'000	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>529.93</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>534.81</b>	kN			
$V_{Rd} =$	<b>534.81</b>	kN	$V_{Ed} =$	<b>213.20</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 19

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.608		Coefficiente
$h =$	600	mm	Altezza geometrica della sezione
$d =$	541	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00314		Percentuale di armatura
$N_{Ed} =$	4'500	kN	Azione assiale di progetto
$A_c =$	541'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>609.42</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>615.03</b>	<b>kN</b>			
$V_{Rd} =$	<b>615.03</b>	<b>kN</b>	$V_{Ed} =$	<b>607.10</b>	<b>kN</b>
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 20

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.488		Coefficiente
$h =$	900	mm	Altezza geometrica della sezione
$d =$	840	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00249		Percentuale di armatura
$N_{Ed} =$	0	kN	Azione assiale di progetto
$A_c =$	840'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	0.00	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>274.99</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>292.27</b>	<b>kN</b>			
$V_{Rd} =$	<b>292.27</b>	<b>kN</b>	$V_{Ed} =$	<b>76.70</b>	<b>kN</b>
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 5y

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck}$ =	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k$ =	1.639		Coefficiente
$h$ =	550	mm	Altezza geometrica della sezione
$d$ =	490	mm	Altezza statica della sezione
$A_s$ =	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1$ =	0.00427		Percentuale di armatura
$N_{Ed}$ =	2'100	kN	Azione assiale di progetto
$A_c$ =	490'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc}$ =	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp}$ =	3.98	MPa	Sforzo di compressione agente
$b_w$ =	1'000	mm	Larghezza sezione collaborante

$V_{Rd1}$ =	<b>504.31</b>	<b>kN</b>			
$V_{Rd2}(v_{min})$ =	<b>489.93</b>	<b>kN</b>			
$V_{Rd}$ =	<b>504.31</b>	<b>kN</b>	$V_{Ed}$ =	<b>125.90</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 5y

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck}$ =	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k$ =	1.638		Coefficiente
$h$ =	550	mm	Altezza geometrica della sezione
$d$ =	492	mm	Altezza statica della sezione
$A_s$ =	1'340	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1$ =	0.00272		Percentuale di armatura
$N_{Ed}$ =	1'600	kN	Azione assiale di progetto
$A_c$ =	492'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc}$ =	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp}$ =	3.25	MPa	Sforzo di compressione agente
$b_w$ =	1'000	mm	Larghezza sezione collaborante

$V_{Rd1}$ =	<b>422.58</b>	<b>kN</b>			
$V_{Rd2}(v_{min})$ =	<b>437.65</b>	<b>kN</b>			
$V_{Rd}$ =	<b>437.65</b>	<b>kN</b>	$V_{Ed}$ =	<b>233.70</b>	<b>kN</b> $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 17

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	491	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00346		Percentuale di armatura
$N_{Ed} =$	4'100	kN	Azione assiale di progetto
$A_c =$	491'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>490.75</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>490.81</b>	kN			
$V_{Rd} =$	<b>490.81</b>	kN	$V_{Ed} =$	<b>90.30</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 18

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	491	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00346		Percentuale di armatura
$N_{Ed} =$	2'400	kN	Azione assiale di progetto
$A_c =$	491'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>490.75</b>	kN			
$V_{Rd2}(v_{min}) =$	<b>490.81</b>	kN			
$V_{Rd} =$	<b>490.81</b>	kN	$V_{Ed} =$	<b>160.60</b>	kN
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 19

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.638		Coefficiente
$h =$	550	mm	Altezza geometrica della sezione
$d =$	491	mm	Altezza statica della sezione
$A_s =$	1'696	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00346		Percentuale di armatura
$N_{Ed} =$	3'600	kN	Azione assiale di progetto
$A_c =$	491'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	3.98	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>490.75</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>490.81</b>	<b>kN</b>			
$V_{Rd} =$	<b>490.81</b>	<b>kN</b>	$V_{Ed} =$	<b>456.20</b>	<b>kN</b>
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

- SECTION 20

**VERIFICA A TAGLIO SECONDO NTC2008 Art. 4.1.2.1.3.1**

Verifica sezione senza armatura a taglio

$f_{ck} =$	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k =$	1.503		Coefficiente
$h =$	850	mm	Altezza geometrica della sezione
$d =$	790	mm	Altezza statica della sezione
$A_s =$	2'094	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1 =$	0.00265		Percentuale di armatura
$N_{Ed} =$	1'000	kN	Azione assiale di progetto
$A_c =$	790'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc} =$	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp} =$	1.27	MPa	Sforzo di compressione agente
$b_w =$	1'000	mm	Larghezza sezione collaborante

$V_{Rd1} =$	<b>416.66</b>	<b>kN</b>			
$V_{Rd2}(v_{min}) =$	<b>429.10</b>	<b>kN</b>			
$V_{Rd} =$	<b>429.10</b>	<b>kN</b>	$V_{Ed} =$	<b>54.40</b>	<b>kN</b>
					$V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

Plate force\_Fxx / ST\_NSLE-1

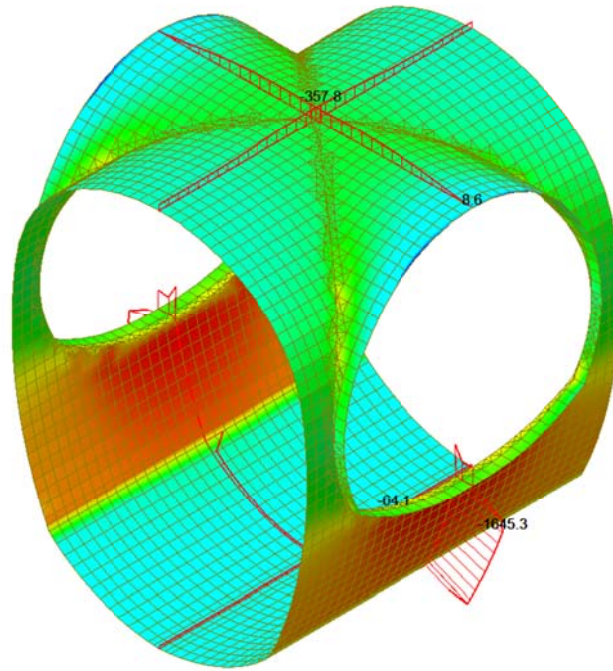


Plate force\_Fyy / ST\_NSLE-1

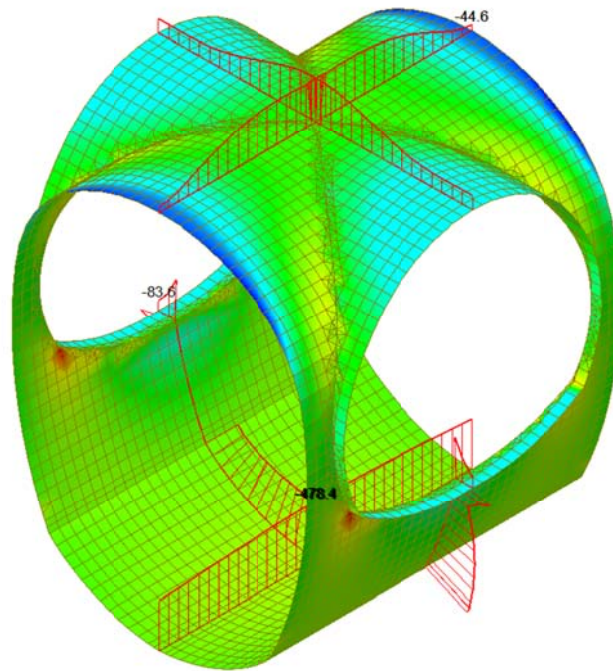
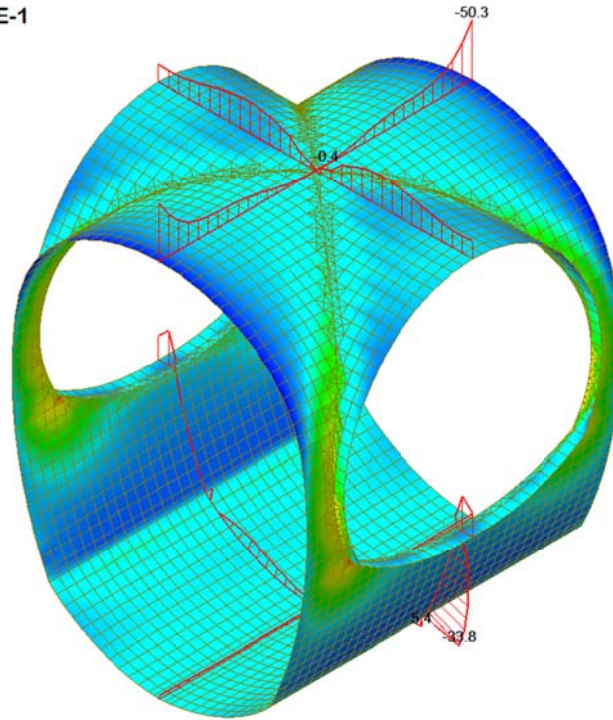


Plate force\_Mxx / ST\_NSLE-1



midas Gen  
POST-PROCESSOR

PLATE FORCE

MOMENT-Mxx

194.66
172.01
149.36
126.70
104.05
81.40
58.75
36.09
13.44
0.00
-31.87
-54.52

ST: NSLE-1  
Avg Nodal Active-

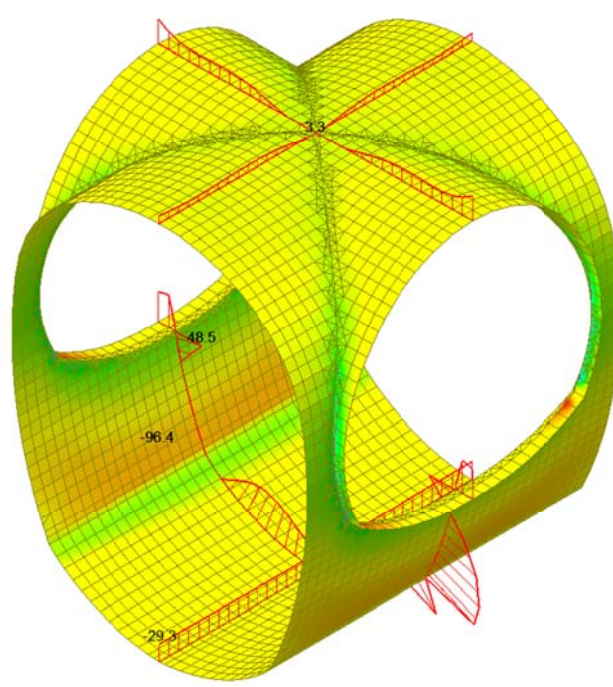
MAX : 21409  
MIN : 20328

FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574



Plate force\_Myy / ST\_NSLE-1



midas Gen  
POST-PROCESSOR

PLATE FORCE

MOMENT-Myy

198.56
161.44
124.32
87.21
50.09
0.00
-24.14
-61.26
-98.38
-135.49
-172.61
-209.73

ST: NSLE-1  
Avg Nodal Active-

MAX : 20774  
MIN : 20773

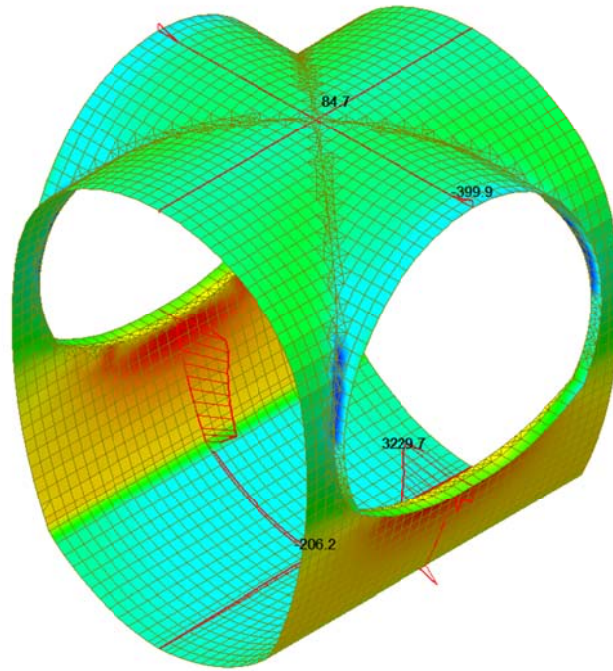
FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574



A.5.5.15. Load combination SLE 2

Plate force\_Fxx / ST\_NSLE-2



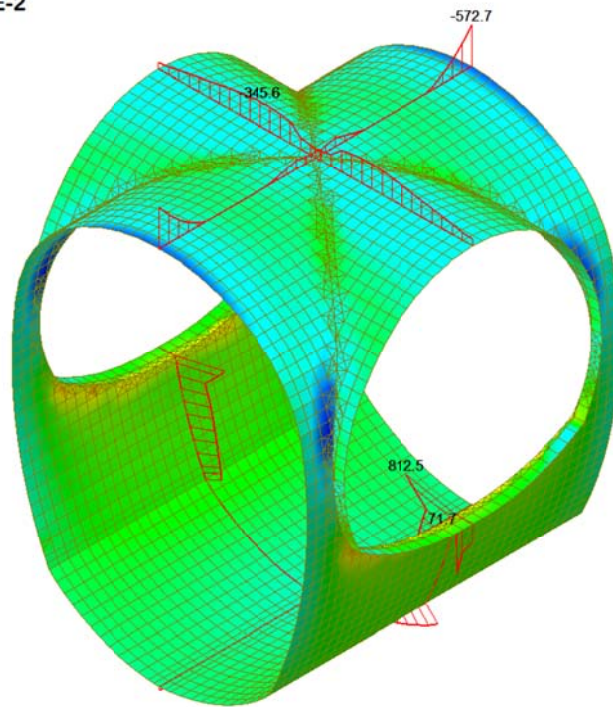
midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fxx	
3229.74	
2847.12	
2464.49	
2081.86	
1699.24	
1316.61	
933.98	
551.35	
0.00	
-213.90	
-596.53	
-979.16	

ST: NSLE-2	
Avg Nodal Active-	
MAX :	21615
MIN :	23194
FILE :	PdE-V-IN-F-
UNIT :	kN/m
DATE :	10/24/2014
VIEW-DIRECTION	
X :	-0.584
Y :	0.574
Z :	0.574



Plate force\_Fyy / ST\_NSLE-2



midas Gen	
POST-PROCESSOR	
PLATE FORCE	
FORCE-Fyy	
1902.98	
1661.12	
1419.26	
1177.41	
935.55	
693.69	
451.84	
209.98	
0.00	
-273.74	
-515.59	
-757.45	

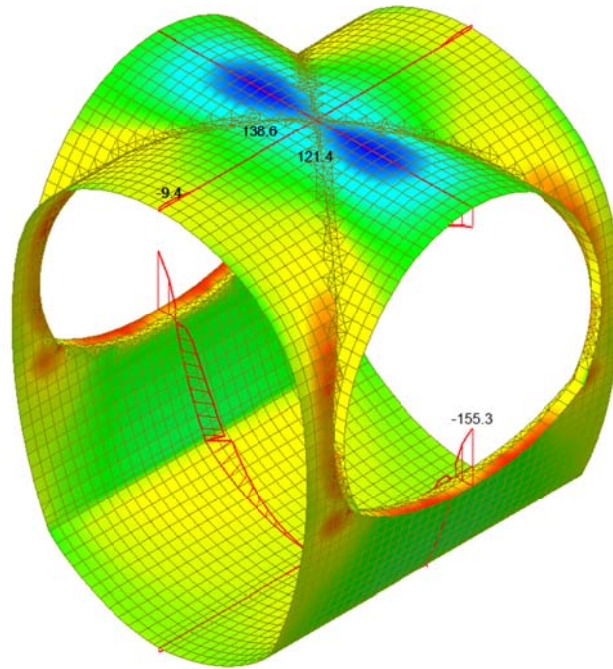
  

ST: NSLE-2	
Avg Nodal Active-	
MAX :	23568
MIN :	21081
FILE :	PdE-V-IN-F-
UNIT :	kN/m
DATE :	10/24/2014
VIEW-DIRECTION	
X :	-0.584
Y :	0.574
Z :	0.574





Plate force\_Mxx / ST\_NSLE-2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

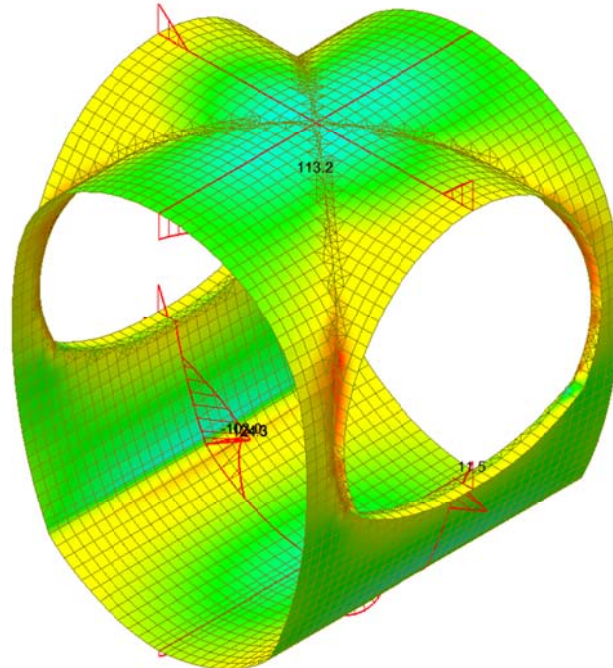
MOMENT-Mxx

138.65
107.98
77.31
46.64
15.97
0.00
-45.37
-76.04
-106.71
-137.38
-168.05
-198.72

ST: NSLE-2  
Avg Nodal Active-  
MAX : 19326  
MIN : 21409  
FILE: PSE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_NSLE-2



