


# PONTE SULLO STRETTO DI MESSINA



## PROGETTO DEFINITIVO

### EUROLINK S.C.p.A.

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<p><i>Unità Funzionale</i></p> <p><i>Tipo di sistema</i></p> <p><i>Raggruppamento di opere/attività</i></p> <p><i>Opera - tratto d'opera - parte d'opera</i></p> <p><i>Titolo del documento</i></p>	<p>OPERA D'ATTRAVERSAMENTO</p> <p>SOVRASTRUTTURE</p> <p>ELEMENTI DI CARATTERE GENERALE</p> <p>Generale</p> <p>Validazione del modello globale agli elementi finiti</p>	<p><b>PS0005_F0</b></p>
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## 1 Sommario

Il rapporto documenta le attività svolte ed i risultati ottenuti per la validazione del software utilizzato per le fasi di progettazione dell'opera di attraversamento. La validazione è avvenuta per confronto tra i risultati prodotti per identiche condizioni di carico tra il software detto (IBDAS) ed un software di confronto di riconosciuta affidabilità (ADINA). I modelli di calcolo 3D sono stati costruiti in forma indipendente e sono relativi ai disegni di progetto della fase di gara. I modelli di calcolo comprendono il solo ponte sospeso dotato di opportuni vincoli di interfaccia alle estremità dell'impalcato sospeso. I modelli tengono conto dell'interazione terreno-struttura. Le condizioni elementari di carico riguardano azioni statiche e dinamiche. In entrambi i casi le azioni non riproducono effettive condizioni di carico di progetto, ma costituiscono idealizzazioni di situazioni tipiche limite di sollecitazione del ponte. In considerazione del tipo di analisi (geometrico-nonlineare e materiale-lineare) l'intensità delle azioni è stata calibrata in modo che fosse rappresentativa di sollecitazioni ancora realistiche per il ponte seppure di elevata intensità. L'effetto dei buffer (alle torri, alle crociere, nelle strutture terminali) è stato considerato secondo due situazioni limite: buffer assenti o buffer fissi. Il primo caso è stato analizzato estensivamente, il secondo per casi campione. La validazione ha riguardato il confronto tra diverse grandezze di risposta (sia statiche che cinematiche) sensibili ai carichi applicati e rappresentative dei principali elementi strutturali del ponte. Sono state poste a confronto inizialmente le configurazioni assunte dai modelli a fine costruzione allo scopo di disporre di un condizionamento iniziale dei modelli. Il condizionamento è simile e le differenze rientrano nei limiti di variazione accettabili per la configurazione "a vuoto". Sono quindi stati confrontati i risultati delle diverse condizioni di carico statico. In tutti i casi si osserva una buona corrispondenza per gli spostamenti anche per le componenti meno sensibili come quelle ortogonali alla direzione del carico. Considerazioni analoghe si applicano al confronto tra le sollecitazioni che mostra una buona corrispondenza dei risultati tra i due modelli. In accompagnamento alle analisi dinamiche sono state preliminarmente effettuate analisi modali allo scopo di esaminare le proprietà dinamiche intrinseche dei modelli preliminarmente all'effettuazione delle analisi dinamiche condotte per integrazione diretta delle equazioni del moto. Si è riscontrata una corrispondenza elevata tra i modi dei due modelli sia in termini di frequenze che di forme modali e di massa partecipante, sia anche nell'ordine di distribuzione dei modi. La similitudine si conferma anche per modi superiori quali ad esempio quelli relativi alle torri. Anche nel caso delle diverse condizioni di carico dinamico (impulsivo) si osserva

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un'ottima corrispondenza sia qualitativa (come profilo della time history, presenza o meno di battimenti, oscillazioni sincrone e in fase/opposizione di fase) che quantitativa (come entità della risposta e periodo fondamentale di vibrazione).

## 2 Introduzione

### 2.1 Scopo

Il rapporto ha lo scopo di fornire i dati per la validazione del modello 3D IBIDAS del ponte sospeso. Con il termine validazione si intende la verifica indipendente dei risultati forniti dal programma IBIDAS. Il modello in parola è la versione di gara anche detto "modello 2005". Il modello 3D di confronto è implementato in ambiente ADINA. La validazione è condotta per confronto tra i risultati ottenuti con IBIDAS e ADINA per identiche condizioni di carico (sia statiche che dinamiche). L'analisi riguarda la risposta del modello 3D e non include verifiche dello stato tensionale o deformativo.

La casistica di riferimento su cui condurre la validazione è stata concordata con Cowi ed è contenuta nel documento denominato "model validation \_ draft \_ rev.1".



Le attività di validazione comprendono le seguenti analisi:

#### 1. Configurazione del ponte a fine costruzione

Questa analisi non rappresenta effettivamente un caso di test, ma serve a definire le condizioni di riferimento a fine costruzione. Infatti, le sollecitazioni e gli spostamenti calcolati per i diversi casi di carico da porre a confronto sono da considerarsi "totali" nel senso che comprendono anche lo stato tensionale e di deformazione di riferimento.

#### 2. Casi di carico statico

I casi di carico statico considerati comprendono condizioni di carico definite sia da forze concentrate che da forze distribuite. I casi di carico non riproducono alcun specifico carico di progetto, ma sono modelli di carico rappresentativi di situazioni tipiche di sollecitazione del ponte.

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Le condizioni di carico comprendono sia distribuzioni simmetriche che emisimmetriche per direzioni di carico semplice, cioè secondo una direzione di azione. Le direzioni di azione considerate sono le tre direzioni principali del ponte: longitudinale, trasversale e verticale.

### 3. *Analisi Modale*

Con l'analisi modale si intende controllare le proprietà dinamiche intrinseche del modello 3D. Si considera una numerosità modale (circa 400 modi) tale da eccitare un massa modale cumulata dell'ordine del 90% per ciascuna direzione. La restituzione grafica delle forme modali è limitata alle prime 20 frequenze del ponte con l'aggiunta di forme modali selezionate per i modi di torre (sia longitudinali che trasversali) che maggiormente contribuiscono alla risposta sismica.

### 4. *Carichi impulsivi*

Con la denominazione carichi impulsivi si intendono casi di carico riferiti alla risposta dinamica in vibrazione libera smorzata. Le oscillazioni libere derivano sia da effettivi carichi impulsivi applicati che da condizioni iniziali in termini di spostamento impresso. Il profilo di carico è identico per tutti i casi considerati.

Nelle analisi si tiene conto della non linearità geometrica, ma non di quella materiale. I buffer (alle torri, alla crociera alle torri e nella struttura terminale) non vengono linearizzati, ma sono considerati nelle due configurazioni limite: buffer assenti (denominati free-free nella terminologia COWI) e buffer attivi reagenti con la rigidezza iniziale a limite plastico infinito (denominati fixed-fixed nella terminologia COWI). La analisi modali sono linearizzate nell'intorno della configurazione del ponte a fine costruzione.

## 2.2 **Organizzazione del rapporto**

Il rapporto è organizzato in due parti. Nella prima parte sono riportate le informazioni che permettono di comprendere le condizioni di carico esaminate e il tipo di confronti effettuati; nella seconda parte sono riportati i risultati articolati in quattro sezioni così distinte:



- *Sezione 1:* Configurazione del ponte a fine costruzione;
- *Sezione 2:* Casi di carico statico;

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- *Sezione 3:* Analisi modale;
- *Sezione 4:* Carichi impulsivi.

Il programma delle attività concordato con Cowi e contenuto nel rapporto “model validation \_ draft \_ rev.1” ed il modello ADINA sono stati già consegnati e non vengono allegati al presente rapporto.



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### 3 Analisi condotte



Vengono descritti i casi di carico statico e dinamico considerati. Le analisi modali sono state condotte nelle due configurazioni di buffer: free-free e fixed-fixed.

#### 3.1 Casi di carico statico

I simboli impiegati nella tabella sottostante che riassume i casi di carico considerati hanno il seguente significato:

- LC = condizione di carico,
- V = direzione verticale; L = longitudinale; T = trasversale,
- F = forza, M = momento/coppia (l'asse è nella direzione V, L, T)
- U = carico uniforme, P = carico uniforme distribuito a scacchiera, O = carico uniforme distribuito su metà larghezza dell'impalcato

LC	Forza	Tipo	Posizione	Direzione	buffer fix-fix
1	Concentrata	F	Mezzeria impalcato	V	
2	Concentrata	F	Impalcato a 1/10 dalla torre	V	*
3	Concentrata	F	Impalcato ad una estremità	L	
4	Concentrata	F	Sommità ambo le torri	T	
5	Concentrata	M	Sommità ambo le torri	V	
6	Distribuita	U	Torre a tutta altezza	L	
7	Distribuita	O	Impalcato (metà larghezza per tutta la lunghezza)	V	*
8	Distribuita	P	Deck (metà larghezza e metà lunghezza alternate)	V	
9	Distribuita	U	Impalcato per tutta la lunghezza	T	*
10	Distribuita	O	Impalcato metà lunghezza	V	

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La condizione buffer “free-free” costituisce la configurazione di base per i buffer ed è quella per cui sono valutate tutte le 10 condizioni di carico. La condizione “fixed-fixed” viene considerata per i tre casi indicati con asterisco nella tabella sovrastante.

Gli schemi grafici delle dieci condizioni di carico statico sono riportate alla fine del capitolo e sono indicate con le sigle da LC1 a LC10.

### 3.2 Casi di carico dinamico

Sono state considerate tre condizioni di carico impulsivo associate alle seguenti distribuzioni di carico:

- Caso 1: carico uniformemente distribuito per tutta la lunghezza di impalcato,  $F = 10\text{kN/m}$ ;
- Caso 2: carico uniformemente distribuito per tutta l'altezza della torre,  $F = 100\text{kN/m}$ ;
- Caso 3: spostamento alla base delle torri in direzione longitudinale,  $D = 0.1\text{m}$ .



Il terzo caso di carico è stato considerato nelle due condizioni: buffer free-free e fixed-fixed.

Gli schemi grafici delle tre condizioni di carico impulsivo sono riportate alla fine del capitolo e sono indicate con le sigle da Caso1 a Caso3.

Nei primi due casi si è assunto uno smorzamento alla Rayleigh definito dai seguenti parametri:

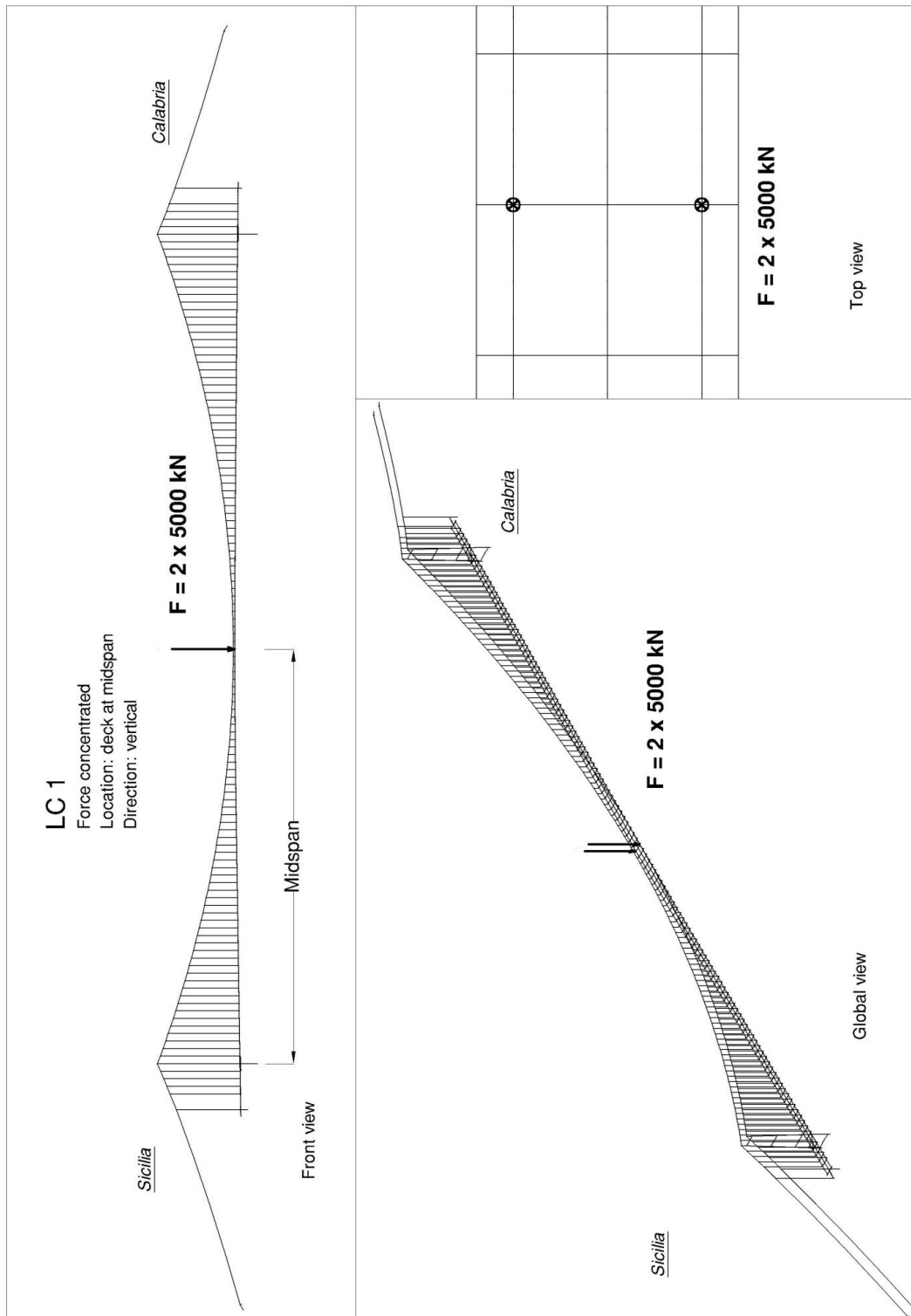
$\alpha$	$\beta$	$f_1$ Hz	$f_2$ Hz	$\omega_1$ rad/s	$\omega_2$ rad/s	$\xi$ %
0.0190695	0.015432	0.0313	1	0.20	6.28	5

Le analisi sono state condotte per integrazione diretta delle equazioni del moto. L'impulso è stato applicato secondo una funzione triangolare di durata doppia del passo di integrazione. Il passo di integrazione è stato calibrato sul modo dominante per la particolare configurazione di carico applicata. Quanto sopra è riassunto nella seguente tabella.

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Caso	Passo (sec)	Durata (sec)	Buffer	Smorzamento
1	1	400	free-free	Rayleigh
2	0.1	51	free-free	Rayleigh
3	0.05	31	free-free	No
3	0.05	31	fixed-fixed	No

Negli ultimi due casi l'unica sorgente di smorzamento sono gli elementi a dissipazione concentrata applicati alla base delle fondazioni.