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

163.80
130.56
97.32
64.09
30.85
0.00
-35.63
-68.87
-102.10
-135.34
-168.58
-201.82

ST: NSLE-2  
Avg Nodal Active-  
MAX : 21138  
MIN : 20782  
FILE: PSE-V-IN-F-  
UNIT: kN\*m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

A.5.5.16. Load combination SLE 3

Plate force\_Fxx / ST\_NSLE-3

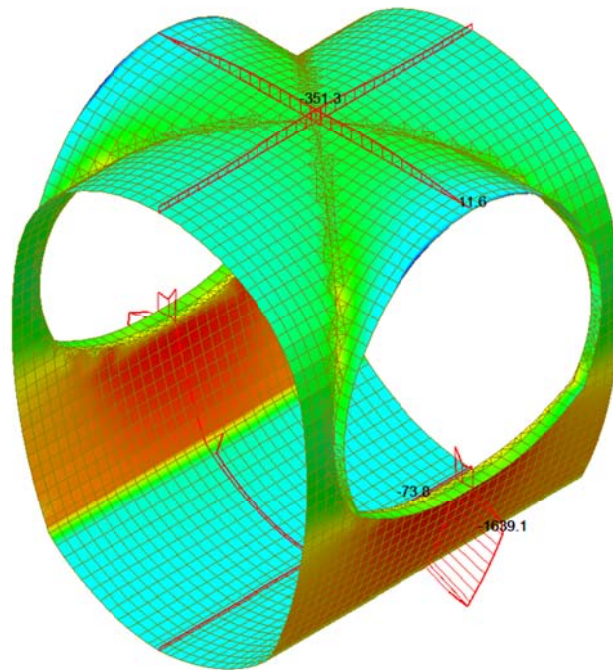


Plate force\_Fyy / ST\_NSLE-3

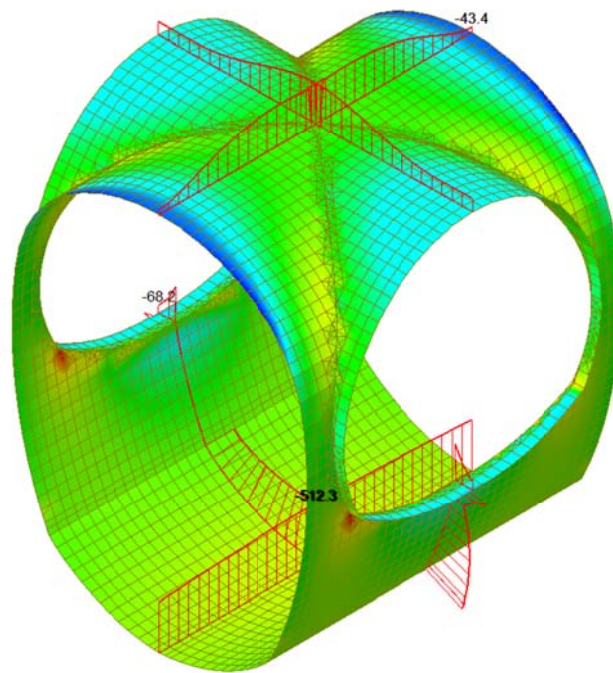
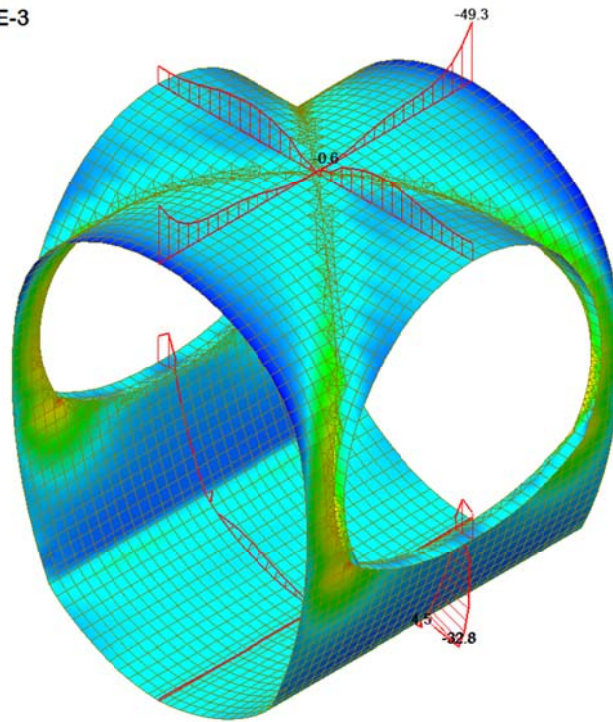


Plate force\_Mxx / ST\_NSLE-3



midas Gen  
POST-PROCESSOR

PLATE FORCE

MOMENT-Mxx

188.40
166.37
144.33
122.29
100.26
78.22
56.18
34.14
12.11
0.00
-31.97
-54.00

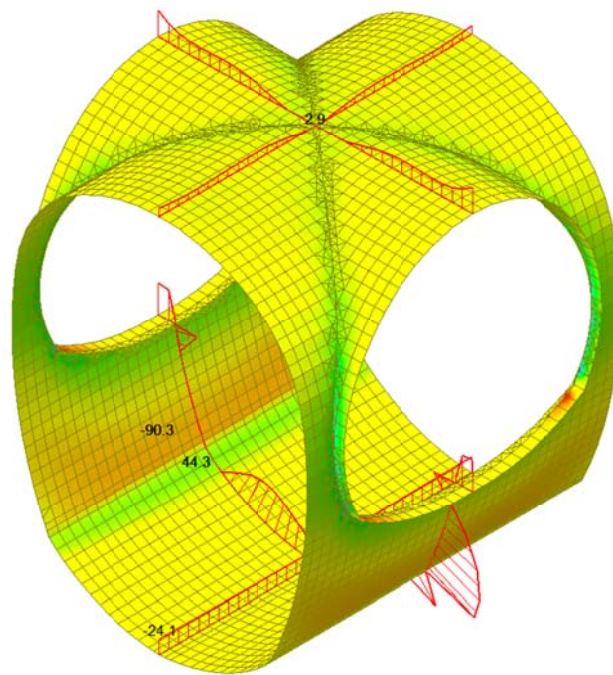
ST: NSLE-3  
Avg Nodal Active-

MAX : 21409  
MIN : 20328

FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_NSLE-3



midas Gen  
POST-PROCESSOR

PLATE FORCE

MOMENT-Myy

194.75
158.78
122.81
86.84
50.87
0.00
-21.07
-57.04
-93.01
-128.98
-164.96
-200.93

ST: NSLE-3  
Avg Nodal Active-

MAX : 20774  
MIN : 20773

FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574

A.5.5.17. Load combination SLE 4

Plate force\_Fxx / ST\_NSLE-4

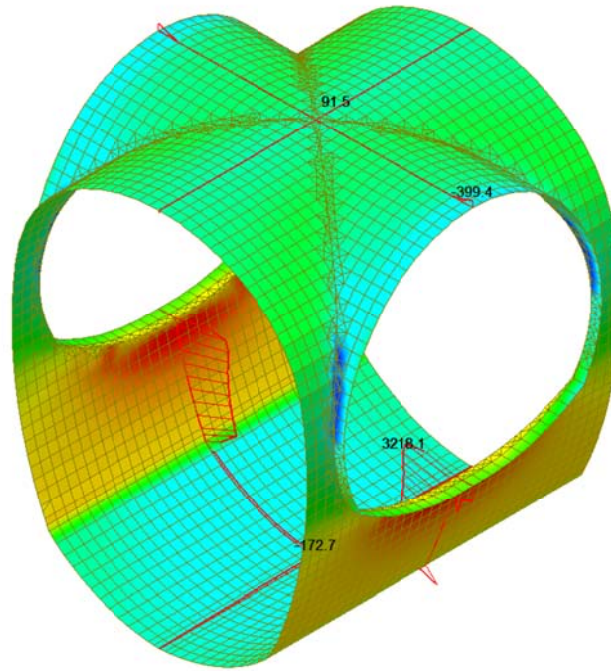


Plate force\_Fyy / ST\_NSLE-4

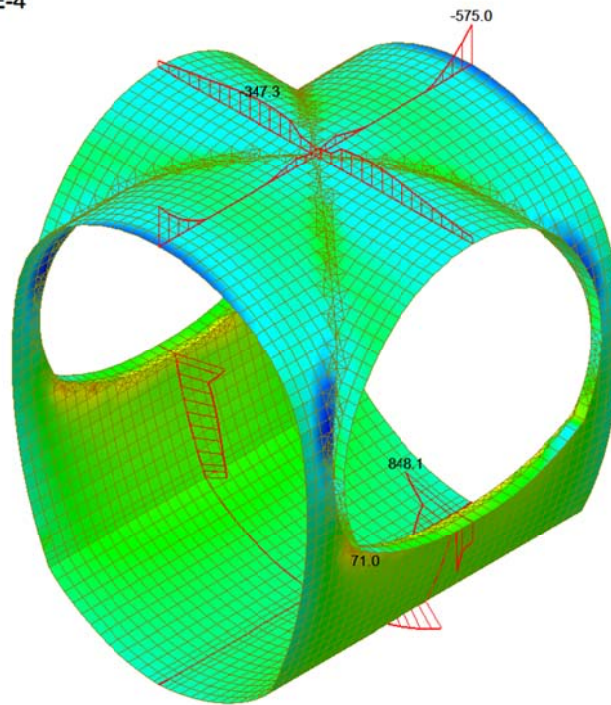
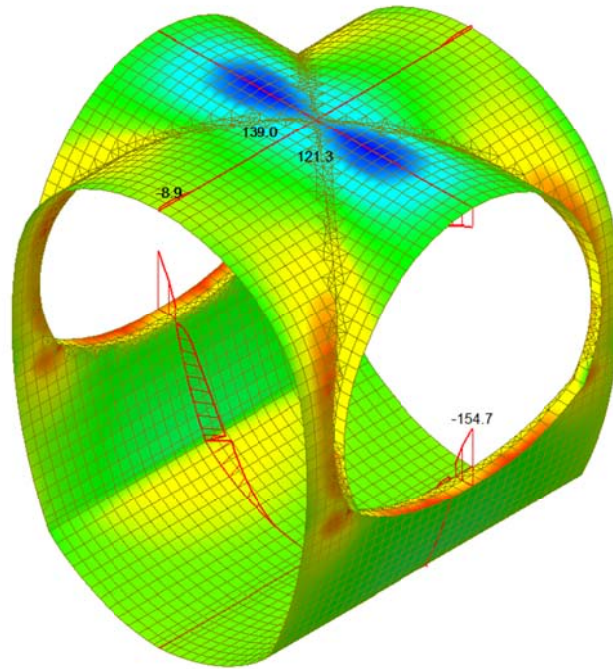


Plate force\_Mxx / ST\_NSLE-4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

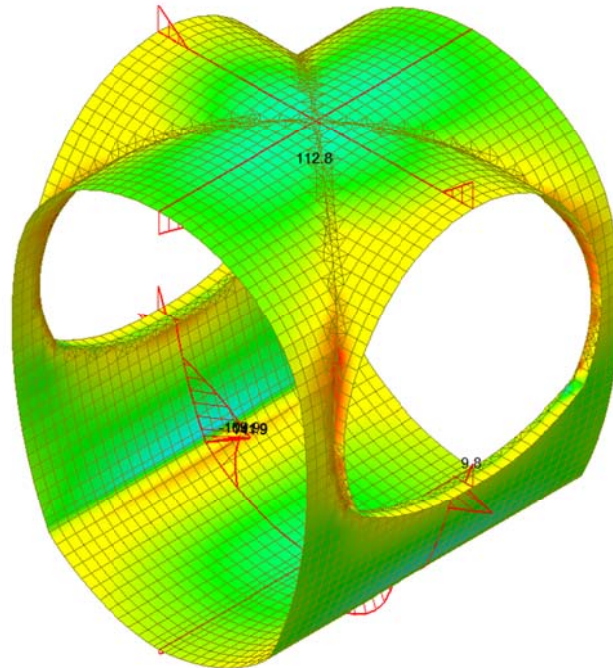
139.00
107.67
76.34
45.02
0.00
-17.64
-48.97
-80.30
-111.63
-142.96
-174.28
-205.61

ST: NSLE-4  
Avg Nodal Active-  
MAX : 19326  
MIN : 21409  
FILE: F0E-V-IN-F-  
UNIT: N/mm  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574



Plate force\_Myy / ST\_NSLE-4



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

171.55
137.75
103.94
70.14
36.34
0.00
-31.27
-65.07
-98.87
-132.68
-166.48
-200.28

ST: NSLE-4  
Avg Nodal Active-  
MAX : 21138  
MIN : 20774  
FILE: F0E-V-IN-F-  
UNIT: N/mm  
DATE: 10/04/2014

VIEW-DIRECTION  
X: -0.574  
Y: 0.574  
Z: 0.574



A.5.5.18. Load combination SLE 5

Plate force\_Fxx / ST\_NSLE-5

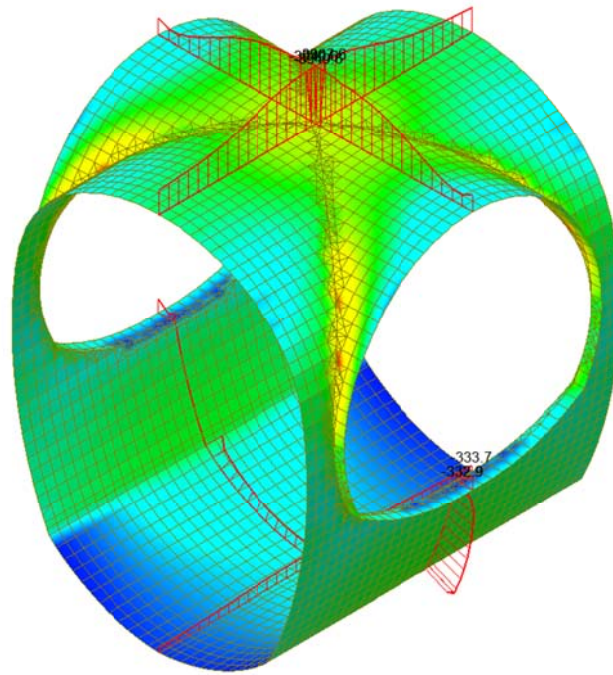


Plate force\_Fyy / ST\_NSLE-5

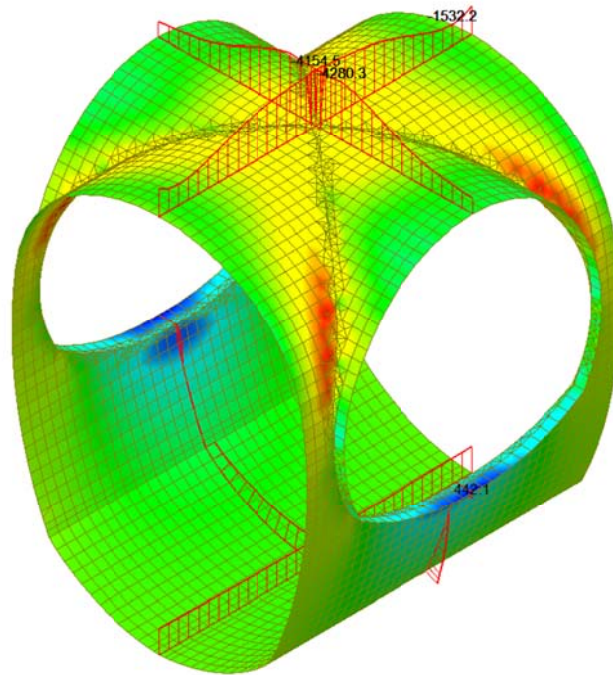
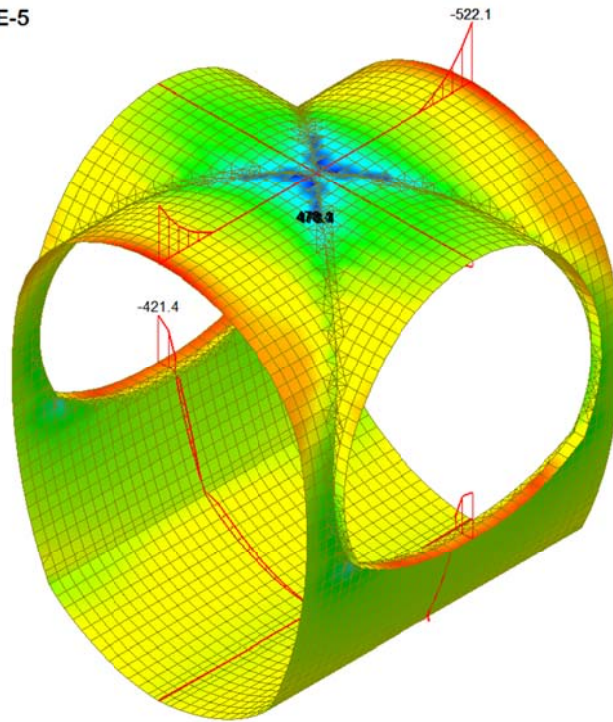


Plate force\_Mxx / ST\_NSLE-5



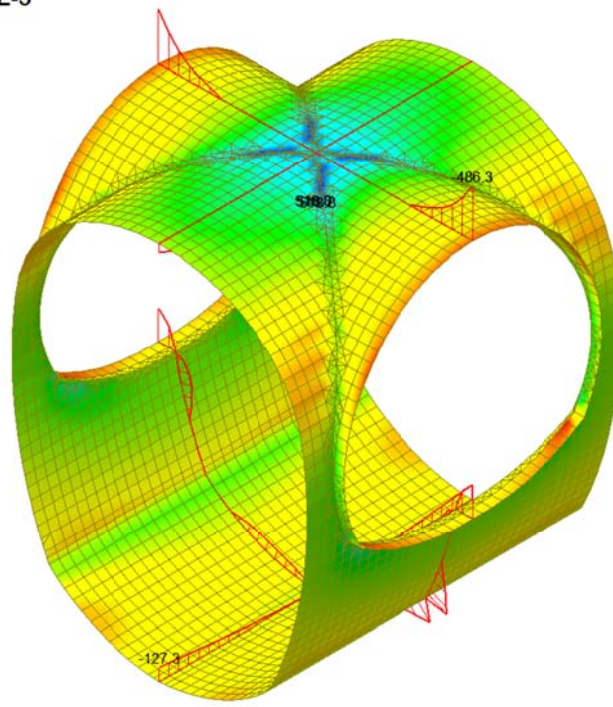
midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