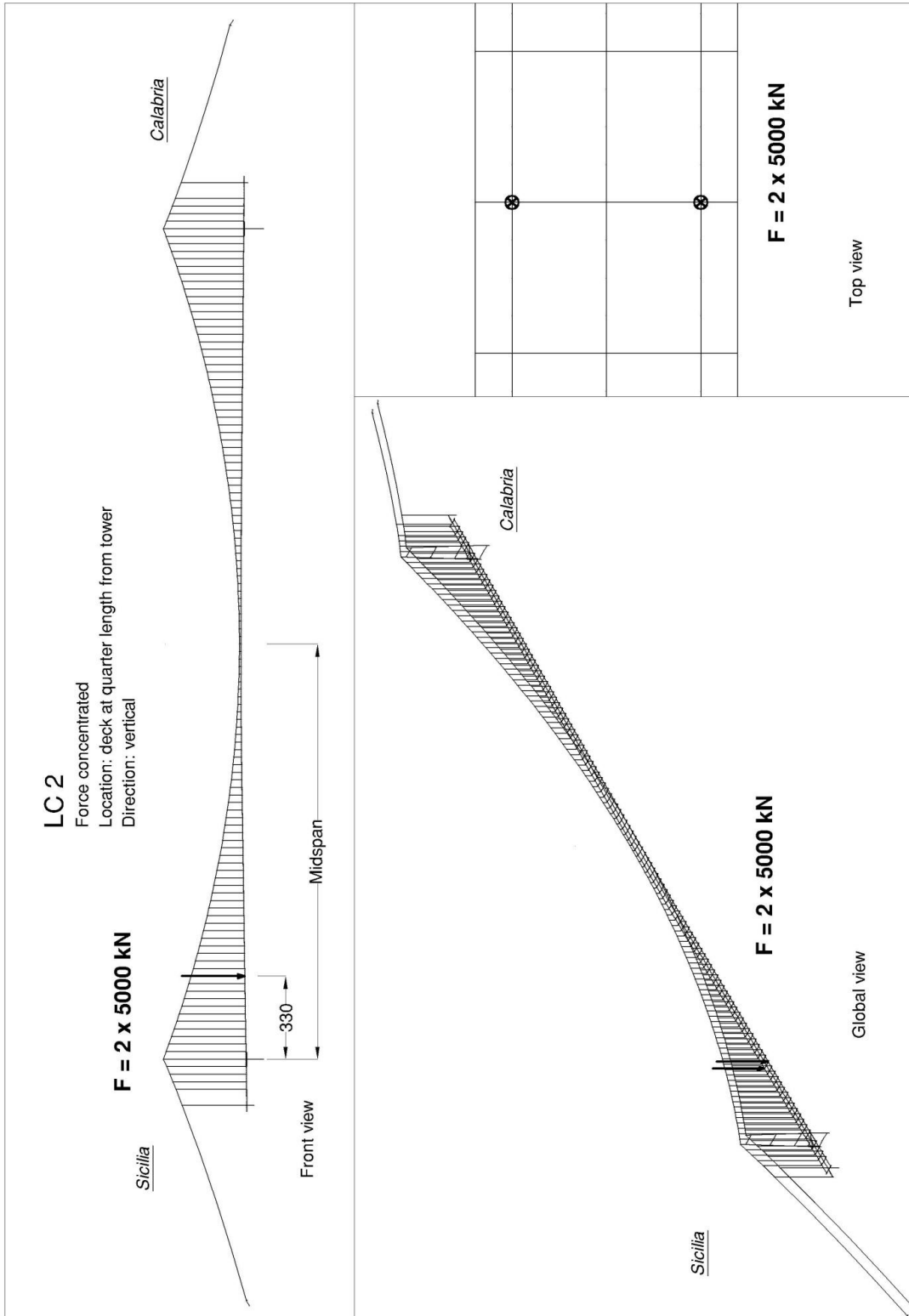


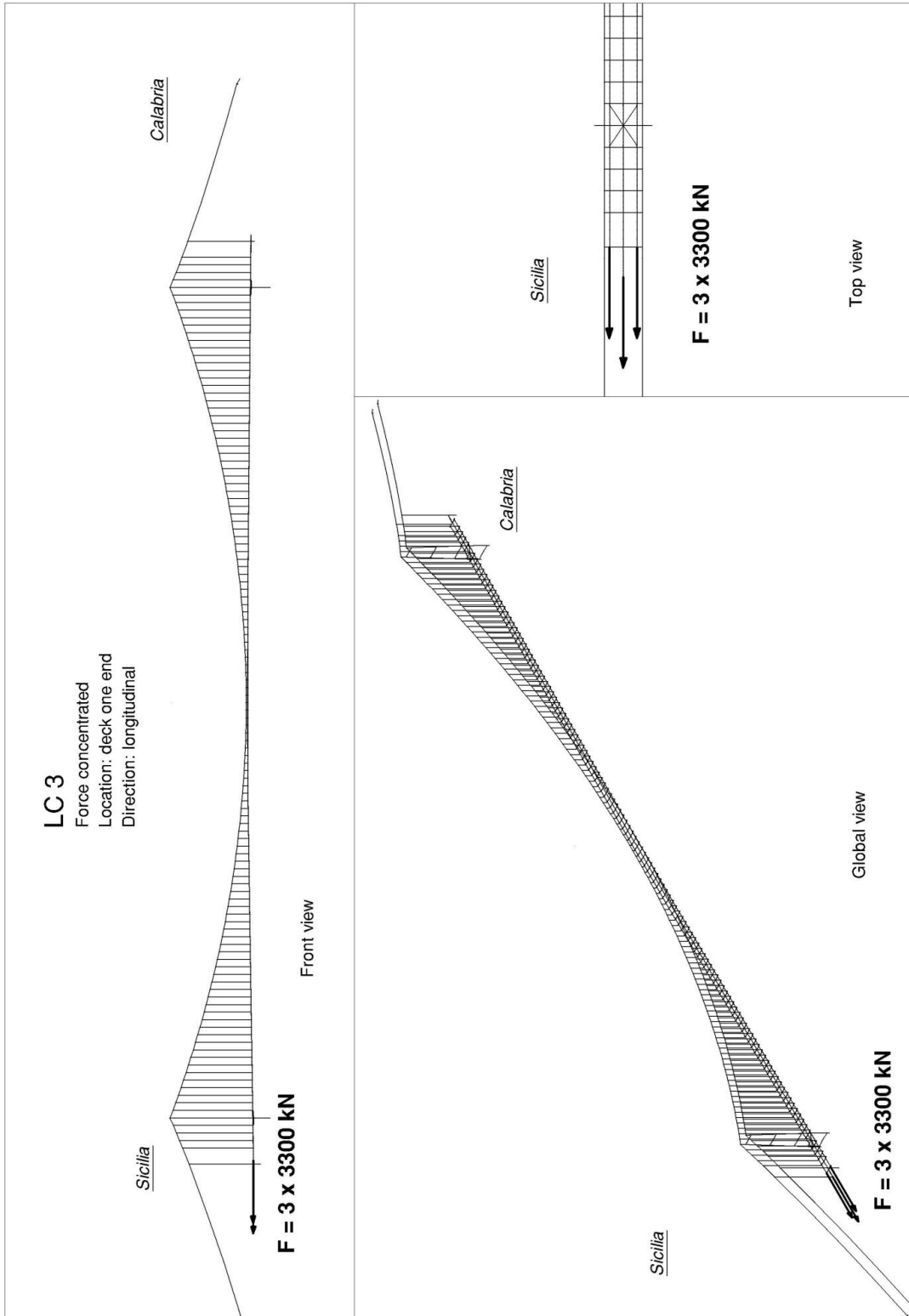
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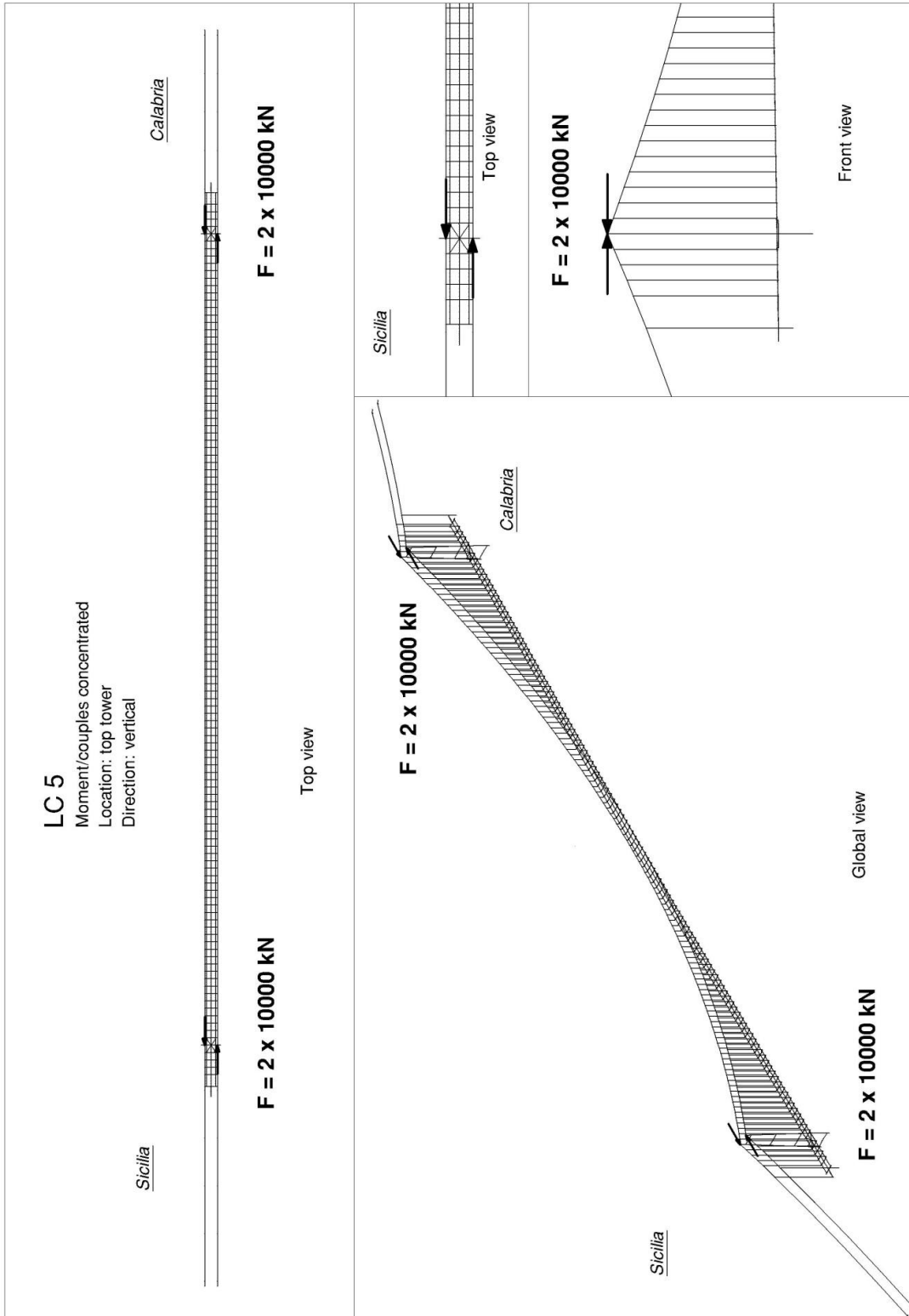
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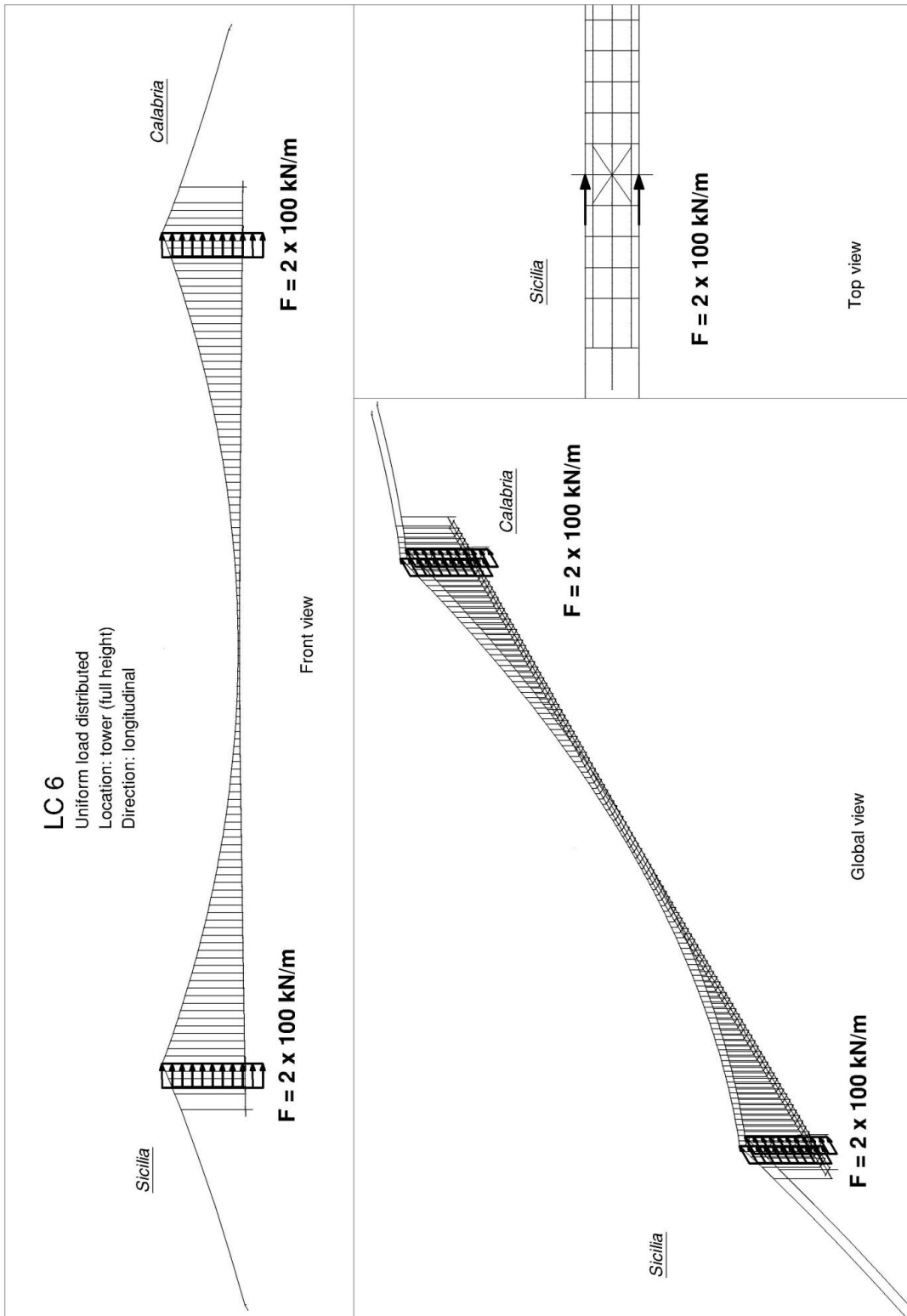


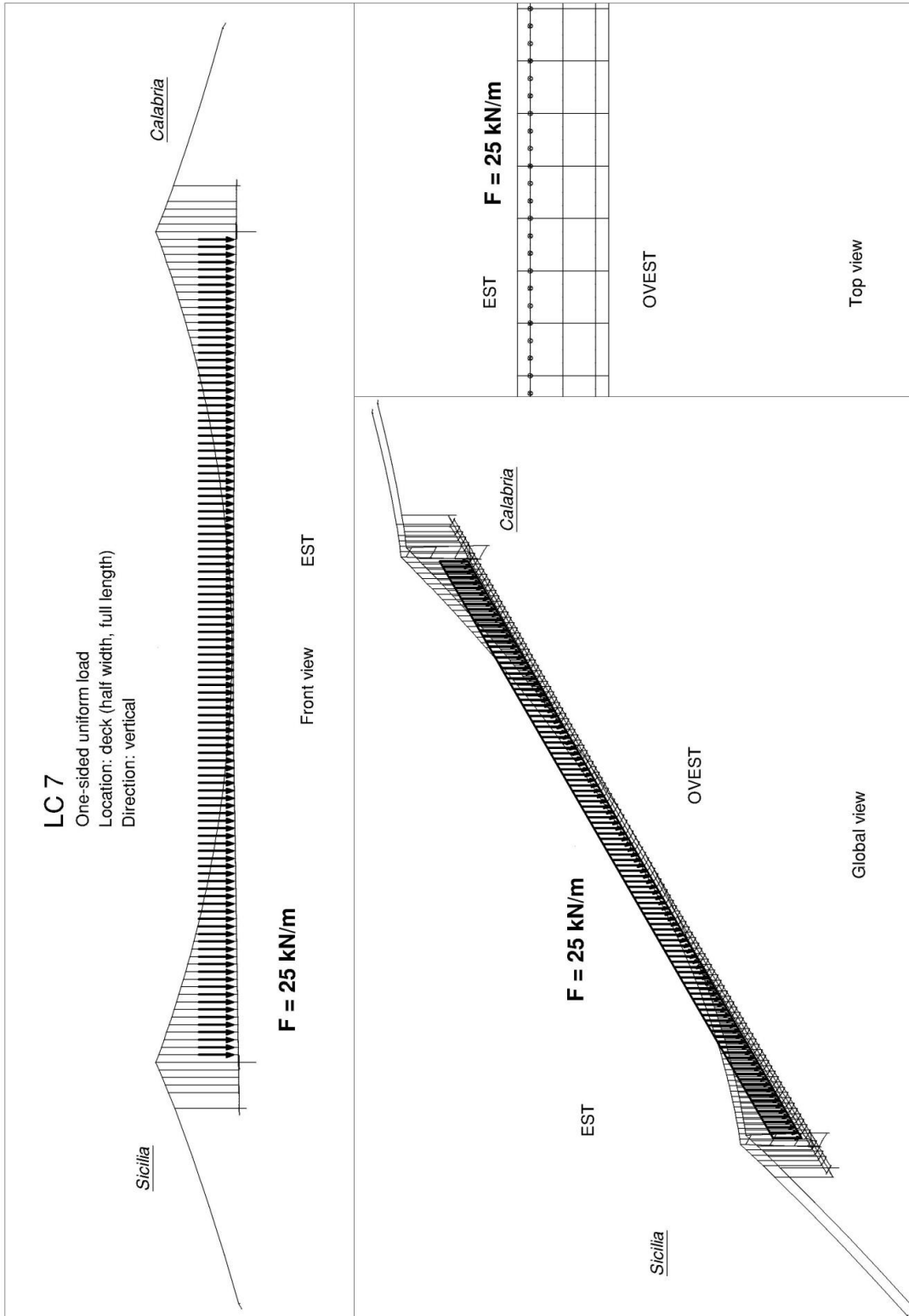
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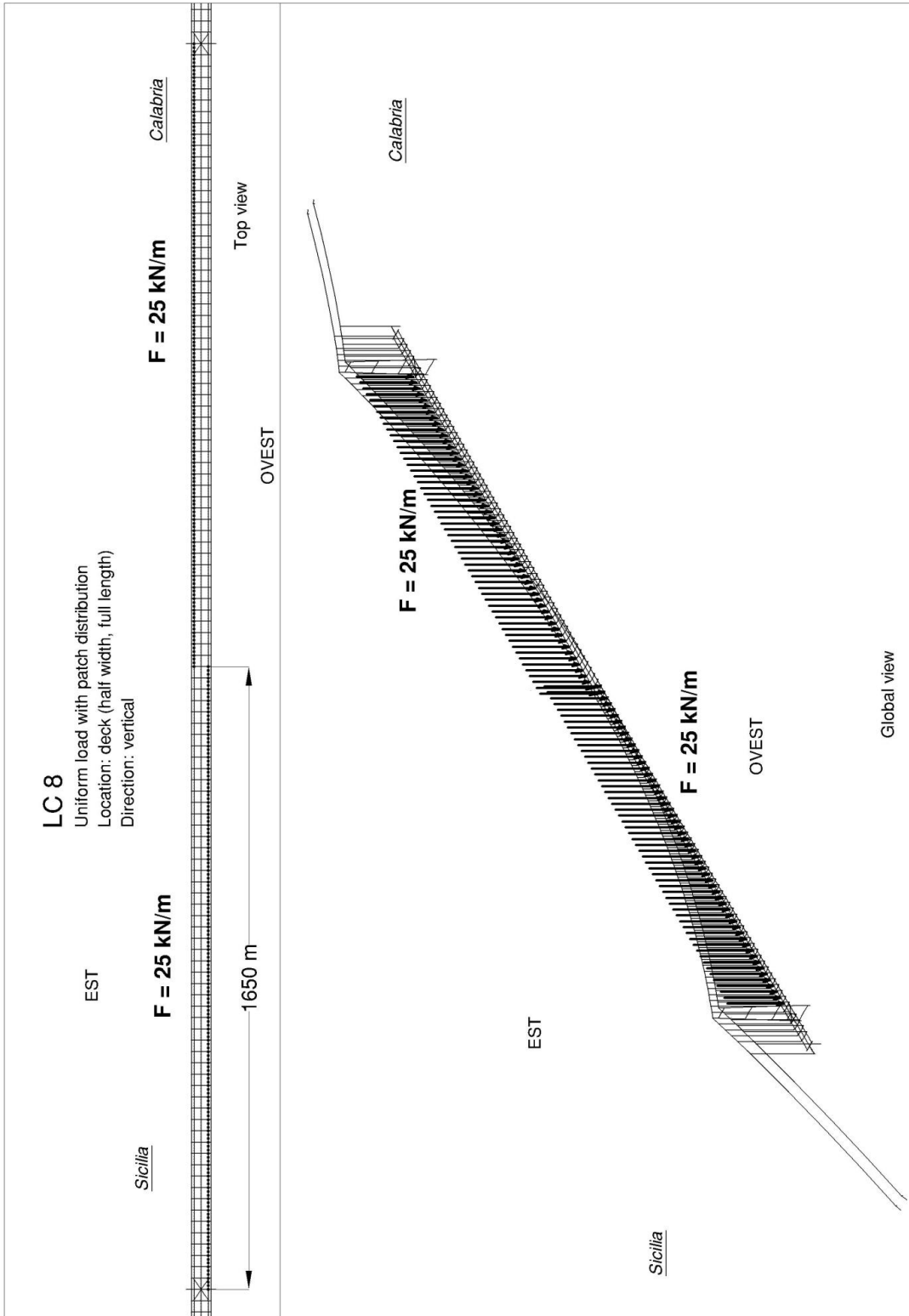