509.88
416.07
322.25
228.44
134.63
0.00
-53.00
-146.81
-240.62
-334.44
-428.25
-522.06

ST: NSLE-5  
Avg Nodal Active-  
MAX : 21411  
MIN : 16662  
FILE: PGE-V-IN-F-  
UNIT: N/mm  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_NSLE-5



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

563.49
454.16
344.82
235.49
126.15
0.00
-92.52
-201.85
-311.19
-420.52
-529.85
-639.19

ST: NSLE-5  
Avg Nodal Active-  
MAX : 23620  
MIN : 20773  
FILE: PGE-V-IN-F-  
UNIT: N/mm  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

A.5.5.19. Load combination SLE 6

Plate force\_Fxx / ST\_NSLE-6

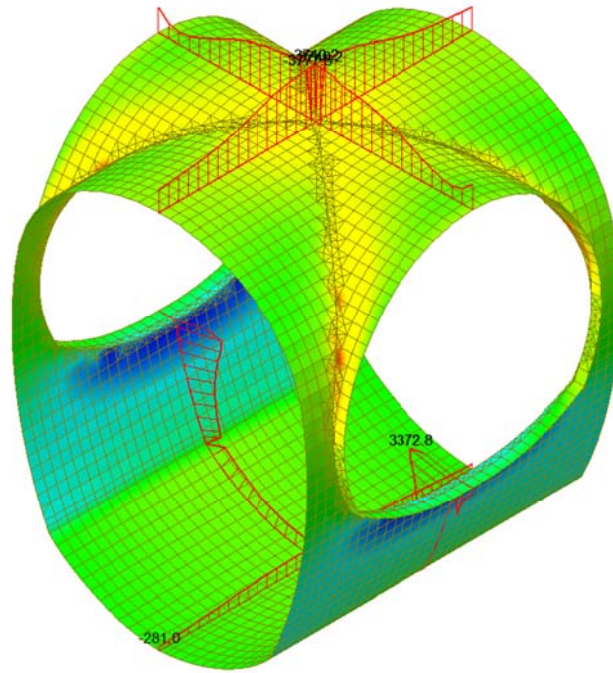


Plate force\_Fyy / ST\_NSLE-6

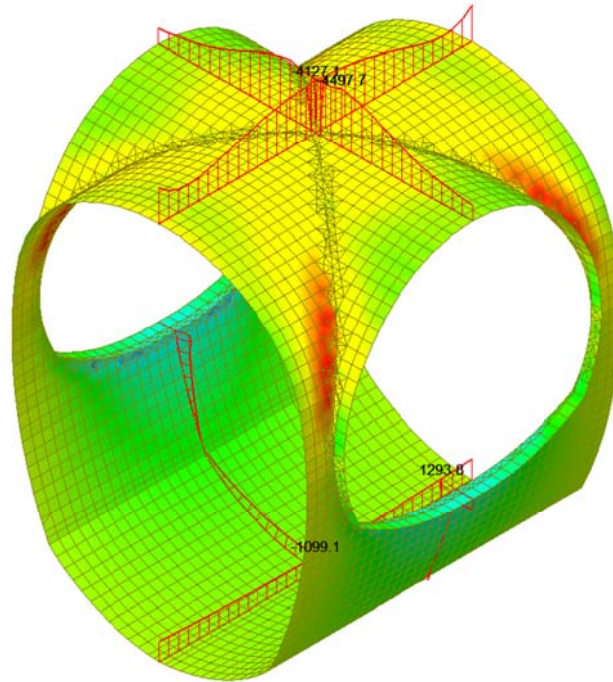
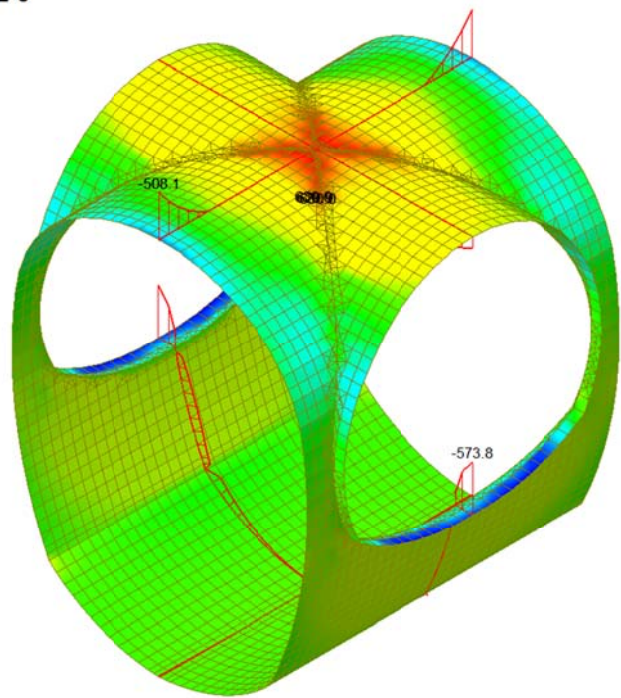




Plate force\_Mxx / ST\_NSLE-6



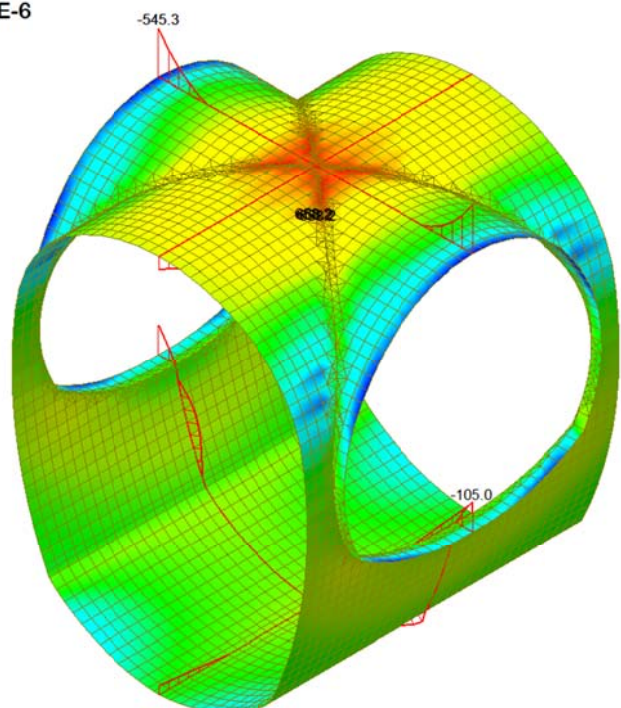
midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Mxx

654.06
537.93
421.79
305.66
189.53
73.39
0.00
-158.87
-275.01
-391.14
-507.27
-623.41

ST: NSLE-6  
Avg Nodal Active-  
MAX : 22617  
MIN : 22091  
FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

Plate force\_Myy / ST\_NSLE-6



midas Gen  
POST-PROCESSOR  
PLATE FORCE

MOMENT-Myy

690.42
576.39
462.36
348.33
234.30
120.28
0.00
-107.78
-221.81
-335.84
-449.87
-563.90

ST: NSLE-6  
Avg Nodal Active-  
MAX : 21208  
MIN : 23196  
FILE: PGE-V-IN-F-  
UNIT: kN/m/m  
DATE: 10/04/2014  
VIEW-DIRECTION  
X: -0.584  
Y: 0.574  
Z: 0.574

A.5.5.20. Section checking: M-N iteration

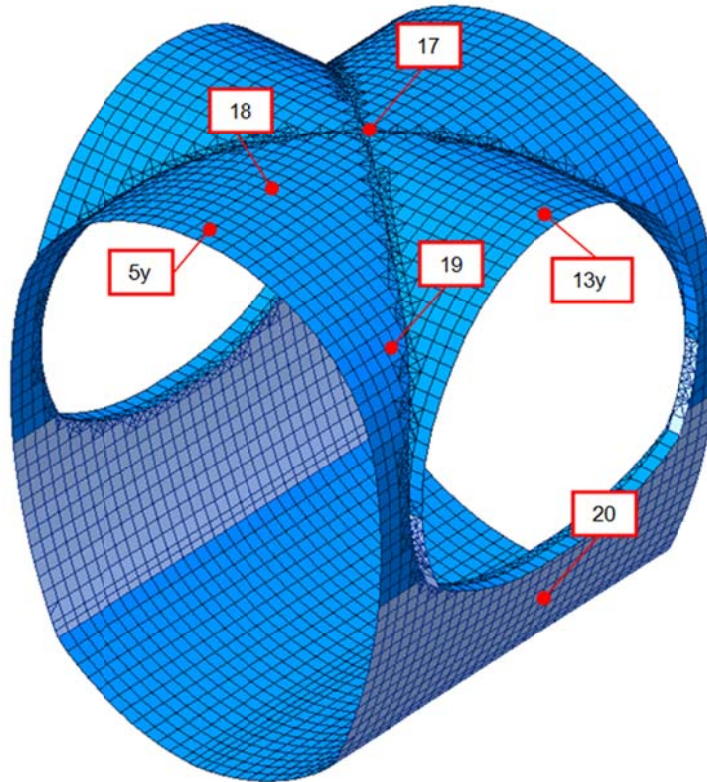


Figure 11 Numbering of sections checked

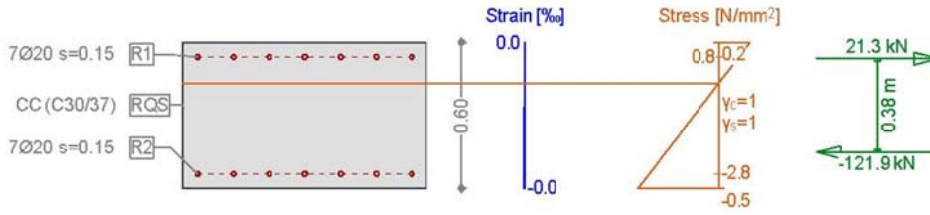
Spessore anello [cm]		60				60				60				90			
Sezioni		17				18				19				20			
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)	Nx (kN)	Mx (kNm)	Vx (kN)	Wk (mm)
SLE	1	-358.1	-4.6	-3.6	0.00	-217.8	-13.5	-2.4	0.00	-468.7	72.6	121.8	0.00	-1602.0	-16.1	-3.4	0.00
	2	70.8	123.1	3.0	0.01	63.2	42.5	-28.8	0.00	254.4	-167.7	-120.7	0.38	2785.7	52.6	15.3	0.37
	3	-351.3	-4.6	-3.5	0.00	-210.7	-13.8	-2.3	0.00	-462.3	72.9	121.7	0.00	-1596.3	-17.6	-2.2	0.00
	4	75.5	123.2	3.1	0.01	69.2	41.9	-28.6	0.00	254.4	-124.6	-119.5	0.01	2786.1	49.9	20.0	0.36
	5	-3967.7	439.9	-36.7	0.00	-2549.3	109.7	-141.5	0.00	-3622.2	-147.4	474.7	0.00	-1793.3	72.7	40.5	0.00
	6	-3777.6	630.0	-31.6	0.00	-2420.4	171.4	-174.4	0.00	-3449.5	-315.1	341.4	0.00	2783.0	143.0	64.8	0.36

Spessore anello [cm]		60				60				60				60			
Sezioni		5y				13y				17y				18y			
Lastfall / Caso di carico Einwirkungskombination / Combinazioni		Ny (kN)	My (kNm)	Vy (kN)	Wk (mm)	Ny (kN)	My (kNm)	Vy (kN)	Wk (mm)	Ny (kN)	My (kNm)	Vy (kN)	Wk (mm)	Ny (kN)	My (kNm)	Vy (kN)	Wk (mm)
SLE	1	-100.6	13.5	13.5	0.00	-121.1	-19.8	-4.1	0.00	-360.6	3.3	9.0	0.00	-282.0	-11.4	-7.1	0.00
	2	-441.7	-15.7	-15.7	0.00	-198.6	21.6	66.1	0.00	-134.1	113.2	-8.2	0.01	61.4	107.8	7.3	0.01
	3	-98.5	13.3	13.3	0.00	-120.1	-19.7	-4.0	0.00	-356.0	2.9	8.7	0.00	-308.4	-11.7	-7.1	0.00
	4	-442.9	-16.0	-16.0	0.00	-199.5	21.7	66.2	0.00	-134.3	112.8	-8.5	0.01	60.4	107.4	7.3	0.01
	5	-2071.7	127.5	127.5	0.00	-1588.2	-139.1	188.5	0.00	-4185.8	518.8	92.2	0.00	-3042.2	343.5	-57.3	0.00
	6	-2494.8	115.9	115.9	0.00	-1778.0	-125.4	266.3	0.00	-4187.2	658.2	78.8	0.00	-2824.3	481.5	55.0	0.00

- SECTION 5y

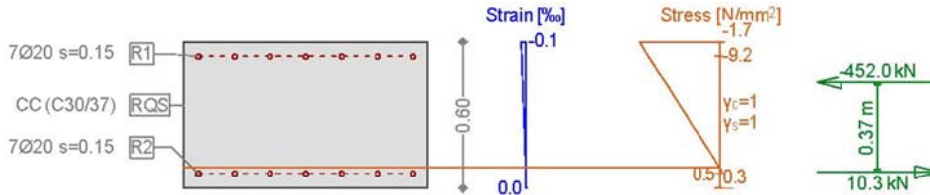
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-100.6; M_y=-23.3;$

Scale 1:30.0



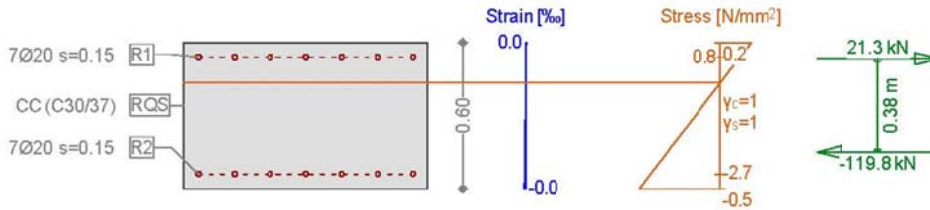
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-441.7; M_y=63.5;$

Scale 1:30.0



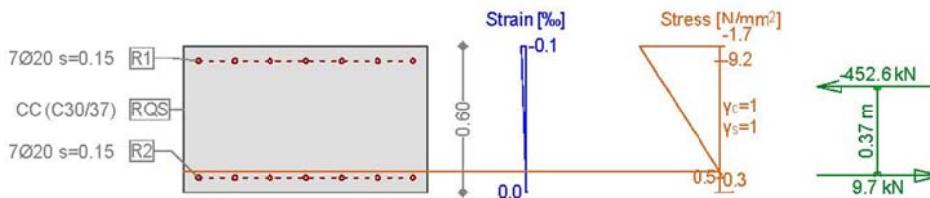
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-98.5; M_y=-23.0;$

Scale 1:30.0



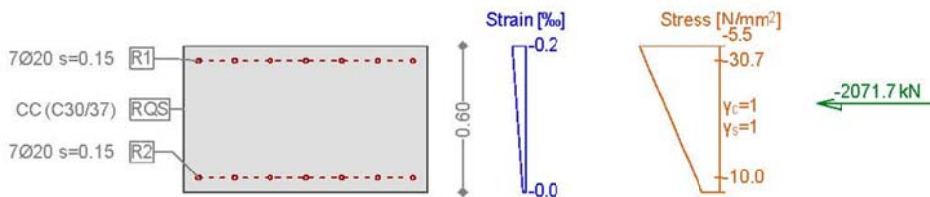
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-442.9; M_y=63.4;$

Scale 1:30.0



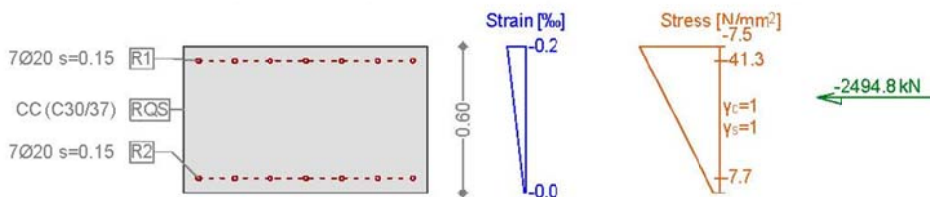
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-2071.7; M_y=136.3;$

Scale 1:30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-2494.8; M_y=221.2;$

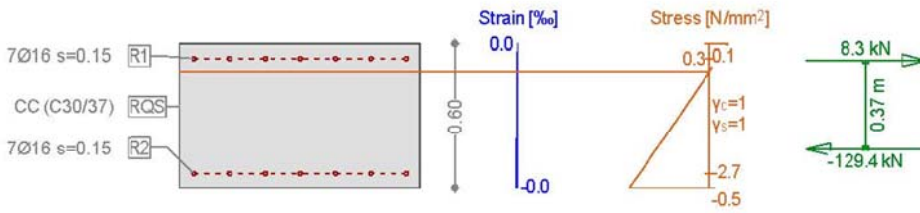
Scale 1:30.0



- SECTION 13y

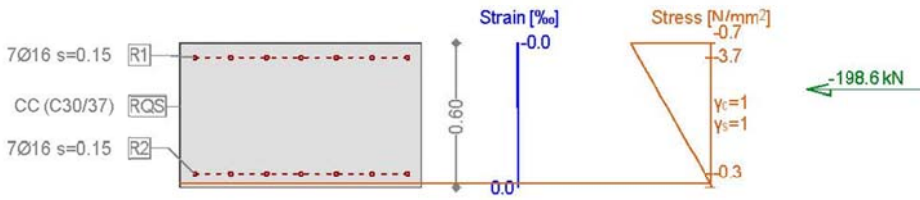
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-121.1$ ;  $M_y=-19.8$ ;