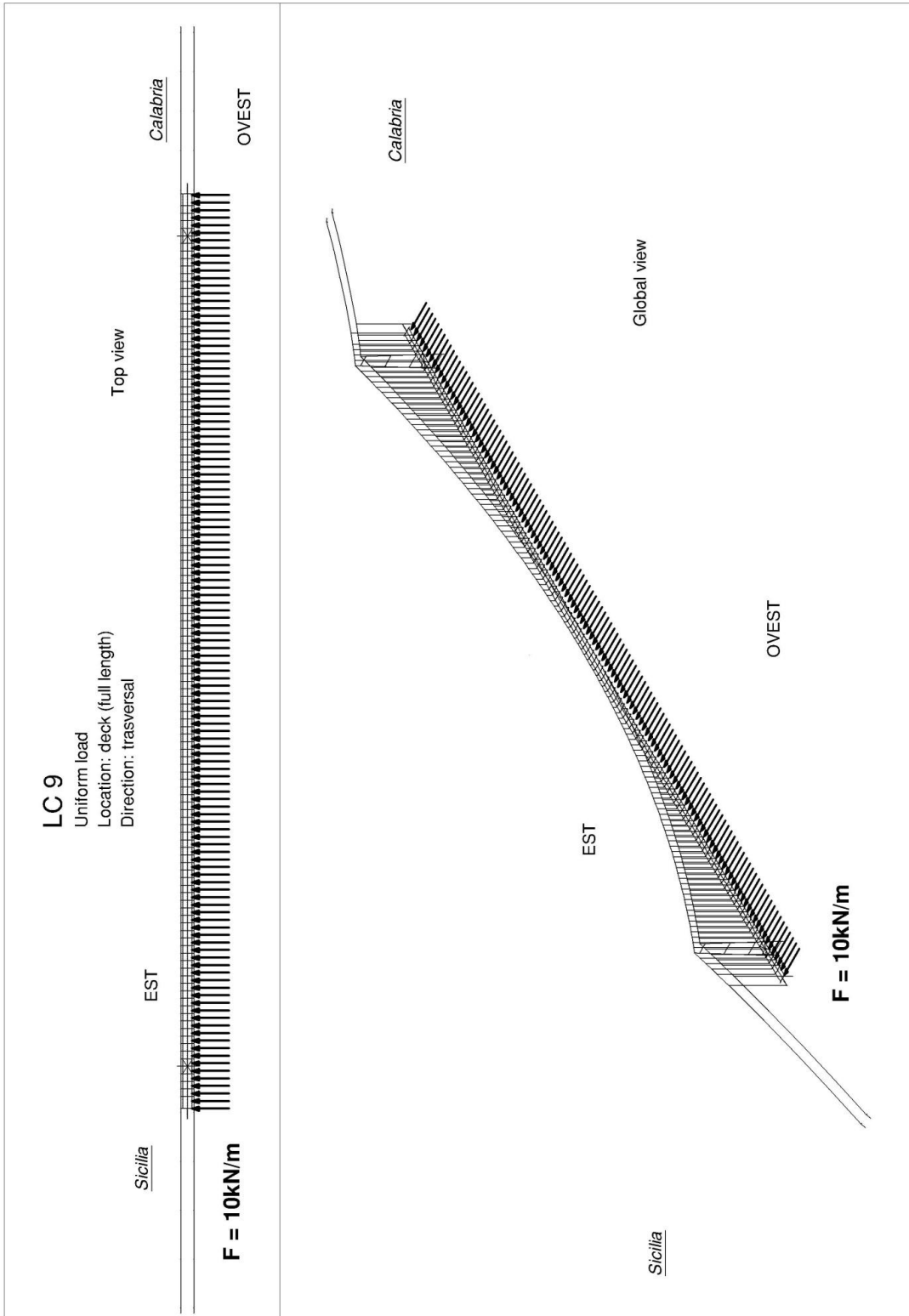
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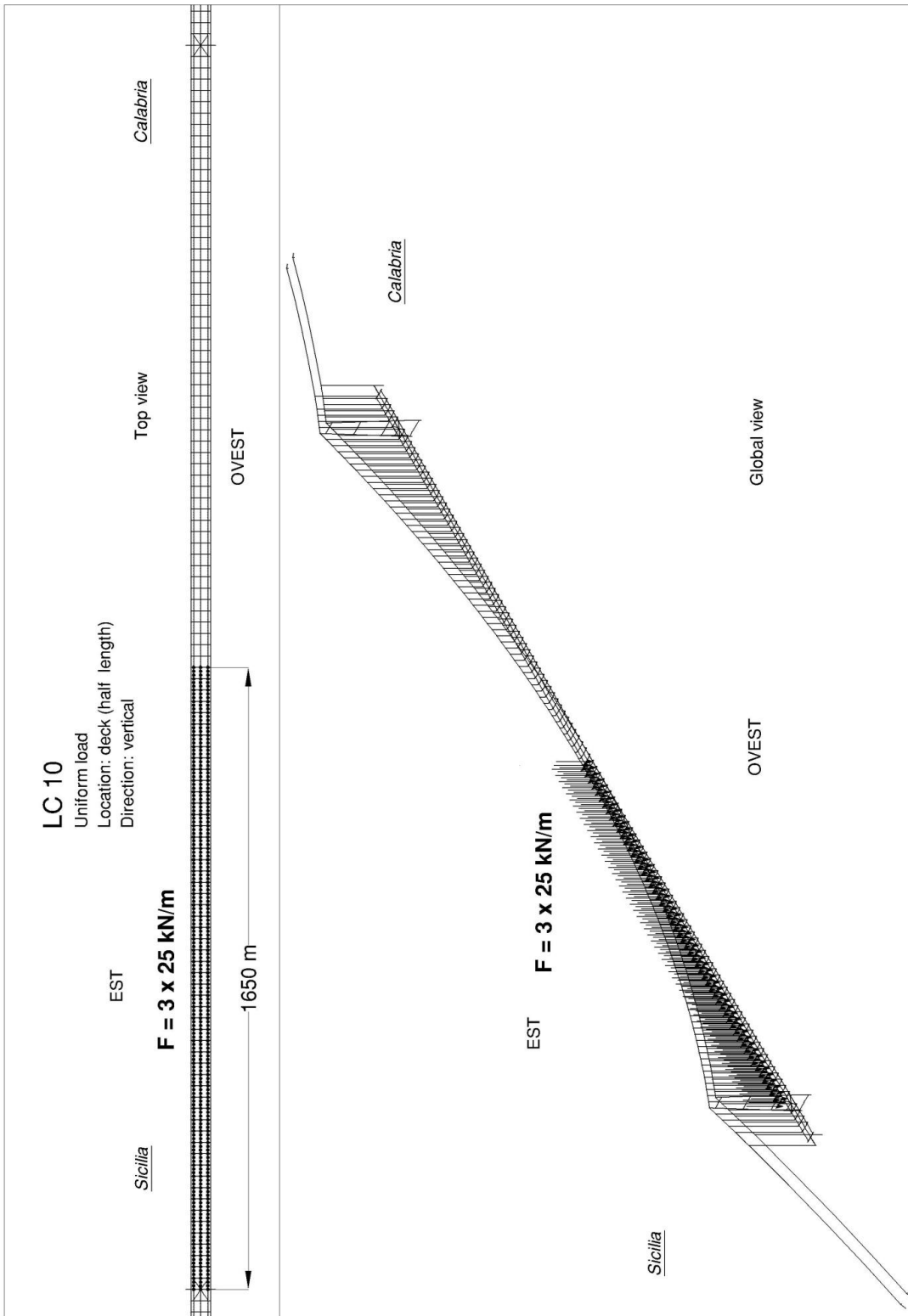