Scale 1 :30.0



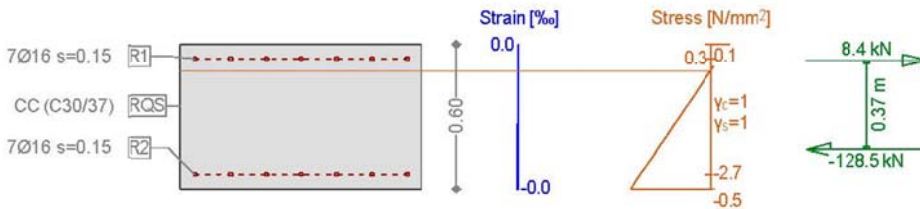
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-198.6$ ;  $M_y=21.6$ ;

Scale 1 :30.0



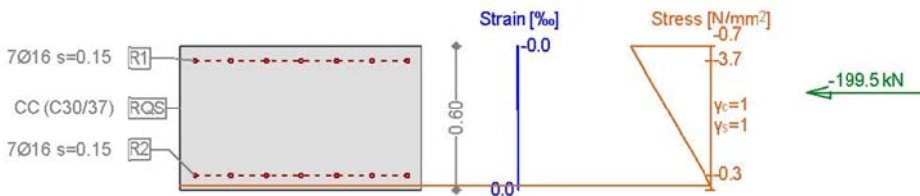
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-120.1$ ;  $M_y=-19.7$ ;

Scale 1 :30.0



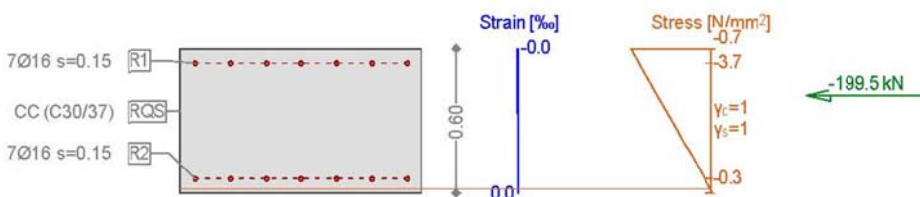
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-199.5$ ;  $M_y=21.7$ ;

Scale 1 :30.0



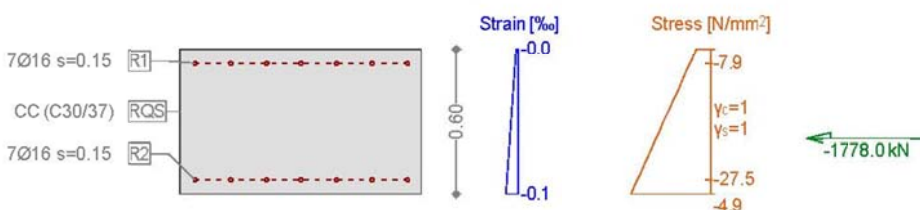
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-199.5$ ;  $M_y=21.7$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1778.0$ ;  $M_y=-125.4$ ;

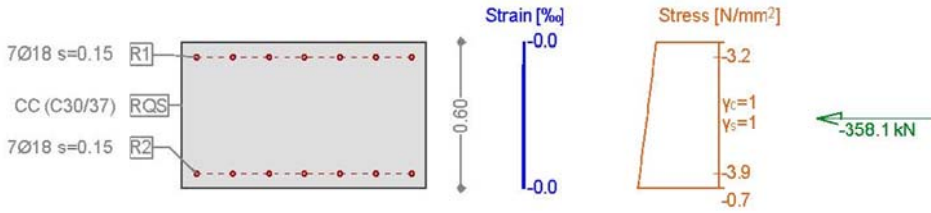
Scale 1 :30.0



• SECTION 17

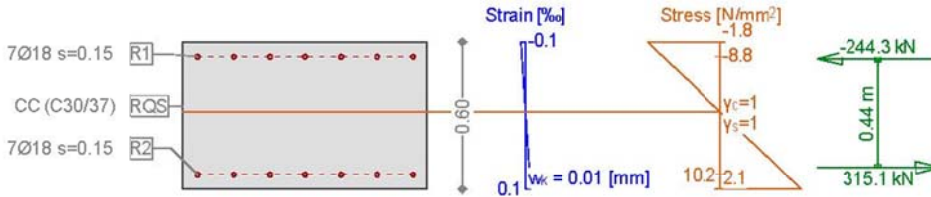
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-358.1$ ;  $M_y=-4.6$ ;

Scale 1 :30.0



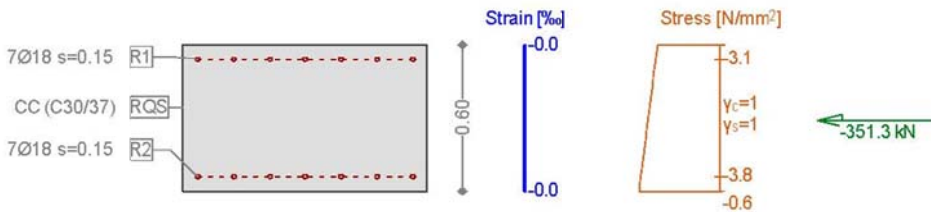
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=70.8$ ;  $M_y=123.1$ ;

Scale 1 :30.0



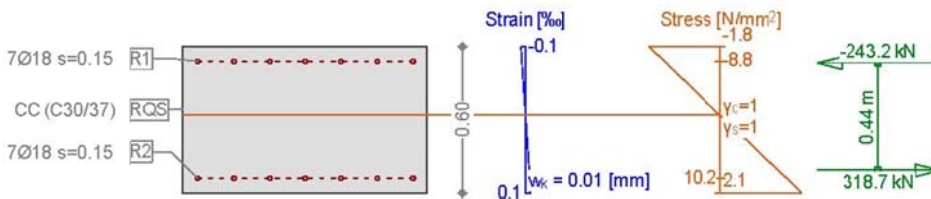
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-351.3$ ;  $M_y=-4.6$ ;

Scale 1 :30.0



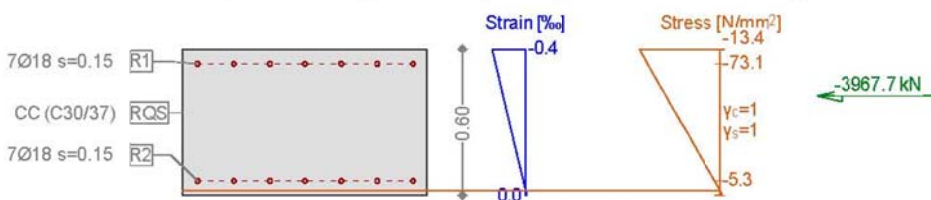
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=75.5$ ;  $M_y=123.2$ ;

Scale 1 :30.0



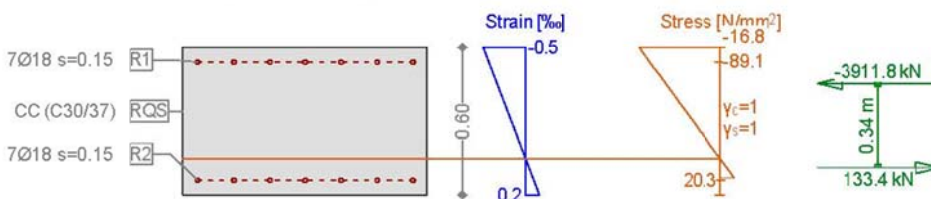
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3967.7$ ;  $M_y=439.9$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3777.6$ ;  $M_y=630.0$ ;

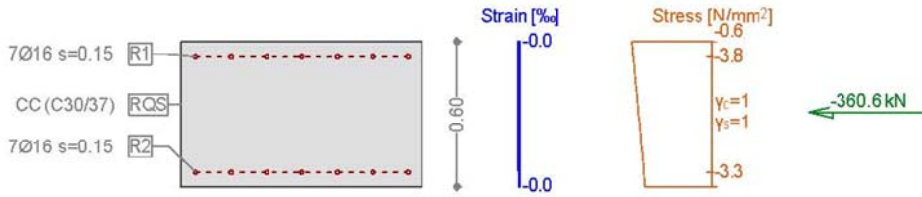
Scale 1 :30.0



- SECTION 17y

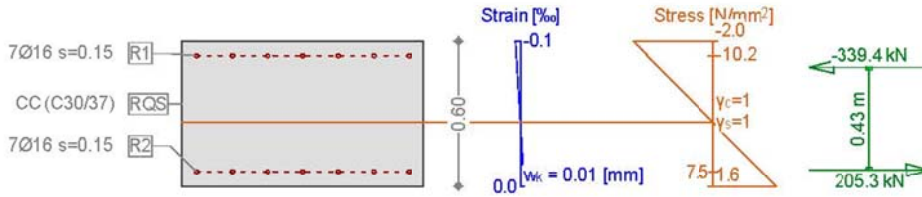
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-360.6$ ;  $M_y=3.3$ ;

Scale 1 :30.0



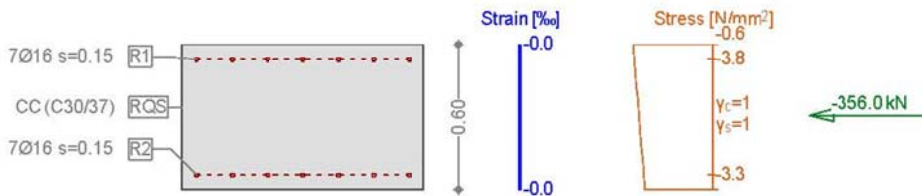
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-134.1$ ;  $M_y=113.2$ ;

Scale 1 :30.0



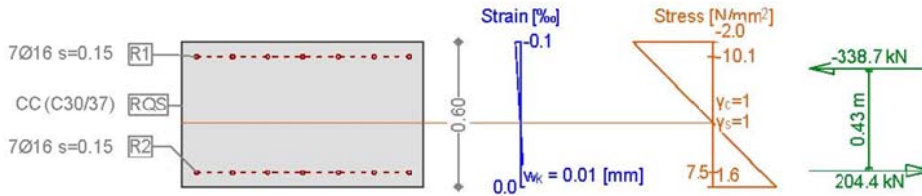
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-356.0$ ;  $M_y=2.9$ ;

Scale 1 :30.0



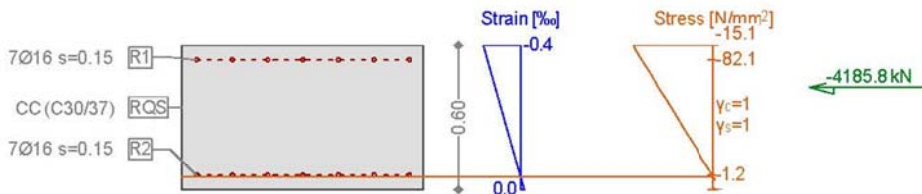
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-134.3$ ;  $M_y=112.8$ ;

Scale 1 :30.0



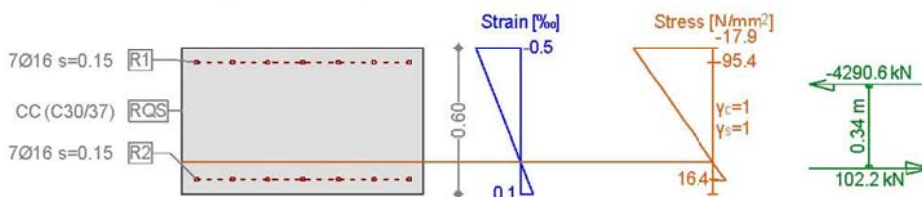
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-4185.8$ ;  $M_y=518.8$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-4187.2$ ;  $M_y=658.2$ ;

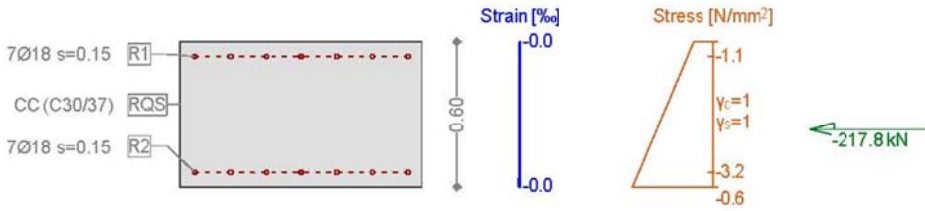
Scale 1 :30.0



- SECTION 18

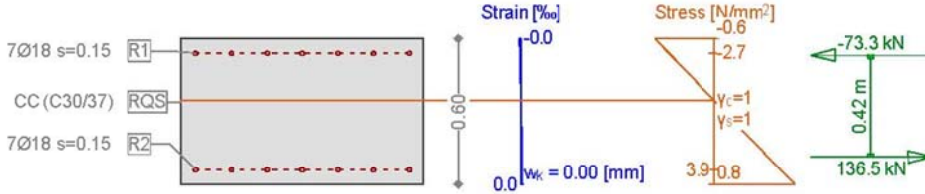
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-217.8$ ;  $M_y=-13.5$ ;

Scale 1 :30.0



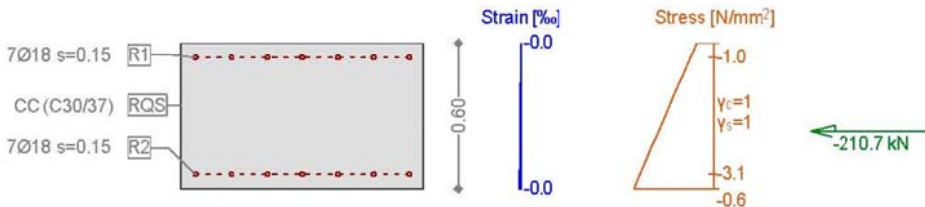
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=63.2$ ;  $M_y=42.5$ ;

Scale 1 :30.0



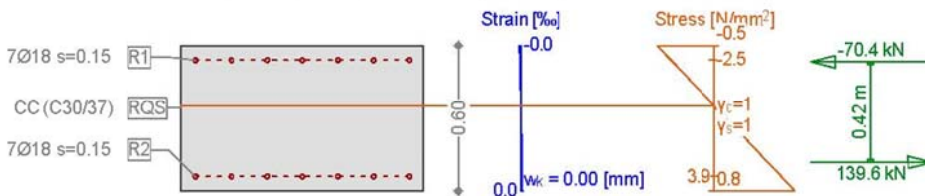
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-210.7$ ;  $M_y=-13.8$ ;

Scale 1 :30.0



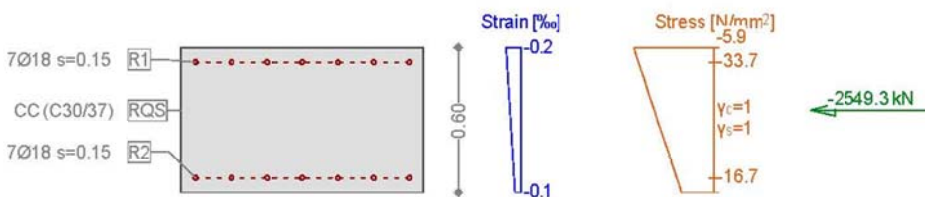
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=69.2$ ;  $M_y=41.9$ ;

Scale 1 :30.0



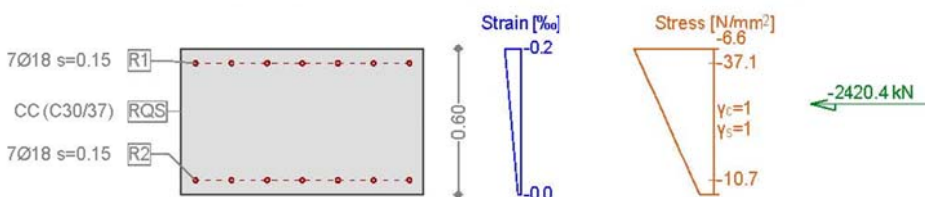
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-2549.3$ ;  $M_y=109.7$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-2420.4$ ;  $M_y=171.4$ ;

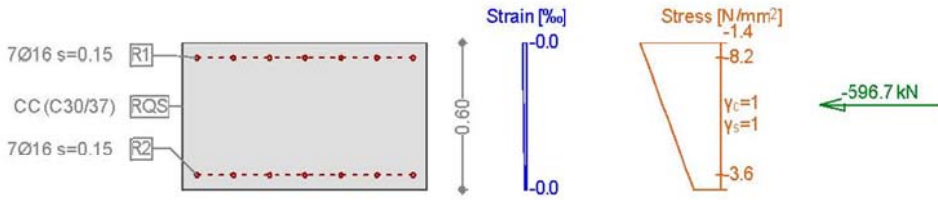
Scale 1 :30.0



• SECTION 18y

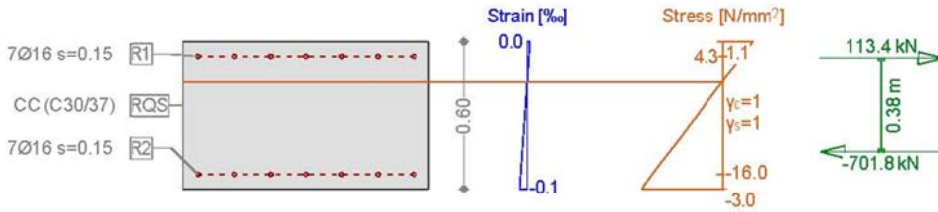
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-596.7$ ;  $M_y=29.6$ ;