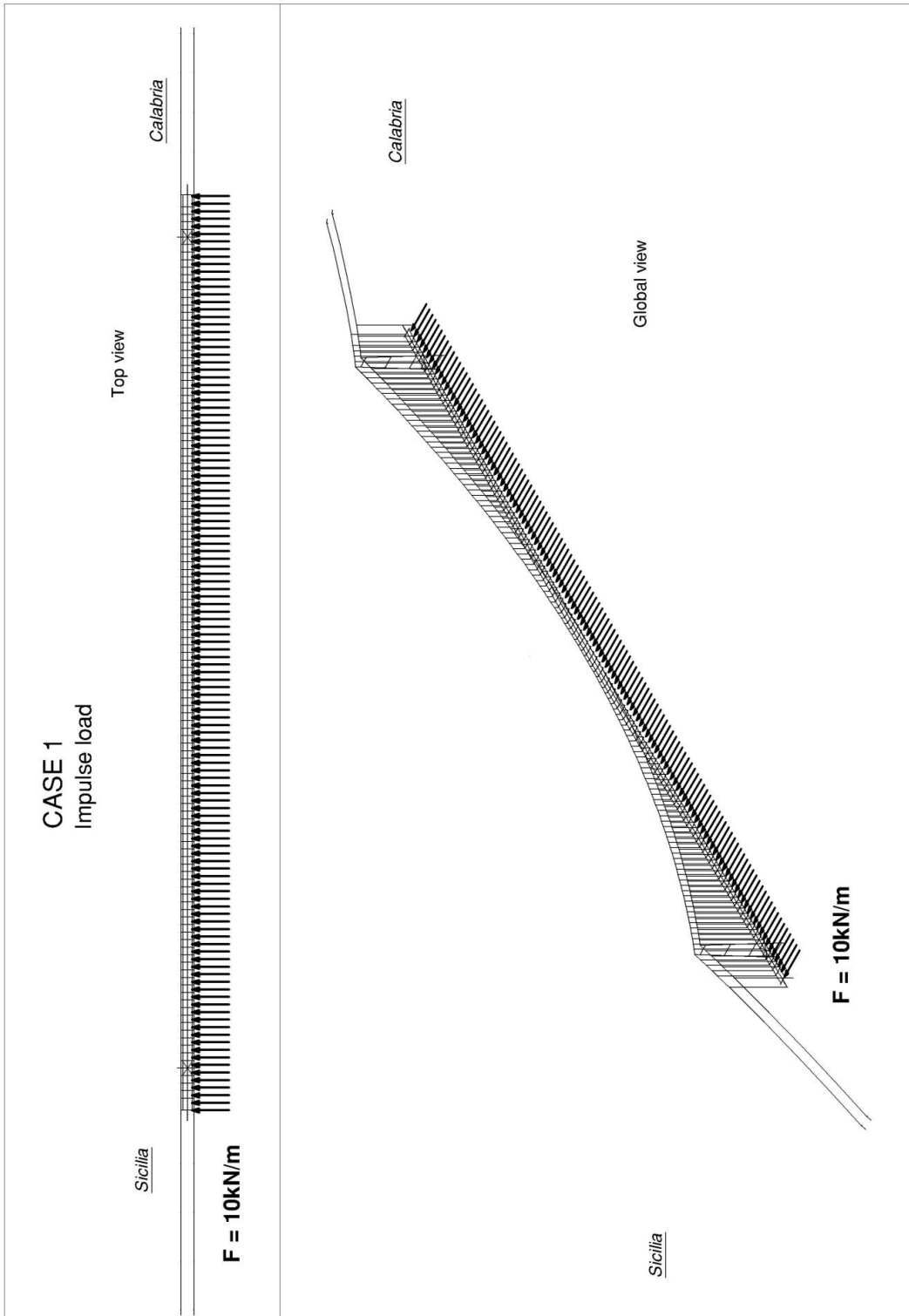
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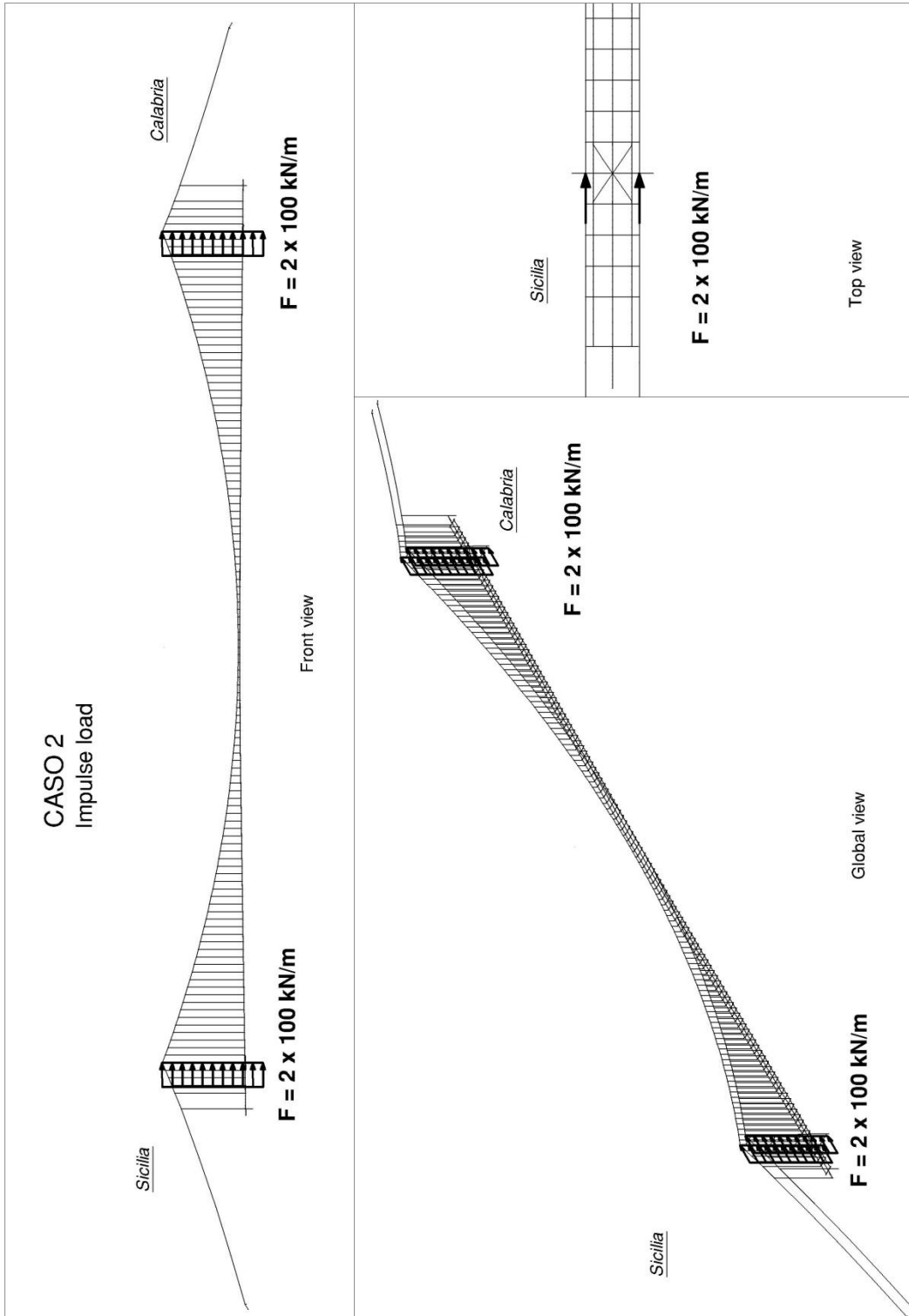


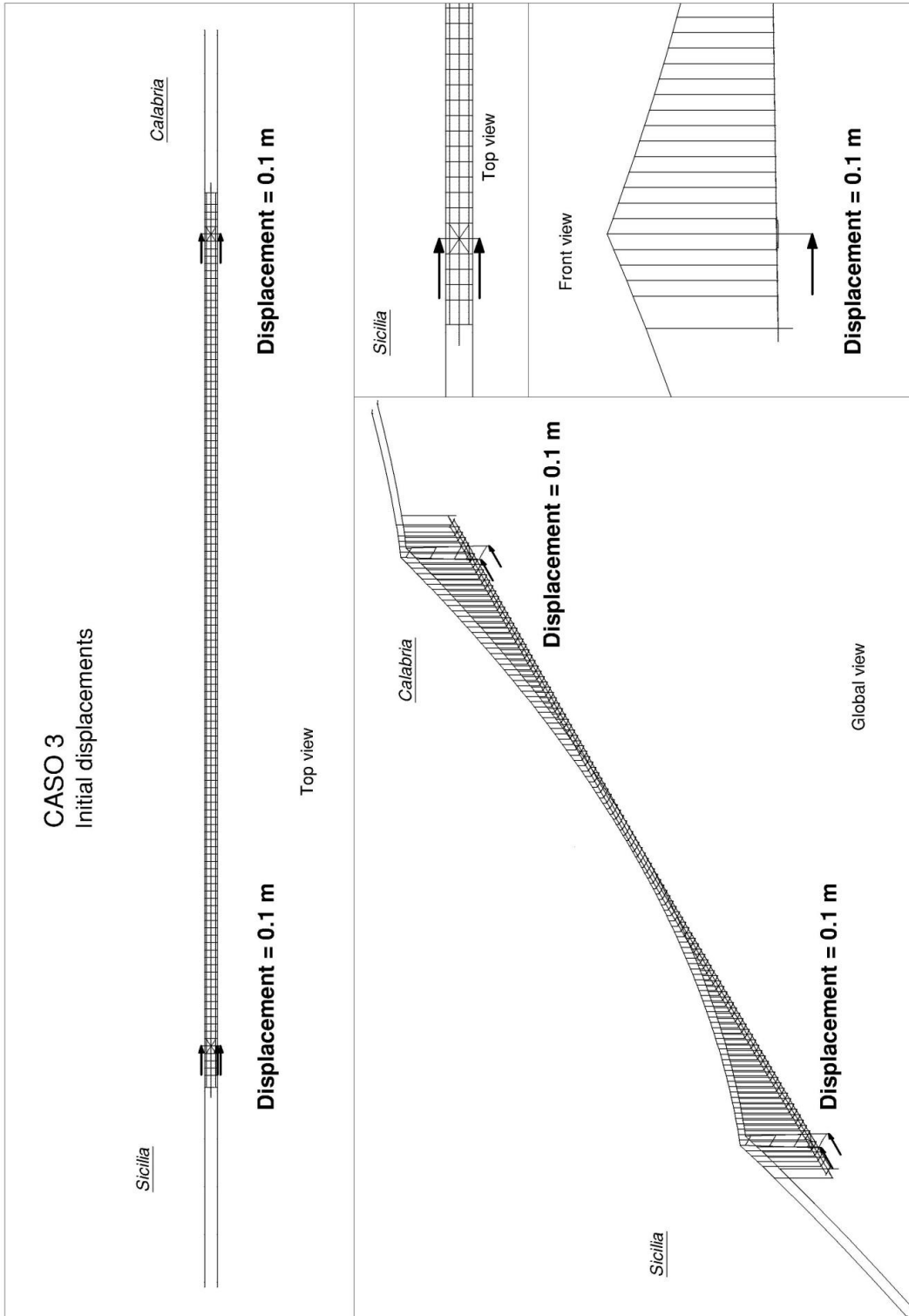
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## 4 Grandezze e punti di controllo

Con la denominazione grandezze di controllo si intendono quelle grandezze di risposta sia statiche (sollecitazioni) che cinematiche (spostamenti) che vengono utilizzate ai fini del confronto dei risultati tra i modelli IBDAS e ADINA.

### Casi di carico statico

Le sollecitazioni/spostamenti negli elementi strutturali sono monitorate nei seguenti punti/elementi:

- Forze nei cavi (agli ancoraggi, in sommità alle torri, in mezzeria)
- Forze alla base delle torri
- Forze nei pendini
- Spostamenti della sezione di mezzeria dei cavi
- Spostamenti in sommità alle torri
- Spostamenti dell'impalcato (ad entrambe le estremità in direzione L ed in mezzeria e alle torri in direzione T)

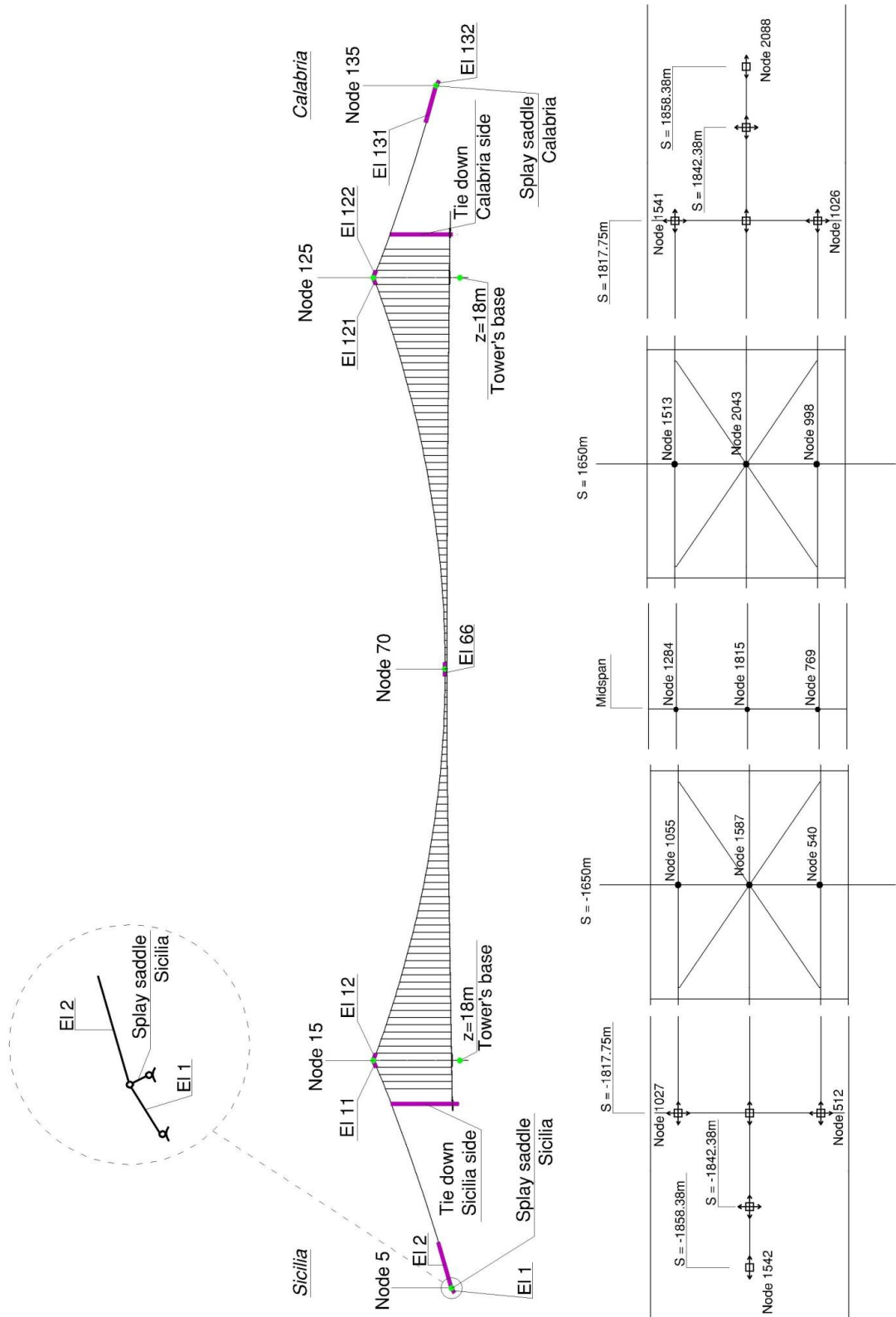
Le sollecitazioni/spostamenti nei dispositivi speciali sono monitorate nei seguenti punti/elementi:



- Forza nei collegamenti alle torri
- Forza nelle funi di tie-down

Per una migliore comprensione dei punti e delle grandezze di controllo, il dettaglio delle posizioni di cui sopra è riportato in forma grafica nella figura seguente.

Le numerazioni di nodi ed elementi e le quote indicate in figura costituiscono anche gli indicatori con cui individuare il punto/grandezza di controllo riportati nelle tabelle dei risultati.

Le stesse quantità di risposta sono riportate per ADINA e IBDAS. Ai fini della comparazione dei risultati (valori con segno) si sottolinea che il riferimento ADINA è destrorso, quello IBDAS sinistrorso. Entrambi i modelli hanno l'asse del ponte orientato dalla Sicilia alla Calabria.





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### Casi di carico impulsivo

La risposta dinamica in termini di forze e di spostamenti viene confrontata nei seguenti punti di controllo:

Grandezza	Elemento / Nodo	Coord. X	Coord. Y	Coord. Z
Spostamento cavo in mezzeria	70	0.00	-26.00	81.00
Forza nei cavi alle torri (lato campata centrale)	12	-1635.00	-26.00	377.00
	121	1635.00	-26.00	377.00
Spostamenti alle torri	3685	-1650.00	-34.82	138.25
	3918	-1650.00	-34.82	138.25
Forze nelle funi di tie-down	3644	-1650.00	-39.23	18.00
	3747	-1650.00	39.23	18.00
	3877	1635.00	-39.23	18.00
	3980	1635.00	39.23	18.00

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## 5 Configurazione statica a fine costruzione - Risultati

La configurazione di riferimento su cui valutare gli incrementi di spostamento e di sollecitazione dovuti alle diverse condizioni di carico è riportata a confronto per i due modelli ADINA e IBDAS. I due risultati sono riportati nell'ordine secondo le grandezze di controllo. In aggiunta è riportato inizialmente un grafico che riporta la vista 3D e le tre viste secondo i piani coordinati della configurazione del ponte a fine costruzione. A seguire sono riportati i grafici della deformata dei cavi, delle sollecitazioni nei cavi e delle sollecitazioni nei pendini disegnate a confronto per ADINA e IBDAS.

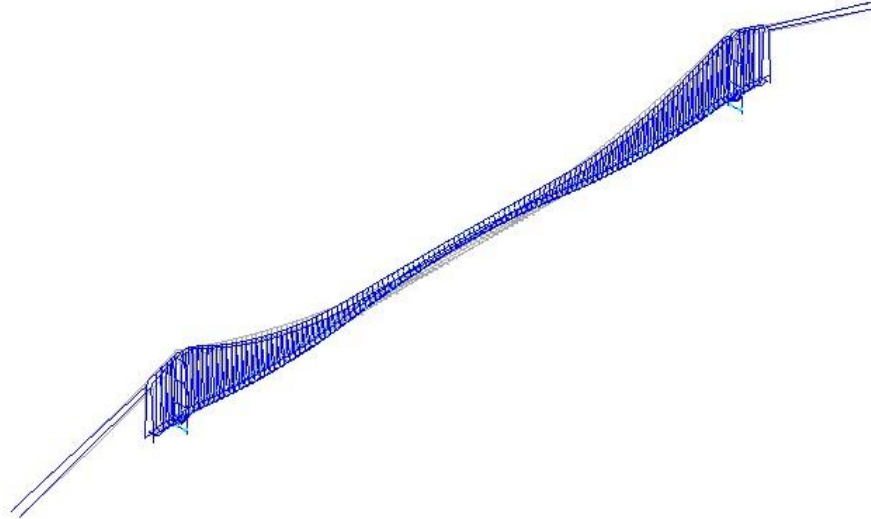
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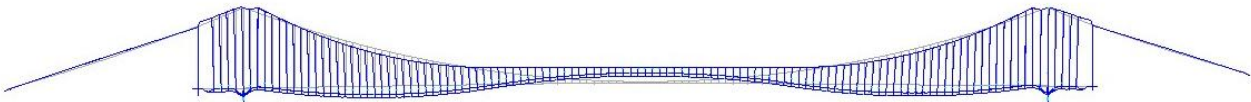
- **OUTPUT ADINA**



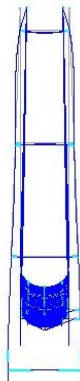
3d view



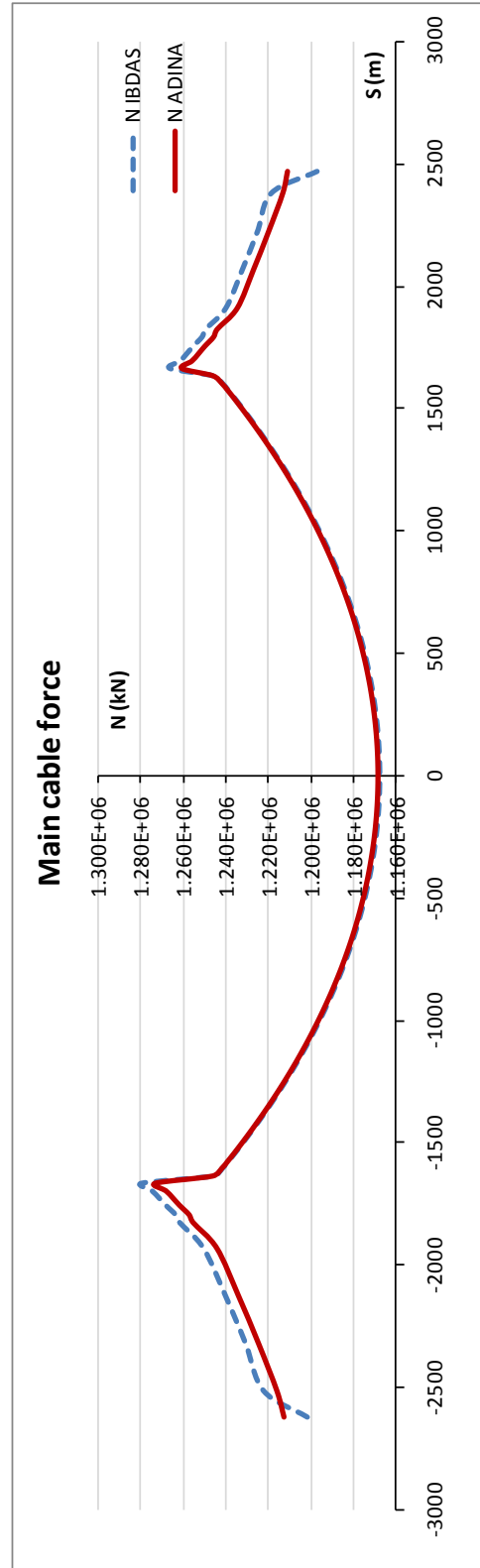
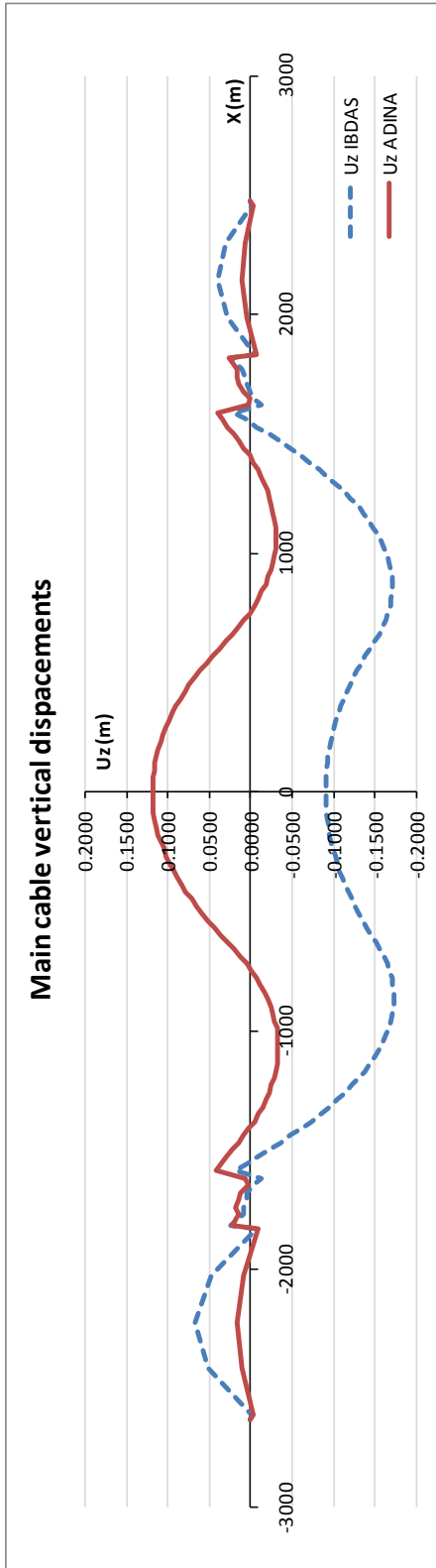
Plane view