Scale 1 :30.0



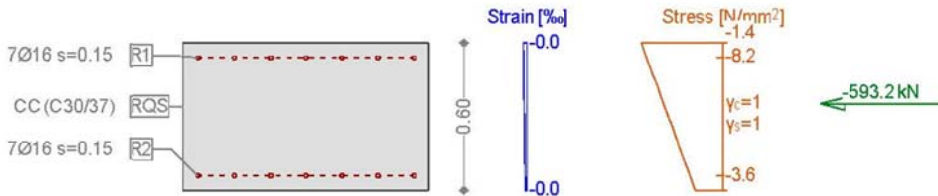
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-588.4$ ;  $M_y=-130.2$ ;

Scale 1 :30.0



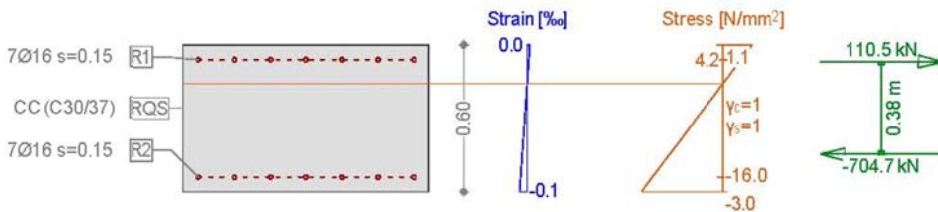
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-593.2$ ;  $M_y=30.0$ ;

Scale 1 :30.0



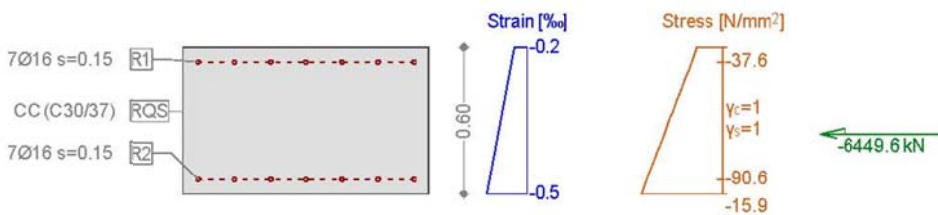
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-594.2$ ;  $M_y=-129.6$ ;

Scale 1 :30.0



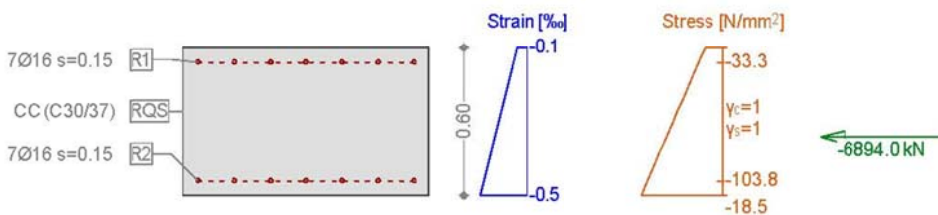
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-6449.6$ ;  $M_y=-340.0$ ;

Scale 1 :30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-6894.0$ ;  $M_y=-452.7$ ;

Scale 1 :30.0

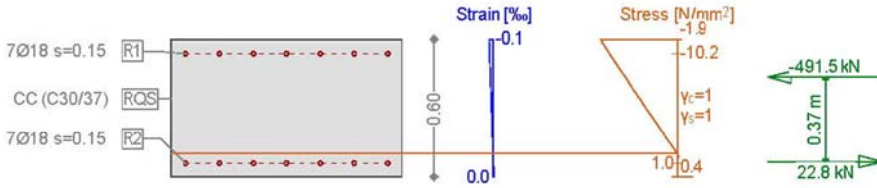




• SECTION 19

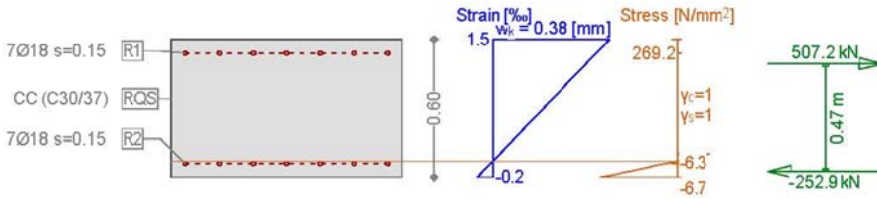
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-468.7; M_y=72.6;$

Scale 1:30.0



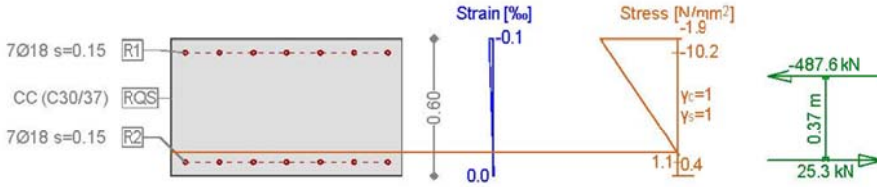
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=254.4; M_y=-167.7;$

Scale 1:30.0



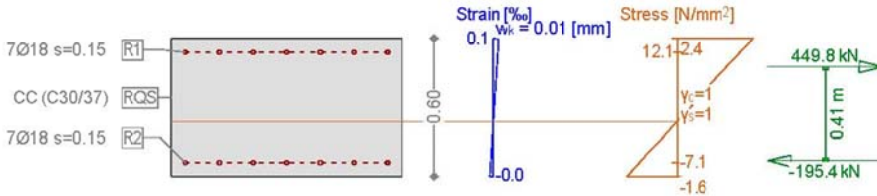
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-462.3; M_y=72.9;$

Scale 1:30.0



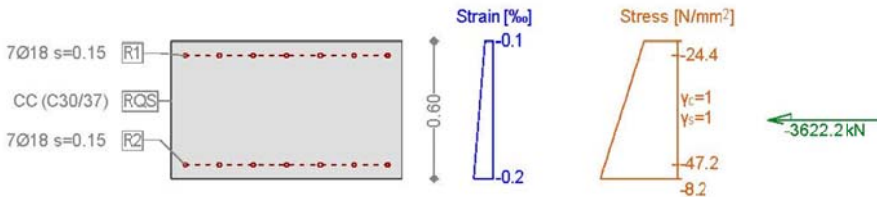
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=254.4; M_y=-124.6;$

Scale 1:30.0



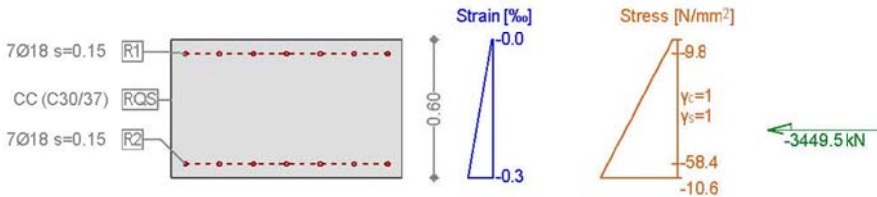
Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3622.2; M_y=-147.4;$

Scale 1:30.0



Cross-section 600X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-3449.5; M_y=-315.1;$

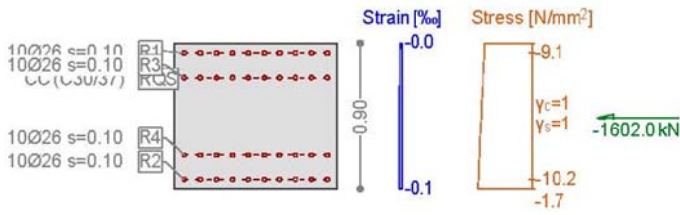
Scale 1:30.0



- SECTION 20

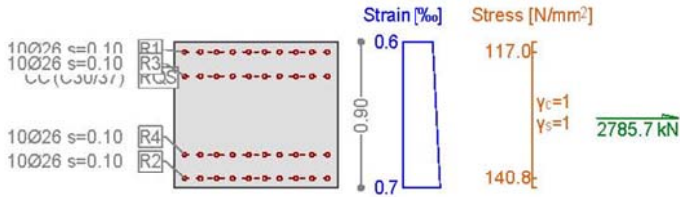
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1602.0$ ;  $M_y=-16.1$ ;

Scale 1 :45.0



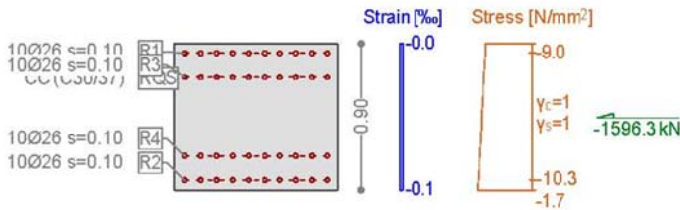
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=2785.7$ ;  $M_y=52.6$ ;

Scale 1 :45.0



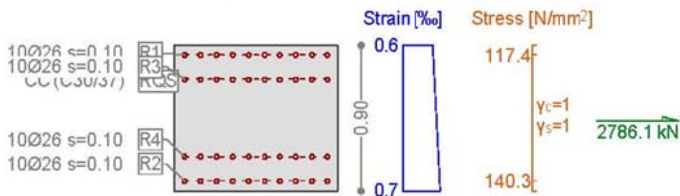
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1596.3$ ;  $M_y=-17.6$ ;

Scale 1 :45.0



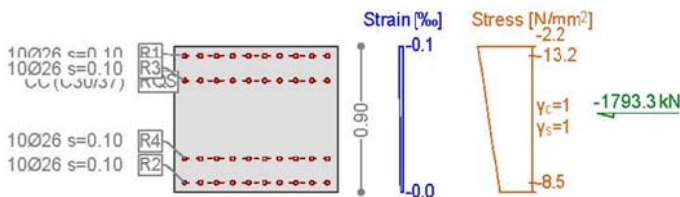
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=2786.1$ ;  $M_y=49.9$ ;

Scale 1 :45.0



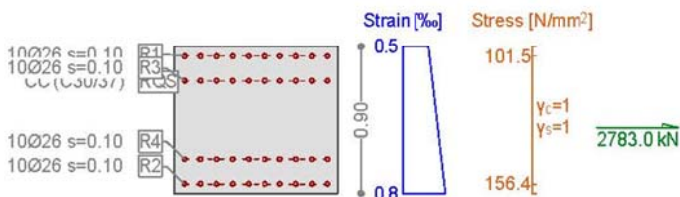
Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=-1793.3$ ;  $M_y=72.7$ ;

Scale 1 :45.0



Cross-section 900X1000 (C30/37;B450C): Stress analysis with given forces  $N_x=2783.0$ ;  $M_y=143.0$ ;

Scale 1 :45.0



## **ANHANG 2 - ZIWSCHENPLATTE**

Der Anhang 2 beinhaltet die Nachweisführung der Zwischenplatte im Mittelstollen Trens im Bereich des Anschlusses FdE-CcTa im GZT und GZG.

## **APPENDICE 2 – SOLETTA INTERMEDIA**

L'appendice 2 contiene le verifiche sezionali allo SLU e SLE svolte sulla soletta intermedia all'interno del cunicolo centrale di Trens nella sezione di innesto FdE-CcTa.

## 1 EINFÜHRUNG

Dieser Bericht handelt von der Dimensionierung der Zwischenplatte, welche im Mittelstollen mit verbreitertem Querschnitt vorgesehen ist.

Die Struktur hat eine Lichtweite von ca. 9.3 m und liegt auf die Innenschale des Tunnels, wie aus der folgenden Abbildung hervorgeht, auf.

## 1 INTRODUZIONE

Il presente allegato tratta il dimensionamento della soletta intermedia prevista nel Cunicolo centrale di Trens sezione allargata.

La struttura ha una luce di circa 9.3 m ed è appoggiata agli estremi sul rivestimento definitivo della galleria, come illustrato nella seguente figura.

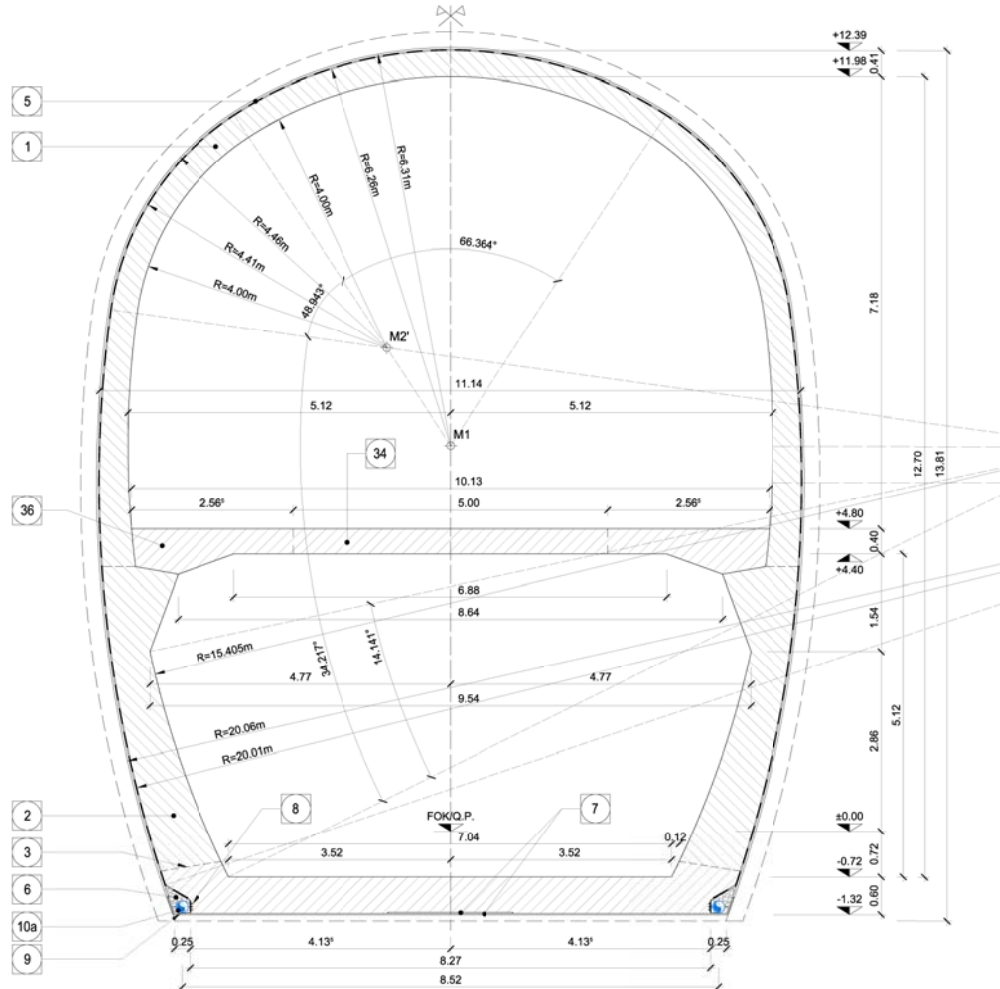


Abbildung 1: Darstellung der Zwischenplatte

Illustrazione 1: Rappresentazione della soletta intermedia

## 2 NORMEN UND RICHTLINIEN

- [1] M.D. Infrastruktur und Verkehr vom 28. Oktober 2005 „Sicherheit in Eisenbahntunnels. Risikoanalyse - Schutz- und Sicherheitsmassnahmen - Genehmigung der Projekte“
- [2] NTC 2008 vom 14 Januar 2008, " Technische Normen für Bauprodukte Ministerialerlass Infrastruktur"
- [3] UNI EN 1992-1-1:2005 „Planung von Stahlbeton- und Spannbetontragwerken – Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau“
- [4] UNI EN 1992-1-2:2005 „Planung von Stahlbeton- und

## 2 NORMATIVA

- [1] D.M. Infr. e Trasp. 28 ottobre 2005, "Sicurezza nelle gallerie ferroviarie. Analisi dei rischi - Misure di prevenzione e protezione - Approvazione dei progetti".
- [2] NTC 2008 del 14 gennaio 2008, "Norme tecniche delle Costruzioni D. Min. Infrastrutture".
- [3] UNI EN 1992-1-1:2005 "Progettazione delle strutture in calcestruzzo Parte 1-1: Regole generali e regole per gli edifici"
- [4] UNI EN 1992-1-2:2005 "Progettazione delle strutture in calcestruzzo Parte 1-2: Regole generali -

Spannbetontragwerken – Teil 1-2: Allgemeine Regeln  
– Tragwerksbemessung für den Brandfall“

- [5] UNI 11076 vom 1. Juli 2003, „Prüfmethoden zur Bewertung der baulichen Brandschutz-Maßnahmen für Decken von Untertagebauwerken im Brandfall.“

Progettazione strutturale contro l'incendio"

- [5] UNI 11076 del 1 luglio 2003, "Modalità di prova per la valutazione del comportamento di protettivi applicati a soffitti di opere sotterranee, in condizioni di incendi".

### 3 MATERIALIEN

#### 3.1 BETON

Für die Dimensionierung der Decke ist in der Regel ein Beton der Festigkeitsklasse C30/37 mit folgenden Eigenschaften zu berücksichtigen:

$$E_{cm} = 33000 \text{ MPa}$$

$$f_{ck} = 30 \text{ MPa}$$

Hierbei sind:

- $E_{cm}$  ist der Mittelwert des Sekanten Elastizitätsmoduls
- $f_{ck}$  ist die charakteristische Druckfestigkeit des Betons nach 28 Tagen

#### 3.2 BEWEHRUNGSSTAHL

Für die Dimensionierung der Decke wird Baustahl des Typs B450C verwendet:

$$E_s = 210000 \text{ MPa}$$

$$f_{yk} = 450 \text{ MPa}$$

Hierbei ist:

- $E_s$  ist das Elastizitätsmodul
- $f_{yk}$  – charakteristischer Wert der Streckgrenze des Betonstahls

### 4 BERECHNUNGSMODELL

Das Berechnungsmodell der Innenschale ist der eines Trägers auf zwei Stützen mit 9.3 m Stützweite.

#### 4.1 BELASTUNGSANALYSE

Anschließend werden die für die Dimensionierung der Innenschale zu benutzenden Belastungen festgelegt.

##### 4.1.1 Eigengewicht G1

Die für die Berechnung des Eigengewichts verwendete Querschnittsfläche pro Tunnelmeter basiert auf den effektiven Abmessungen der Struktur.

Das spezifische Eigengewicht des Stahlbetons ist mit

### 3 MATERIALI

#### 3.1 CALCESTRUZZO

Per il dimensionamento della soletta si considera un calcestruzzo con classe di resistenza C30/37 con le seguenti caratteristiche:

Dove:

- $E_{cm}$  è il valore medio del modulo elastico secante
- $f_{ck}$  è la resistenza caratteristica a compressione dello calcestruzzo a 28 giorni

#### 3.2 ACCIAIO DA ARMATURA

Per il dimensionamento della soletta si utilizza l'acciaio tipo B450C:

dove:

- $E_s$  è il modulo elastico
- $f_{yk}$  è la tensione caratteristica di snervamento acciaio per cemento armato

### 4 MODELLO DI CALCOLO

Lo schema di calcolo della soletta intermedia è di trave su due appoggi con luce pari a 9.3m.

#### 4.1 ANALISI DEI CARICHI

In seguito si definiscono le azioni da utilizzare nel dimensionamento della soletta intermedia

##### 4.1.1 Peso proprio G1

Il volume utilizzato per il calcolo del peso proprio si basa sulle dimensioni effettive della struttura.

Il peso specifico del calcestruzzo viene assunto pari  $\gamma = 25 \text{ kN/m}^3$ .

$\gamma = 25 \text{ kN/m}^3$  zu berücksichtigen.

#### 4.1.2 Lüftung Q1

Für die Dimensionierung der Innenschale wurde eine Sonderlast von  $\pm 20 \text{ kN/m}^2$  (Szenario N), eine häufige Last von  $+9.27 \text{ kN/m}^2$  (Szenario SZ 21), eine seltene Last von  $-5.90 \text{ kN/m}^2$  (Szenario N) und eine Ermüdungslast von  $+6.56 \text{ kN/m}^2$  (Szenario SZ 14) angesetzt. Gemäß Übereinkommen haben die nach oben wirkenden Lasten positives (+) und die nach unten wirkenden negatives (-) Vorzeichen.

#### 4.1.3 Nutzung Q2

Für die Dimensionierung der Innenschale wurde eine wechselnde Last von  $-4.0 \text{ kN/m}^2$  angesetzt. Gemäß Übereinkommen haben die nach oben wirkenden Lasten positives (+) und die nach unten wirkenden negatives (-) Vorzeichen.

#### 4.1.4 Brand A1

Gemäß den Vorschriften des MD 28/10/2005 Eisenbahntunnelsicherheit wird eine Standfestigkeit aller Werke angesichts der Temperatur-Zeitkurve laut UNI 11076 gewährleistet.

##### 4.1.4.1 Temperatur-Zeitkurve im Tunnelbau [UNI 11076]

Die Feuerexposition wird mittels der Temperatur-Zeitkurve der Norm UNI 11076 beschrieben, die anschließend dargestellt, und im Rechnungsprogramm CPI win REI Calcolo verwendet wird.

#### 4.1.2 Ventilazione Q1

Per il dimensionamento delle solette intermedie si è adottato un carico eccezionale pari a  $\pm 20 \text{ kN/m}^2$  (scenario N), un carico frequente pari a  $+9.27 \text{ kN/m}^2$  (scenario SZ 21), un carico raro pari a  $-5.90 \text{ kN/m}^2$  (scenario N) e un carico a fatica pari a  $+6.56 \text{ kN/m}^2$  (scenario SZ 14). Per convenzione si intendono agenti verso l'alto i carichi indicati con segno + e agenti verso il basso quelli con segno -.

#### 4.1.3 Utilizzazione Q2

Per il dimensionamento delle solette intermedie si è adottato un carico variabile pari a  $-4.0 \text{ kN/m}^2$ . Per convenzione si intendono agenti verso l'alto i carichi indicati con segno + e agenti verso il basso quelli con segno -.

#### 4.1.4 Incendio A1

In accordo con le prescrizioni del DM 28/10/2005 Sicurezza gallerie ferroviarie viene garantita la stabilità di tutte le opere in considerazione della curva temperatura-tempo secondo la UNI 11076.

##### 4.1.4.1 Curva della temperatura/tempo per tunnel [UNI 11076]

L'esposizione al fuoco viene descritta dalla curva della temperatura/tempo della normativa UNI 11076, di seguito riportata ed inserita nel programma di calcolo CPI win REI Calcolo.

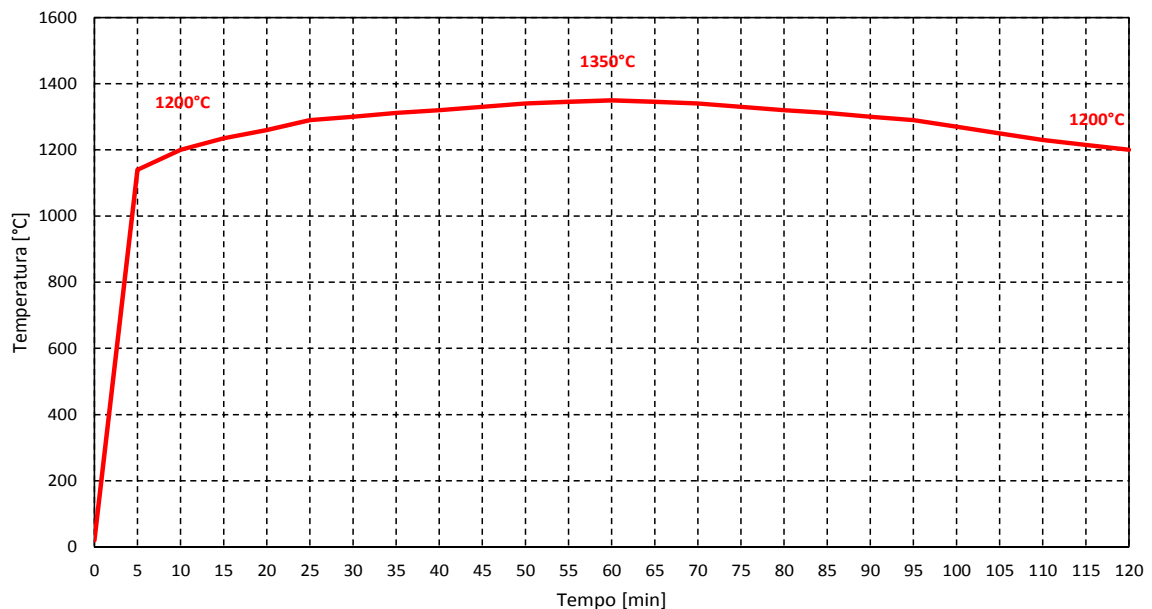


Abbildung 2: Temperatur-Zeitkurve

Illustrazione 2: Curva della temperatura/tempo

Tempo (min)	Temperatura (°C)
0	20
5	1140
10	1200
15	1235
20	1260
25	1290
30	1300
35	1312
40	1320
45	1330
50	1340
55	1345
60	1350
65	1345
70	1340
75	1330
80	1320
85	1312
90	1300
95	1290
100	1270
105	1250
110	1230
115	1215
120	1200

Abbildung 3: Temperaturwerte zu den verschiedenen Zeitpunkten

Illustrazione 3: Valori della temperatura nei diversi istanti temporali

4.1.4.2 Koeffizient zur Bewertung der temperaturbedingten Festigkeitsminderung der Materialien

4.1.4.2 Coefficienti per la valutazione della diminuzione delle caratteristiche di resistenza dei materiali in funzione della temperatura

Laut Norm UNI EN 1992-1-2 wird die Materialfestigkeit durch Überhitzung gemindert, wie in den nachfolgenden Abbildungen dargestellt:

In conformità alla UNI EN 1992-1-2 la resistenza dei materiali si riduce con l'aumento della temperatura, come rappresentato nelle figure seguenti:

- 1 Curva 1: calcestruzzo ordinario con aggregati silicei
- 2 Curva 2: calcestruzzo ordinario con aggregati calcarei

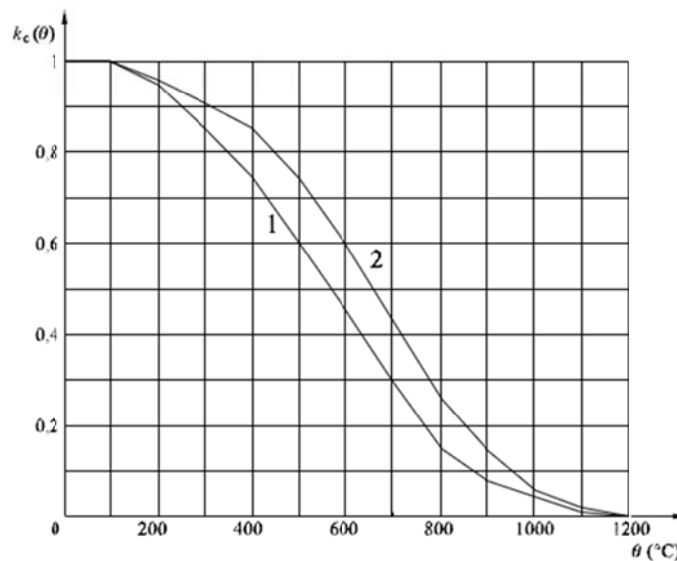


Abbildung 4: Koeffizient  $k_c(\theta)$  zur Bewertung der Abminderung der Festigkeit ( $F_{ck}$ ) des Betons

Illustrazione 4: Coefficiente  $k_c(\theta)$  per tener conto della diminuzione della resistenza caratteristica ( $f_{ck}$ ) del calcestruzzo

Curva 1 Armatura tesa (laminata a caldo) per deformazioni  $\epsilon_{a,fi} \geq 2\%$   
 Curva 2 Armatura tesa (trafilata a freddo) per deformazioni  $\epsilon_{a,fi} \geq 2\%$   
 Curva 3 Armatura compressa e tesa per deformazioni  $\epsilon_{a,fi} < 2\%$

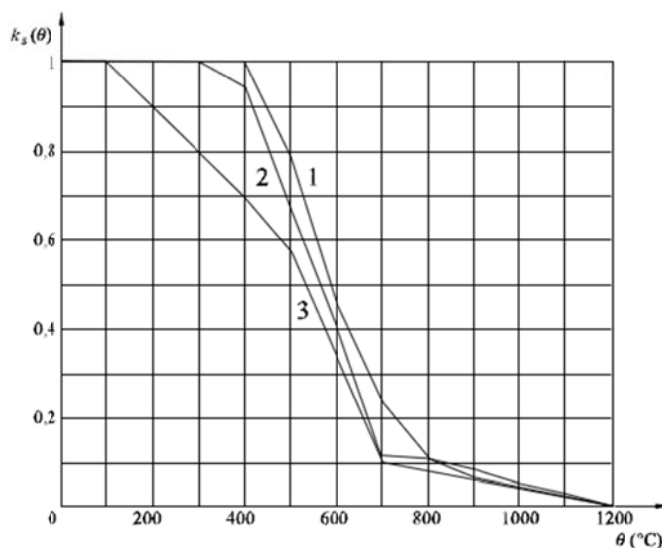


Abbildung 5: Koeffizient  $k_s$  ( $\vartheta$ ) zur Bewertung der Abminderung der charakteristischen Zug- und Druckfestigkeit ( $f_{yk}$ ) des Stahlbetons der Klasse N

Illustrazione 5: Coefficiente  $k_s$  ( $\vartheta$ ) per tener conto della diminuzione della resistenza caratteristica ( $f_{yk}$ ) a trazione e a compressione dell'armatura classe N.

#### 4.2 NACHWEISVERFAHREN

Für den Nachweis des Grenzzustandes der Trag- und Gebrauchstauglichkeit der Innenschale wurden die Wirkungskombinationen gemäß den Vorgaben im NTC2008, Abs. 2.5.3 berücksichtigt.

#### 4.2 VERIFICHE

Per la verifica allo stato limite ultimo ed allo stato limite di esercizio della soletta intermedia sono state considerate le combinazioni delle azioni in conformità delle prescrizioni del paragrafo 2.5.3 delle NTC2008.

##### 4.2.1 Grenzzustand der Tragfähigkeit (GZT) und Grenzzustand der Gebrauchstauglichkeit (GZG)

##### 4.2.1 Stati Limite Ultimi (SLU) e Stati Limite di Esercizio (SLE)

4.2.1.1 Kombinations- und Teilkoeffizienten der Sicherheit der Wirkungen

4.2.1.1 Coefficienti di combinazione e parziali di sicurezza per le azioni

Die Kombinationen der zu analysierenden Wirkungen müssen, laut allen NTC 2008, mit den entsprechenden Kombinationskoeffizienten  $\psi$  rechnen. Im überprüften Fall werden folgende Werte angewendet:

Le combinazioni delle azioni da analizzare devono essere considerate, in conformità alle NTC 2008, con i relativi coefficienti di combinazione  $\psi$ , nel caso in esame si adottano i seguenti valori:

Gefahren-Szenario / Scenario Di Pericolo	Nachweis-Verfahren / Verifica	Eigengewicht / Peso Proprio	Dauerlasten (Auslastung) / Carichi Permanenti (Utilizzazione)	Wechselast (Auslastung) / Carichi Variabili (Utilizzazione)	Lüftungs-Druck (Ausnahme) / Pressione Ventilazione (Eccezionale)	Lüftungs-Druck (Wechselnd) / Pressione Ventilazione (Variabile)
Lüftung / Ventilazione	SLU	$\gamma_g = 1.00$	-	-	$\gamma_a = 1.00$	-
	SLE (FREQUENTE)	$\gamma_g = 1.00$	-	-	-	$\gamma_0 = 0.00$
	SLE (RARO)	$\gamma_g = 1.00$	-	-	-	$\gamma_1 = 1.00$
Brand/ Incendio	SLU	$\gamma_g = 1.00$	-	-	-	-
Ermüdung/ Fatica	SLU	$\gamma_g = 1.00$	-	-	-	$\gamma_q = 1.00$
Auslastung / Utilizzazione	SLU	$\gamma_g = 1.35$	-	$\gamma_q = 1.50$	-	-
	SLE (FREQUENTE)	$\gamma_g = 1.00$	-	$\gamma_q = 1.00$	-	-

Abbildung 6: Kombinations- und Teilkoeffizienten der Sicherheit der Wirkungen

Illustrazione 6: Coefficienti di combinazione e parziali di sicurezza per le azioni



4.2.1.2 Teilkoeffizienten der Festigkeitssicherheit

4.2.1.2 Coefficienti parziali di sicurezza per le resistenze

Die Sicherheitskoeffizienten, um eine Lebensdauer der Werke von 200 Jahren zu gewährleisten, die mit BBT SE vereinbart worden sind und der Materialfestigkeit angewendet werden sind folgende:

I coefficienti di sicurezza, concordati con BBT SE al fine di garantire una vita utile dell'opera di 200 anni, applicati alle resistenze dei materiali sono i seguenti:

$\gamma_c=1.6$  e  $\gamma_s=1.2$  für Auslastungskombinationen

$\gamma_c=1.6$  e  $\gamma_s=1.2$  per le combinazioni di utilizzazione

$\gamma_c=1.2$  e  $\gamma_s=1.0$  für Sonderkombinationen (Lüftung)

$\gamma_c=1.2$  e  $\gamma_s=1.0$  per le combinazioni eccezionali (ventilazione) e per il carico da incendio