Elevation XZ plane



Elevation YZ plane



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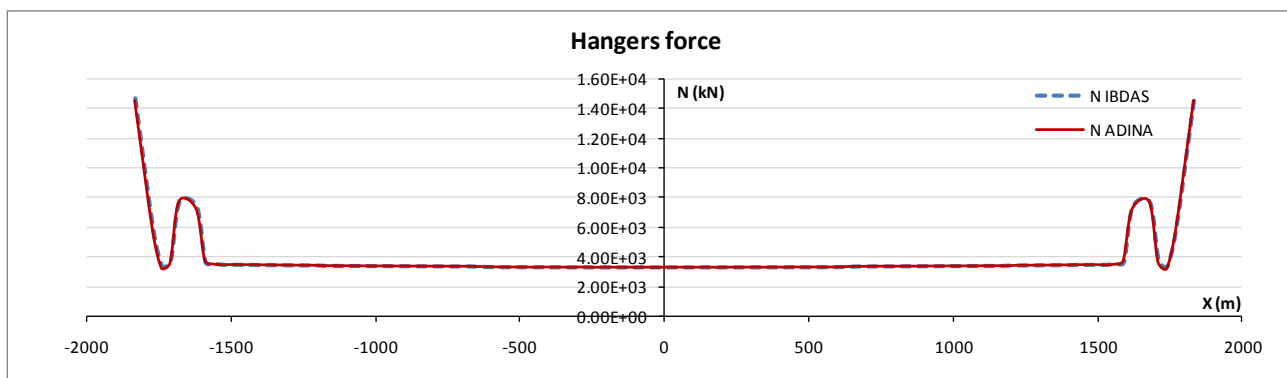
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**Cable displacement**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	-0.015	0.035	0.003	Sicilia tower - Top
70	0	-26.00	81.10	-0.003	0.006	0.119	Mid span
125	1650	-26.00	382.60	0.010	0.034	0.001	Calabria tower - Top

**Cable forces**

Elemen t	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.21E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.22E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.27E+06		Sicilia tower – Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower – Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Calabria tower - Top
122	1665	-26	377	1.26E+06		Calabria tower - Top
131	2382	-26	140	1.21E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.21E+06		Calabria splay saddle (anchorage side)



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**Forces at the base of the tower leg**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	9.01E+00	-1.00E+03	1.19E+06	Sicilia Tower
3747	-1650	39.23	18	9.18E+00	1.01E+03	1.19E+06	Sicilia Tower
3877	1650	-39.23	18	-4.41E+00	-9.51E+02	1.15E+06	Calabria Tower
3980	1650	39.23	18	-4.29E+00	9.55E+02	1.15E+06	Calabria Tower

	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	7.90E+03	1.84E+04	1.01E+02	Sicilia Tower
3747	-1650	39.23	18	-8.64E+03	1.84E+04	-1.07E+02	Sicilia Tower
3877	1650	-39.23	18	7.26E+03	-1.10E+04	-6.48E+01	Calabria Tower
3980	1650	39.23	18	-7.93E+03	-1.10E+04	6.02E+01	Calabria Tower

**Forces in special elements**

Element	N (kN)
Tie-down - Sicilia	1.45E+04
Tie-down - Calabria	1.45E+04
Splay saddle - Sicilia	3.47E+05
Splay saddle - Calabria	3.49E+05
Link - Sicilia tower	-1.76E+00
Link - Calabria tower	-1.12E+00

**Deck displacements**

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.75	-18.72	52.06	-0.002	Road box girder Sicilia side
1542	-1858.38	0.00	51.01	-0.003	Railway box girder Sicilia side
1027	-1817.75	18.72	52.06	-0.002	Road box girder Sicilia side
1026	1817.75	-18.72	62.43	-0.004	Road box girder Calabria side
2088	1858.38	0.00	61.65	-0.004	Railway box girder Calabria side
1541	1817.75	18.72	62.43	-0.004	Road box girder Calabria side



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Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.004	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.004	Road box girder mid span
540	-1650	-18.70	54.45	0.003	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.003	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.003	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.003	Road box girder tower Calabria side

**Reactions at the supports of the terminal structures**

	Coordinate (m)			Reaction (kN)			
	X	Y	Z	R <sub>x</sub>	R <sub>y</sub>	R <sub>z</sub>	
512	-1818	-18.72	52.06	0.00E+00	0.00E+00	2.27E+03	Sicilia road box girder
1026	1818	-18.72	62.43	0.00E+00	0.00E+00	2.26E+03	Calabria road box girder
1027	-1818	18.72	52.06	0.00E+00	0.00E+00	2.27E+03	Sicilia road box girder
1541	1818	18.72	62.43	0.00E+00	0.00E+00	2.26E+03	Calabria road box girder
1542	-1858	0	51.01	0.00E+00	-3.50E-01	6.80E+02	Sicilia railway box girder
1546	-1842	0	51.25	0.00E+00	0.00E+00	7.31E+02	Sicilia railway box girder
1559	-1818	0	51.61	0.00E+00	8.24E-01	5.98E+03	Sicilia railway box girder
2071	1818	0	61.98	0.00E+00	5.86E-01	5.97E+03	Calabria railway box girder
2084	1842	0	61.78	0.00E+00	0.00E+00	7.38E+02	Calabria railway box girder
2088	1858	0	61.65	0.00E+00	-2.15E-01	6.79E+02	Calabria railway box girder

**Vertical global reaction**

Sicilia tower (z=18m)	2.38E+06 kN
Calabria tower (z=18 m)	2.30E+06 kN
Splay saddle	1.28E+06 kN
Road box girder	9.06E+03 kN
Railway box girder	1.48E+04 kN
Main cable anchorage	-2.54E+06 kN
Tie down	-5.67E+04 kN

• **OUTPUT IBIDAS**

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650	-26	379	0.029	0.031	-0.004
0	-26	81	0.003	0.006	-0.054
1650	-26	379	-0.020	0.030	-0.004

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620	-26	47	1202.199
-2513	-26	81	1222.626
-1665	-26	376	1279.800
-1635	-26	377	1246.247
-15	-26	81	1168.253
1635	-26	377	1246.187
1665	-26	377	1266.357
1911	-26	286	1240.303
2470	-26	112	1197.624

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833	-26	165	14.256
1833	-26	180	14.185

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1820	-19	52	0.006
-1858	0	51	0.005
-1820	19	52	0.006
1820	-19	62	-0.001
1858	0	62	0.000
1820	19	62	-0.001

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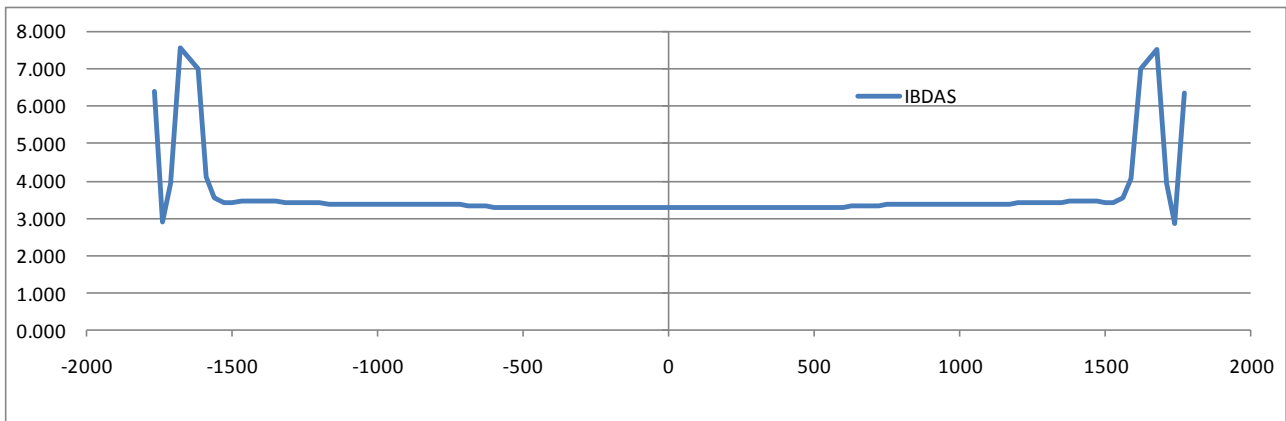
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s[m]	y[m]	z[m]	uy[m]
0	-19	74	0.004
0	0	74	0.000
0	19	74	-0.004
-1650	-19	54	0.000
-1650	0	54	-0.001
-1650	19	54	-0.003
1650	-19	64	0.000
1650	0	63	-0.002
1650	19	64	-0.003

### Hanger forces



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
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## 6 Casi di carico statico – Risultati

I risultati sono riportati nell'ordine per ciascuna condizione di carico elementare considerata. Le condizioni di carico sono 10 per il caso di buffer free-free più 3 per il caso di buffer fixed-fixed.

Ciascun caso di carico contiene i risultati organizzati come segue:

### Schema di carico

#### Risultati ADINA

- Deformate: vista 3D più tre viste di cui una in pianta e 2 in alzato (longitudinale e trasversale)
- Grafici: spostamento verticale dei cavi, forze nei cavi, forze nei pendini
- Tabelle: valori numerici "totali" delle grandezze di controllo nei punti di controllo

#### Risultati IBDAS



- Grafici: forze nei pendini
- Tabelle: valori numerici "totali" delle grandezze di controllo nei punti di controllo

### Confronto risultati

Il confronto dei risultati tra IBDAS e ADINA è riportato a parte alla fine di ciascun caso di carico. Sono confrontati gli spostamenti dei cavi e dell'impalcato, le sollecitazioni delle torri, dei cavi e delle funi di tie-down. I valori di confronto sono riportati nei punti di controllo per ciascun elemento strutturale.

Per una migliore comprensione dei risultati riportati si segnala quanto segue.