4.3 ERGEBNISSE

4.3 RISULTATI

4.3.1 Grenzzustand der Tragfähigkeit (GZT)

4.3.1 Sollecitazioni Stati Limite Ultimi (SLU)

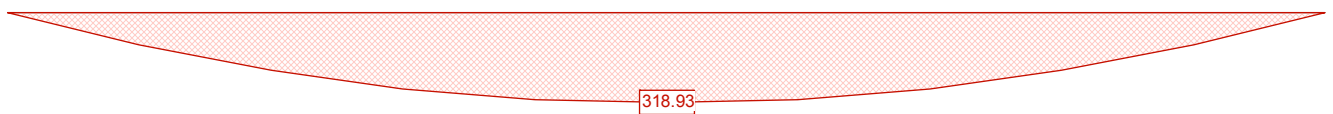


Abbildung 7:  $M_{GZT-LÜFTUNG}$

Illustrazione 7:  $M_{SLU-VENTILAZIONE}$

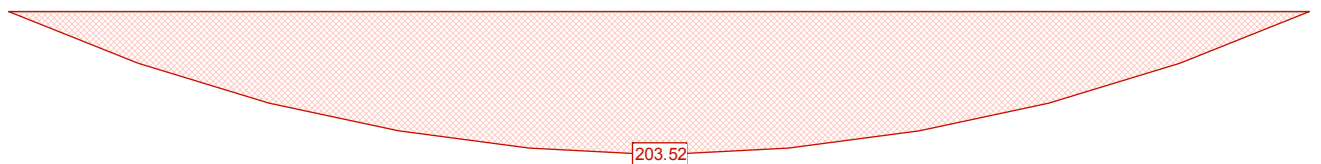


Abbildung 8:  $M_{GZT-NUTZUNG}$

Illustrazione 8:  $M_{SLU-UTILIZZAZIONE}$

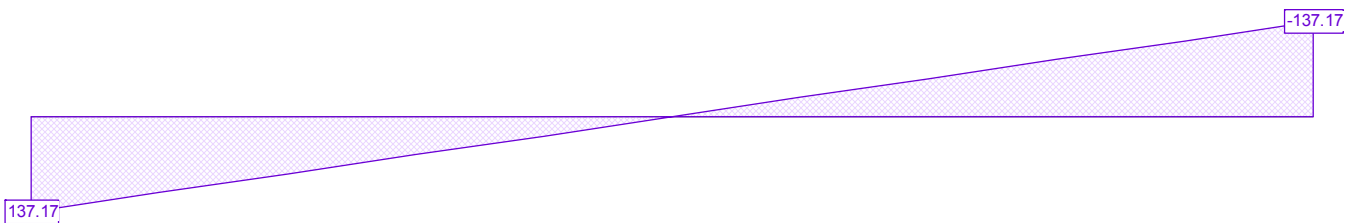


Abbildung 9:  $V_{GZT-MAXIMUM}$

Illustrazione 9:  $V_{SLU-MASSIMO}$

4.3.2 Grenzzustand der Gebrauchstauglichkeit (GZG)

4.3.2 Sollecitazioni Stati Limite d'Esercizio (SLE)

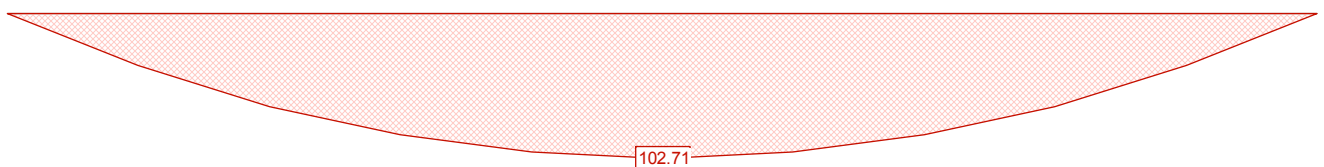


Abbildung 10:  $M_{GZG-LÜFTUNG-HÄUFIG}$

Illustrazione 10:  $M_{SLE-VENTILAZIONE-FREQUENTE}$

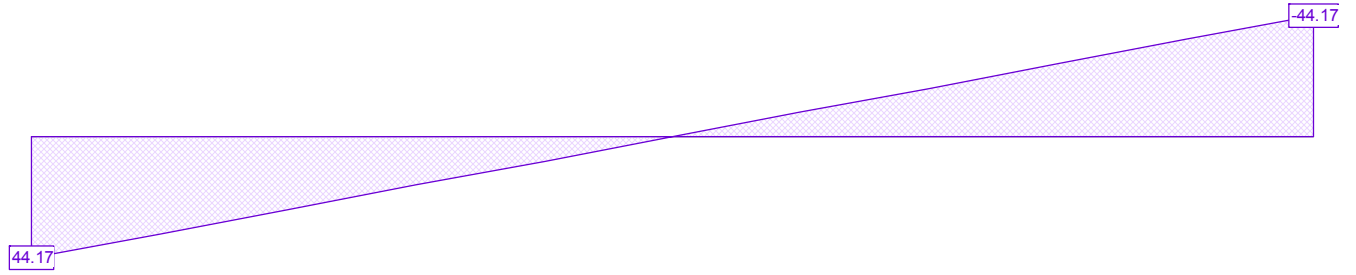


Abbildung 11:  $V_{GZT-EIGENGEWICHT}$

Illustrazione 11:  $V_{SLU-PESO\ PROPRIO}$

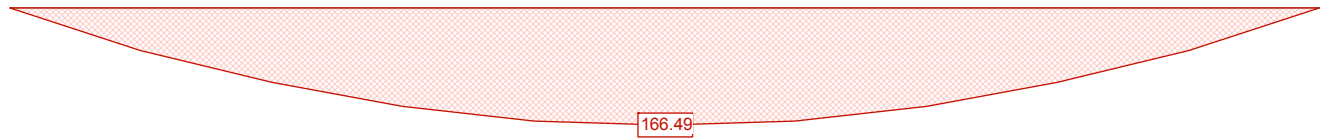


Abbildung 12:  $M_{GZG-LÜFTUNG-SELTEN}$

Illustrazione 12:  $M_{SLE-VENTILAZIONE-RARO}$

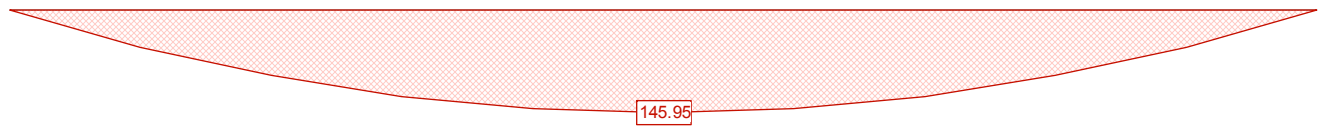


Abbildung 13:  $M_{GZG-NUTZUNG-HÄUFIG}$

Illustrazione 13:  $M_{SLE-UTILIZZAZIONE-FREQUENTE}$

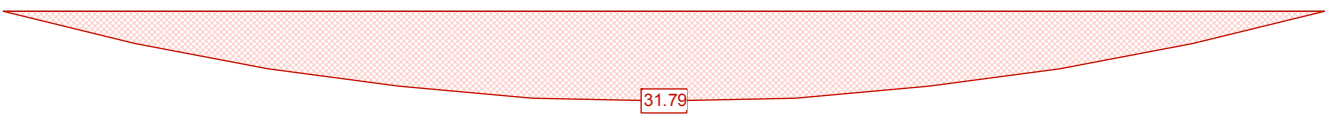


Abbildung 14:  $M_{GZG-ERMÜDUNG}$

Illustrazione 14:  $M_{SLE-FATICA}$

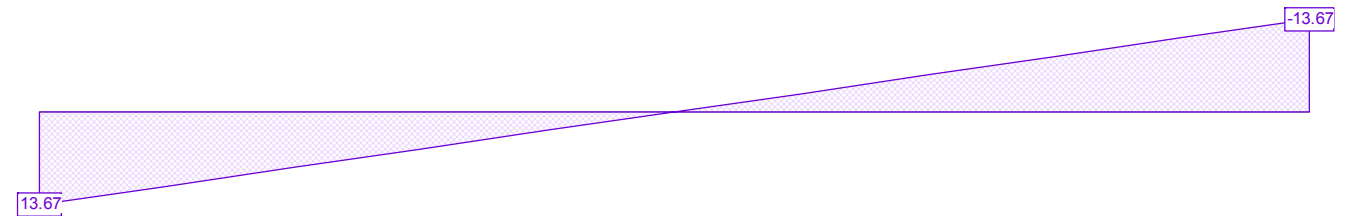


Abbildung 15:  $V_{GZG-ERMÜDUNG}$

Illustrazione 15:  $V_{SLE-FATICA}$

4.3.3 Brandlast (GZT)

4.3.3 Sollecitazioni incendio (SLU)

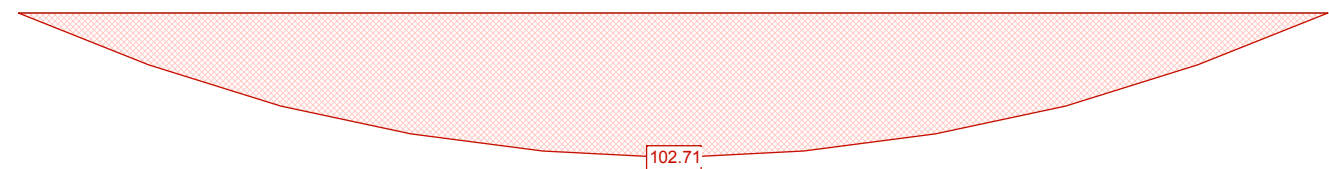


Abbildung 16:  $M_{GZT-BRAND}$

Illustrazione 16:  $M_{SLU-INCENDIO}$

#### 4.4 NACHWEISVERFAHREN

##### 4.4.1 Nachweis des Grenzzustands der Tragfähigkeit

###### 4.4.1.1 Nachweis auf Biegung

Unter Berücksichtigung der Bautoleranz von 2 cm wird der Nachweis an einem symmetrischen Bewehrungsquerschnitt von 100x38 cm anstatt 100x40 cm mit Bewehrungseisen  $\phi 26/15$  und Abstandhalter  $\phi 12/15$ , netto Betondeckung 5 cm geführt.

Im Anlage 1 wird die Querschnittsprüfung auf Biegung im Grenzzustand der Tragfähigkeit aufgezeigt.

###### 4.4.1.2 Nachweis auf Querkraft

Im Anlage 2 wird die Querschnittsprüfung auf Querkraft im Grenzzustand der Tragfähigkeit des Querschnitts mit Abmessung 100x38 cm aufgezeigt.

##### 4.4.2 Prüfungen des Grenzzustands der Gebrauchstauglichkeit

Im Anlage 3 wird die Querschnittsprüfung auf Biegung im Grenzzustand der Gebrauchstauglichkeit aufgezeigt.

###### 4.4.3 Nachweis auf Rissbildung

Im Anlage 4 wird die Prüfung auf Rissbildung aufgezeigt.

###### 4.4.4 Nachweis auf Verformung

Anschließend wird die Prüfung auf elastische sowie auf viskose Verformung gezeigt.

Wie im Absatz C.4.1.2.2.2 des Rundschreibens der NTC2008 ist der Grenzwert  $1/250 r$  Lichtweite.

$$9300\text{mm}/250 = 37.2\text{mm}$$

###### **Elastische Verformung:**

b =	1000	mm
h =	380	mm
q =	14	kN/m
L =	9300	mm
E =	33000	N/mm <sup>2</sup>
J =	4572666667	mm <sup>4</sup>
f =	8.71	mm

###### **Viskose Verformung:**

Im Falle von viskose Verformung wird das elastische Modul reduziert laut UNI EN 1992-1-1 Absatz 7.4.3 mit der Formel

#### 4.4 VERIFICHE

##### 4.4.1 Verifiche Stati Limite Ultimi

###### 4.4.1.1 Verifica a flessione

Tenuti conto dei 2 cm di tolleranza si verifica una sezione 100x38cm invece della sezione 100x40cm armata simmetricamente con ferri principali  $\phi 26/15$  e ripartitori  $\phi 12/15$ , copriferro netto 5cm.

Nell'Allegato 1 si riporta la verifica della sezione a flessione agli Stati Limite Ultimi.

###### 4.4.1.2 Verifica a taglio

Nell'Allegato 2 si riporta la verifica della sezione a taglio agli Stati Limite Ultimi della sezione pari a 100x38 cm.

##### 4.4.2 Verifiche Stati Limite d'Esercizio

Nell'Allegato 3 si riporta la verifica della sezione a flessione agli Stati Limite di Esercizio

###### 4.4.3 Verifiche a fessurazione

Nell'Allegato 4 si riporta la verifica a fessurazione.

###### 4.4.4 Verifica di deformabilità

Nel seguito si esegue la verifica di deformabilità sia in fase elastica che viscosa.

Come indicato nel paragrafo C.4.1.2.2.2 della circolare delle NTC2008 il limite è pari a  $1/250$  della luce.

$$9300\text{mm}/250 = 37.2\text{ mm}$$

###### **Deformazione elastica:**

b =	1000	mm
h =	380	mm
q =	14	kN/m
L =	9300	mm
E =	33000	N/mm <sup>2</sup>
J =	4572666667	mm <sup>4</sup>
f =	8.71	mm

###### **Deformazione viscosa:**

Nel caso di deformazione viscosa il modulo elastico viene ridotto secondo UNI EN 1992-1-1 paragrafo 7.4.3 con la

7.20:

$$E_{c,eff} = E_{cm}/(1+\phi^\infty, t_0)$$

Wenn man ein  $t_0$  gleich 7 Tage und eine relative Feuchtigkeit von 75% berücksichtigt erhält man von der Tabelle 11.2.VI der NTC2008 ein  $\phi$  im Wert von 2.5.

b =	1000	mm
h =	380	mm
q =	14	kN/m
$\phi$ =	2.5	
L =	9300	mm
E =	9429	N/mm <sup>2</sup>
J =	4572666667	mm <sup>4</sup>
f =	31.95	mm

In beiden Fällen ist resultierende Durchbiegung kleiner als die maximal zulässige Durchbiegung.

#### 4.4.5 Nachweis auf Ermüdung durch Biegung

Der Nachweis auf Ermüdung durch Biegung wird laut UNI EN 1992-1-1, Absatz 6.8 durch getrennte Prüfungen des Beton und des Stahls ausgeführt. Insbesondere:

Stahlprüfungen: die Überprüfungen werden unter GZG-Zuständen ausgeführt, indem man die zyklischen Wirkungen mit der ungünstigsten Grundkombination addiert (häufige Kombination im Grenzzustand der Gebrauchstauglichkeit). Danach wird die Ungleichung (6.71) der Norm überprüft, wobei eine Zyklusanzahl von  $10^6$  (gerade Barren) und die Sicherheitskoeffizienten  $\gamma_{F,fat}$  und  $\gamma_{S,fat}$  von 1.00 (Vermerk 1 von Absatz 6.8.4) bzw. 1.20 (Sicherheitskoeffizient des Bewehrungsstahls) angenommen werden.

Betonprüfungen: die Überprüfungen werden unter GZG-Zuständen ausgeführt, in dem man die zyklischen Wirkungen mit der ungünstigsten Grundkombination addiert (häufige Kombination bei Gebrauchsgrenzzustand). Danach wird die Ungleichung (6.77) der Norm überprüft. Bei der Berechnung des Designwiderstands auf Ermüdung des Betons ( $f_{cd,fat}$ ) müssen der Typ des Betons und die Dauer in Tagen, bei der die Anwendung der zyklischen Last beginnt, festgelegt werden: auf der sicheren Seite liegend kann  $t_0=28$ Tage und  $s=0.20$  (bei Minimierung des Koeffizienten  $\beta_{cc}$  aus Absatz 3.1.2) angenommen werden.

Im Anlage 5 wird die Prüfung Querschnittsprüfung auf Biegung der Ermüdungsgrenzzustände aufgezeigt.

#### 4.4.6 Nachweis auf Ermüdung infolge Querkraft

formula 7.20:

$$E_{c,eff} = E_{cm}/(1+\phi^\infty, t_0)$$

Considerando un  $t_0$  pari a 7 giorni ed un'umidità relativa pari a 75% si ottiene dalla tabella 11.2.VI delle NTC2008 un  $\phi$  del valore di 2.5.

b =	1000	mm
h =	380	mm
q =	14	kN/m
$\phi$ =	2.5	
L =	9300	mm
E =	9429	N/mm <sup>2</sup>
J =	4572666667	mm <sup>4</sup>
f =	31.95	mm

In entrambi i casi la freccia è inferiore alla freccia limite.

#### 4.4.5 Verifica a fatica a flessione

Le verifiche a fatica a flessione si effettuano secondo UNI EN 1992-1-1, paragrafo 6.8 eseguendo verifiche separate per il calcestruzzo e per l'acciaio. In particolare:

Verifiche lato acciaio: le verifiche sono eseguite in condizione SLE sommando le azioni cicliche alla combinazione di base più sfavorevole (Combinazione Frequente a Stato Limite di Esercizio). Si procede quindi verificando la disequaglianza (6.71) della Normativa, considerando un numero di cicli  $N^*$  pari a  $10^6$  (barre dritte) ed i coefficienti di sicurezza  $\gamma_{F,fat}$  e  $\gamma_{S,fat}$  pari rispettivamente a 1.00 (Nota 1 del paragrafo 6.8.4) e 1.20 (coefficiente di sicurezza sull'acciaio da armatura).

Verifiche lato cls: le verifiche sono eseguite in condizione SLE sommando le azioni cicliche alla combinazione di base più sfavorevole (Combinazione Frequente a Stato Limite di Esercizio). Si procede quindi verificando la disequaglianza (6.77) della Normativa. Nel calcolo della resistenza di progetto a fatica del cls ( $f_{cd,fat}$ ) occorre definire il tipo di cemento e il tempo in giorni in cui comincia l'applicazione del carico ciclico: ponendosi a favore di sicurezza si può assumere  $t_0=28$ gg e  $s=0.20$  (minimizzando il coefficiente  $\beta_{cc}$  definito nel paragrafo 3.1.2).

Nell'Allegato 5 si riporta la verifica della sezione a flessione allo Stato Limite di Fatica

#### 4.4.6 Verifica a fatica a taglio

Der Nachweis auf Ermüdung infolge Querkraft wird laut UNI EN 1992-1-1, Absatz 6.8.7 Punkt (4) geführt. Insbesondere für Bauglieder bei denen die Berechnung der Querkraftbewehrungen im Grenzzustand der Tragfähigkeit nicht nötig ist, kann davon ausgegangen werden, dass der Beton der Ermüdung infolge Querkraft stand hält, wenn folgende Bedingungen erfüllt sind:

- per  $V_{Ed,min}/V_{Ed,max} \geq 0$ :

$$V_{Ed,max} / V_{Rd,c} \leq 0.5 + 0.45 \cdot (V_{Ed,min} / V_{Rd,c}) \leq 0.9$$

$$V_{Ed,min} / V_{Ed,max} = 13.67 / 44.17 = 0.31 \geq 0$$

$$44.17 / 206.27 \leq 0.5 + 0.45 \cdot (13.67 / 206.27) \leq 0.9$$

$$0.21 \leq 0.53 \leq 0.9$$

#### 4.4.7 Nachweis unter Brandeinwirkung (GZT)

Für die Nachweisführung im Brandfall wird auf Anlage 6 verwiesen.

## 5 VERANKERUNGEN

Das geplante Verankerungssystem verhindert das Anheben der Zwischenplatten und besteht aus Stahlbolzen die auf Querkraft arbeiten und in der Kalotte auf Höhe der Seitenschalungen betoniert sind.

Diese Elemente ermöglichen alle Bewegungen innerhalb der Ebene der Zwischenplatte (X,Y Richtungen), aber nicht die Bewegungen senkrecht zu deren Oberfläche (Z Richtung). Die Anwendung dieses Systems ermöglicht das Element isostatisch zu halten, um so die Auswirkungen von Temperatur und Schwinden zu vernachlässigen.

Die maximale Auflagerreaktion ist 137.17 kN, daher werden Bolzen des Typs HSD-CRT134V verwendet, seitlich des Elements werden 3φ12 links und 3φ12 rechts verteilt, insgesamt 6φ12.

Hinsichtlich der Brandbeständigkeit werden die Schubbolzen mit einer im Brandfall aufschäumenden Hülse versehen. Da sich die Bolzen in der Mitte des Querschnitts befinden sind die erreichten Temperatur auf alle Fälle niedriger als die der statischen Bewehrung. Aus den oben genannten Gründen wird die Bemessung der Bolzen unter Brandeinwirkung als nicht problematisch eingeschätzt.

Le verifiche a fatica a taglio si effettuano secondo UNI EN 1992-1-1, paragrafo 6.8.7 punto (4). In particolare per membrature per le quali non è richiesto il calcolo di armature a taglio allo stato limite ultimo, si può ritenere che il calcestruzzo resista a fatica da taglio se si verificano le condizioni seguenti:

- per  $V_{Ed,min}/V_{Ed,max} \geq 0$ :

$$V_{Ed,max} / V_{Rd,c} \leq 0.5 + 0.45 \cdot (V_{Ed,min} / V_{Rd,c}) \leq 0.9$$

$$V_{Ed,min} / V_{Ed,max} = 13.67 / 44.17 = 0.31 \geq 0$$

$$44.17 / 206.27 \leq 0.5 + 0.45 \cdot (13.67 / 206.27) \leq 0.9$$

$$0.21 \leq 0.53 \leq 0.9$$

#### 4.4.7 Verifica incendio (SLU)

Nell'Allegato 6 si riportano le verifiche per la condizione di carico da incendio.

## 5 ANCORAGGI

Il sistema di ritegno pensato per evitare il sollevamento delle solette intermedie è costituito da degli spinotti in acciaio inox lavoranti a taglio inseriti in getto nella calotta, in corrispondenza delle facce laterale delle solette.

Tali elementi permettono tutti gli spostamenti interni al piano della soletta (direzione X,Y) ma non quelli perpendicolari al proprio piano (direzione Z). L'adozione di tale sistema permette di mantenere l'isostaticità dell'elemento, consentendo di trascurare gli effetti di temperatura e ritiro.

La reazione massima all'appoggio è pari a 137.17 kN, quindi si adottano spinotti tipo HSD-CRT134V, ai lati dell'elemento si disporranno 3φ12 a sinistra e 3φ12 a destra per un totale di 6φ12.

Per quanto riguarda la resistenza antincendio, gli spinotti a taglio saranno provvisti di guaina intumescente, inoltre, essendo posizionati in asse allo spessore della soletta, le temperature raggiunte da tali elementi sono comunque inferiori a quelle dall'armatura statica. Per questi motivi non si reputa problematica l'azione incendio in ambito di dimensionamento degli spinotti.

# ANLAGE 1

# ALLEGATO 1

Cross-section 380X1000 (C30/37;B450C): Efficiency  $M_y=318.9$ ;  $eff(M,N) = 0.87$  OK Stress analysis with given forces

Scale 1 :23.3

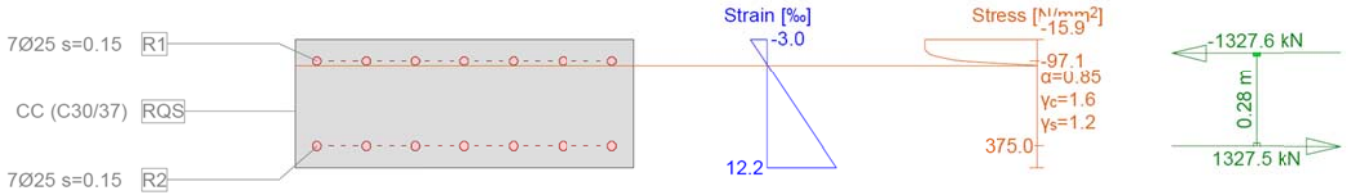


Abbildung 17: Nachweis Biegung und Längskraft, Einwirkung Lüftung, außergewöhnlich (GZT)

Illustrazione 17: Verifica a pressoflessione carico di ventilazione eccezionale (SLU)

Cross-section 380X1000 (C30/37;B450C): Efficiency  $M_y=203.5$ ;  $eff(M,N) = 0.55$  OK Stress analysis with given forces

Scale 1 :23.5

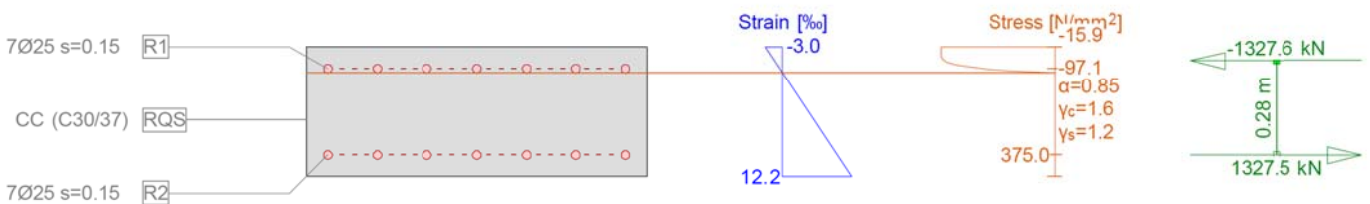


Abbildung 18: Nachweis Biegung und Längskraft, Einwirkung Nutzung, (GZT)

Illustrazione 18: Verifica a pressoflessione carico di utilizzazione (SLU)

## ANLAGE 2

## ALLEGATO 2

### Verifica sezione senza armatura a taglio

$f_{ck}$	=	30.00	MPa	Resistenza caratteristica a compressione cilindrica
$k$	=	1.794		Coefficiente
$h$	=	380	mm	Altezza geometrica della sezione
$d$	=	317	mm	Altezza statica della sezione
$A_s$	=	3'539	mm <sup>2</sup>	Area di armatura longitudinale
$\rho_1$	=	0.01117		Percentuale di armatura
$N_{Ed}$	=	0	kN	Azione assiale di progetto
$A_c$	=	317'000	mm <sup>2</sup>	Area della sezione di calcestruzzo
$\alpha_{cc}$	=	0.85		Coefficiente per carichi di lunga durata
$\sigma_{cp}$	=	0.00	MPa	Sforzo di compressione agente
$b_w$	=	1'000	mm	Larghezza sezione collaborante
$V_{Rd1}$	=	206.27	kN	
$V_{Rd2}(v_{min})$	=	146.06	kN	
$V_{Rd}$	=	206.27	kN	$V_{Ed} = 137.20$ kN $V_{Rd} > V_{Ed}$ VERIFICA SODDISFATTA

Abbildung 19: Prüfung auf Querkraft

Illustrazione 19: Verifica a taglio

### ANLAGE 3

### ALLEGATO 3

Cross-section 380X1000 (C30/37;B450C): Stress analysis with given forces  $M_y=102.7$ ;

Scale 1 :23.5

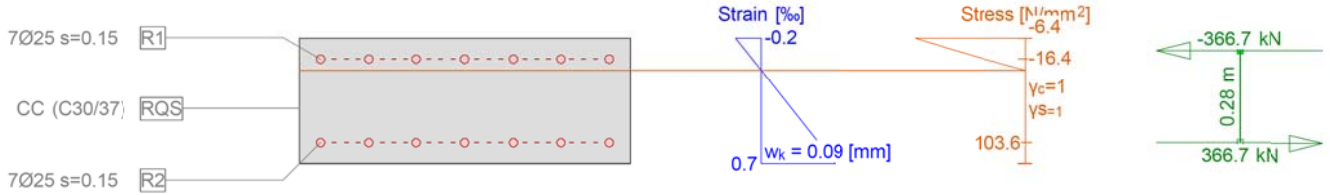


Abbildung 20: Nachweis auf Biegung und Längskraft, Einwirkung Lüftung, ständig (GZG)

Illustrazione 20: Verifica a pressoflessione carico di ventilazione frequente(SLE)

Cross-section 380X1000 (C30/37;B450C): Stress analysis with given forces  $M_y=166.5$ ;

Scale 1 :23.5

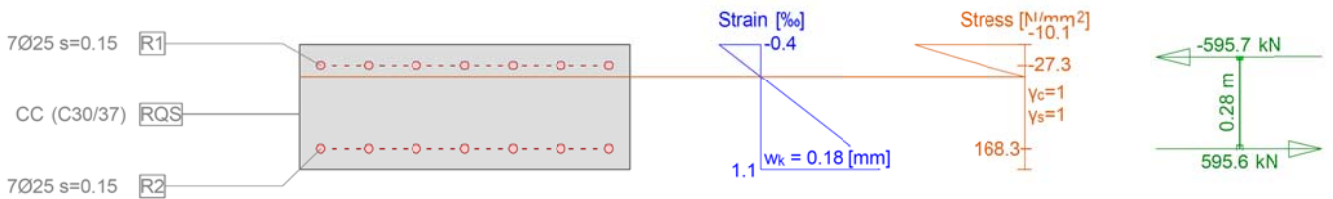


Abbildung 21: Nachweis auf Biegung und Längskraft, Einwirkung Lüftung, selten (GZG)

Illustrazione 21: Verifica a pressoflessione carico di ventilazione raro (SLE)

Cross-section 380X1000 (C30/37;B450C): Stress analysis with given forces  $M_y=146.0$ ;

Scale 1 :23.5

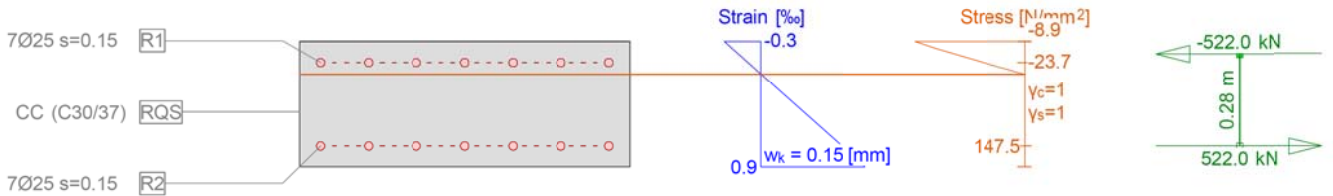


Abbildung 22: Nachweis auf Biegung und Längskraft, Einwirkung Nutzung, ständig (GZG)

Illustrazione 22: Verifica a pressoflessione carico di utilizzazione frequente (SLE)



# ANLAGE 4

# ALLEGATO 4

## Action forces

No.	AP	P	Bending and axial force			Shear forces and torsion			Remarks
			N [kN]	M <sub>y</sub> [kNm]	M <sub>z</sub> [kNm]	V <sub>y</sub> [kN]	V <sub>z</sub> [kN]	T [kNm]	
1	!SLS		0	166.5	-				

- : Calculation with uniaxial bending (neutral axis is horizontal)!

## Analysis-Parameters "SLS"

ID	σ-ε-Diagram			Strain Limits			σ <sub>s</sub> [N/mm <sup>2</sup> ]	Partial factors			Various parameters			
	c	s		ε <sub>c1d</sub> [%]	ε <sub>c2d</sub> [%]	ε <sub>ud</sub> [%]		γ <sub>c</sub> [-]	γ <sub>s</sub> [-]	α [-]	φ [-]			
!SLS	2/0	1					200.0	1.00	1.00			45.00	0	

α : Inclination of diagonal in compression

φ : Creep coefficient

## Extreme stresses and strain

Name	Class	y <sub>q</sub> [m]	z <sub>q</sub> [m]	ε [%]	σ <sub>d</sub> [N/mm <sup>2</sup> ]	γ [-]
RQS	C30/37	0.50	0.38	-0.4	-10.1	1.00
RQS	C30/37	-0.50	0	1.1	0	1.00
R1	B450C	-0.44	0.32	-0.1	-27.3	1.00
R2	B450C	-0.44	0.06	0.8	168.3	1.00

## Stresses and strain during the last iterations step

N [kN]	Internal forces		Strain and Curvature			Stiffness Values		
	M <sub>y</sub> [kNm]	M <sub>z</sub> [kNm]	ε <sub>x</sub> [%]	χ <sub>y</sub> [km <sup>-1</sup> ]	χ <sub>z</sub> [km <sup>-1</sup> ]	N/ε <sub>x</sub> [kN]	M <sub>y</sub> /χ <sub>y</sub> [kNm <sup>2</sup> ]	M <sub>z</sub> /χ <sub>z</sub> [kNm <sup>2</sup> ]
-0.1	166.5	-0.0	0.3	3.8	0	225.71	44324.21	* 3.421E+5

\* : Tangent stiffness

## Crack verification

Text	Value	Text	Value
<b>Basic principles</b>	<b>EN 1992-1-1 7.3</b>		
<b>Cross section</b>			
h	380.0 mm	Compression zone (cracked) x <sub>c</sub>	98.5 mm
d	317.0 mm	h-d	63.0 mm
Cover c	50.3 mm	h <sub>c,eff</sub>	93.8 mm
A <sub>c,eff</sub> Tension surface	93841 mm <sup>2</sup>	= Min[2.5 (h-d); (h-x)/3; h/2]	
<b>Concrete</b>		<b>Additional parameters</b>	
E <sub>c</sub>	33600.0 N/mm <sup>2</sup>	Duration of load k <sub>t</sub>	0.40
α <sub>ce</sub> (E <sub>s</sub> /E <sub>c</sub> )	6.10	Bond properties k <sub>1</sub>	0.800
Creep coefficient φ	0	Distribution of strain k <sub>2</sub>	0.500
f <sub>ctm</sub>	2.9 N/mm <sup>2</sup>	k <sub>3</sub>	3.400
f <sub>ct,eff</sub>	2.9 N/mm <sup>2</sup>	k <sub>4</sub>	0.425
<b>Reinforcement</b>		<b>Results</b>	
E <sub>s</sub>	205000.0 N/mm <sup>2</sup>	Moment	166.5 kNm
A <sub>s</sub> (in tension surface)	3540 mm <sup>2</sup>	Stress in reinforcement σ <sub>s</sub>	168.3 N/mm <sup>2</sup>
Diameter Ø <sub>eq</sub>	25.4 mm	ε <sub>sm</sub> -ε <sub>cm</sub> (7.9)	0.64 o/o
ρ <sub>eff</sub>	3.772 o/o	Crack spacing s <sub>r,max</sub> (7.11)	<b>0.29 m</b>
		Crack width w <sub>k</sub> (7.8)	<b>0.18 mm</b>

Abbildung 23: Nachweis auf Rissbildung (GZG) - Einwirkung Lüftung, selten

Illustrazione 23: Verifica a fessurazione (SLE) - carico di ventilazione raro

**Stress analysis Cross section (Girder): 380X1000****Extreme stresses and strain**

Name	Class	$y_{01}$ [m]	$z_{01}$ [m]	$\varepsilon$ [%]	$\sigma_{01}$ [N/mm <sup>2</sup> ]	$\gamma$ [-]
RQS	C30/37	0.50	0.38	-0.2	-6.4	1.00
RQS	C30/37	-0.50	0	0.7	0	1.00
R1	B450C	-0.44	0.32	-0.1	-16.4	1.00
R2	B450C	-0.44	0.06	0.5	103.6	1.00

Abbildung 24: Nachweis auf Biegung und Längskraft, Einwirkung Eigengewicht (GZG)

Illustrazione 24: Verifica a pressoflessione carico peso proprio (SLE)

**Stress analysis Cross section (Girder): 380X1000****Extreme stresses and strain**

Name	Class	$y_{01}$ [m]	$z_{01}$ [m]	$\varepsilon$ [%]	$\sigma_{01}$ [N/mm <sup>2</sup> ]	$\gamma$ [-]
RQS	C30/37	0.50	0.38	-0.1	-2.0	1.00
RQS	C30/37	-0.50	0	0.2	0	1.00
R1	B450C	-0.44	0.32	-0.0	-4.9	1.00
R2	B450C	-0.44	0.06	0.2	32.0	1.00

Abbildung 25: Nachweis auf Biegung und Längskraft, Einwirkung Ermüdung (GZG)

Illustrazione 25: Verifica a pressoflessione carico a fatica (SLE)

$$\Delta \sigma_s = 103.6 \text{ N/mm}^2 - 32 \text{ N/mm}^2 = 71.6 \text{ N/mm}^2$$

$$71.6 \text{ N/mm}^2 < 162.5/1.2 = 135.42 \text{ N/mm}^2$$

$$\Delta \sigma_c = 6.4 \text{ N/mm}^2 - 2.0 \text{ N/mm}^2 = 4.4 \text{ N/mm}^2$$

$$4.4 \text{ N/mm}^2 < 0.85 \cdot 1 \cdot 15.43 \cdot (1 - (30/250)) = 11.54 \text{ N/mm}^2$$

# ANLAGE 6

# ALLEGATO 6

Cross-section 380X1000 (C30/37;B450C): Efficiency  $M_y=102.7$ ;  $eff(M,N) = 0.28$  OK

Scale 1 :23.5

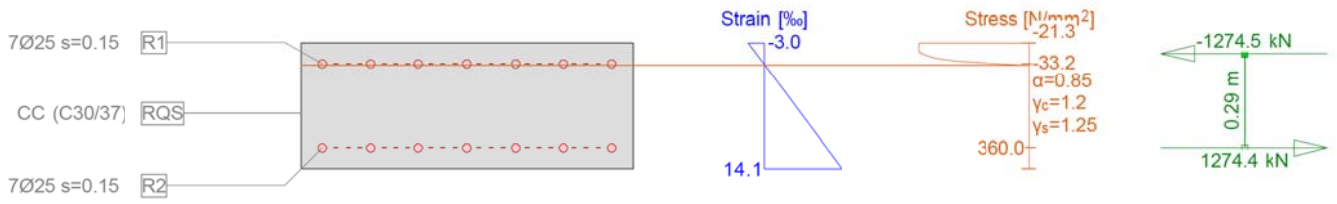


Abbildung 26: Nachweis auf Biegung und Längskraft, Einwirkung Brand (GZT)

Illustrazione 26: Verifica a pressoflessione carico da incendio (SLU)