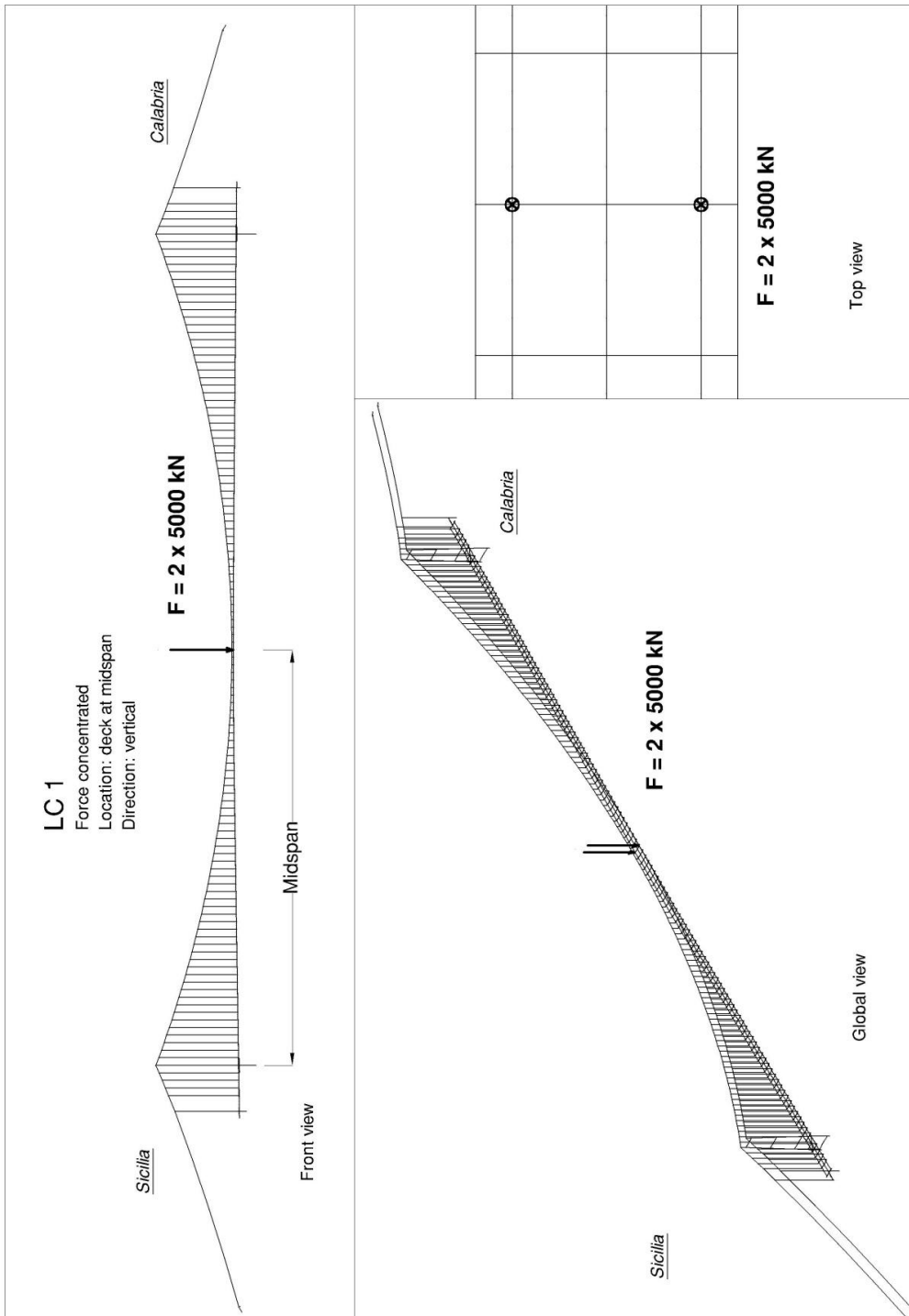
- Nel caso dei cavi vengono riportate tutte e tre le componenti di spostamento nodale; mentre nel caso dell'impalcato vengono confrontati separatamente gli spostamenti in direzione longitudinale (L) e trasversale (T).

		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
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- I valori di spostamento riportati nelle tabelle sono le differenze ( $\Delta$ ) tra gli spostamenti di ADINA e quelli di IBDAS.
- Nel caso delle sollecitazioni nelle torri sono riportati i valori depurati dalla configurazione iniziale a fine costruzione per evidenziare il solo effetto dovuto alla particolare condizione di carico. Non sono operate differenze, ma i risultati ADINA e IBDAS sono giustapposti per permettere un confronto diretto.
- Per quanto riguarda la distribuzione delle forze nei pendini si rimanda alle figure relative contenute nell'elenco risultati ADINA e IBDAS. Si osserva che i grafici delle forze nei pendini ADINA contengono le funi di tie-down, quelli IBDAS no, quindi i valori dei due punti estremi dell'intervallo di disegno sono diversi.
- Nel caso delle forze nei cavi e nelle funi di tie-down, oltre alla differenza  $\Delta$  tra i valori, viene riportata anche la variazione percentuale  $\Delta / RC$  rispetto al tiro presente nella configurazione iniziale (RC).
- Nei confronti si deve prestare attenzione a possibili alternanza di segno tra i risultati ADINA e IBDAS (con particolare riguardo alle sollecitazioni), perché i riferimenti locali possono avere diverso orientamento tra i due modelli.
- Allo stesso modo, nei confronti si deve prestare attenzione a possibili alternanza di valori nelle sollecitazioni tra i risultati ADINA e IBDAS, perché i carichi non simmetrici possono essere posti in posizione alternata tra i due modelli.
- Dell'insieme di tutti i risultati riportati, gli spostamenti e le sollecitazioni da considerare con maggiore attenzione sono quelli "sensibili" alla particolare condizione di carico (p. es. spostamenti verticali per carichi verticali, oppure spostamenti trasversali per carichi trasversali, e così via).

## 6.1 LC1 – Forza concentrata nella mezzeria dell’impalcato (buffer free-free)

- OUTPUT ADINA



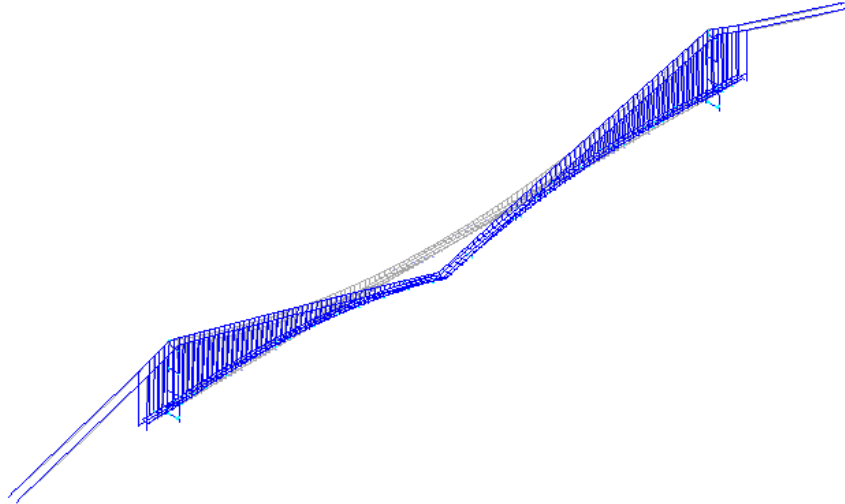
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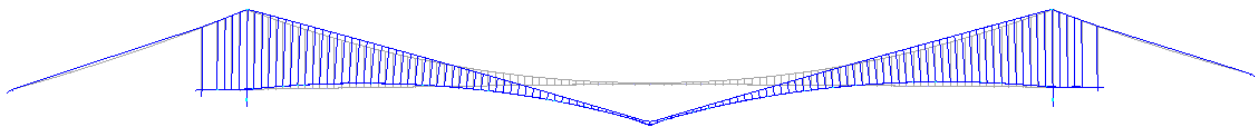
- **OUTPUT ADINA**



3D view



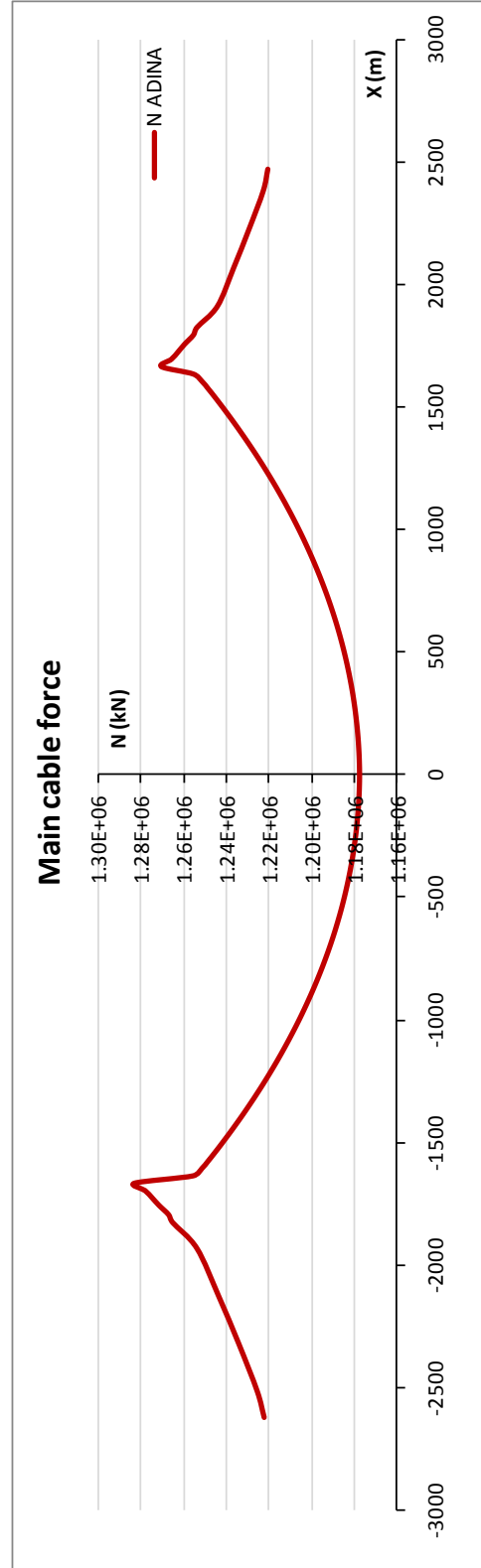
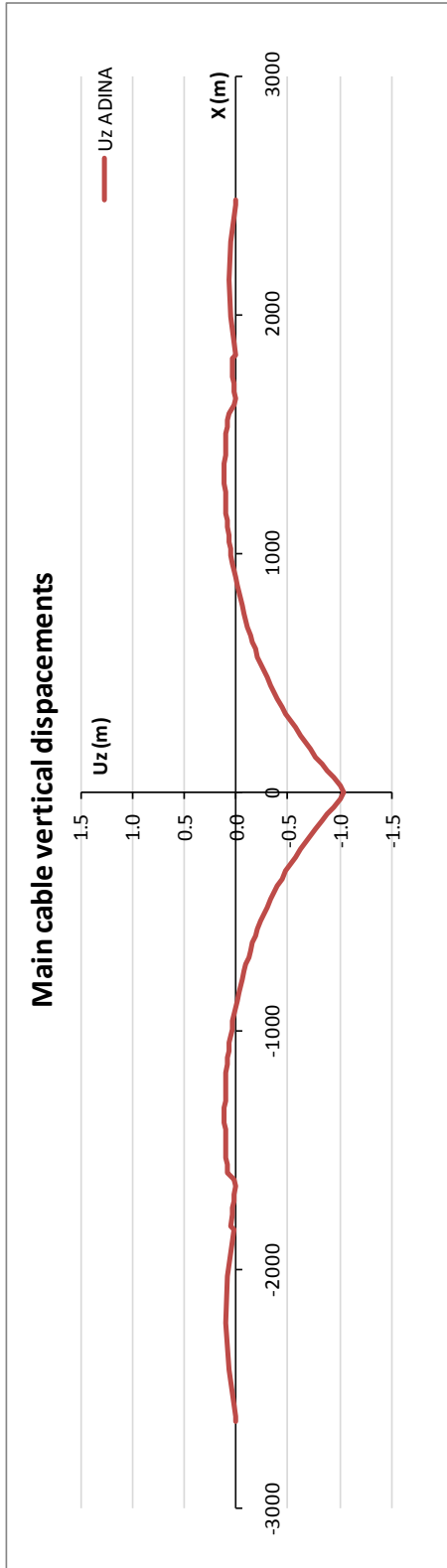
Plane view



Elevation XZ plane



Elevation YZ plane





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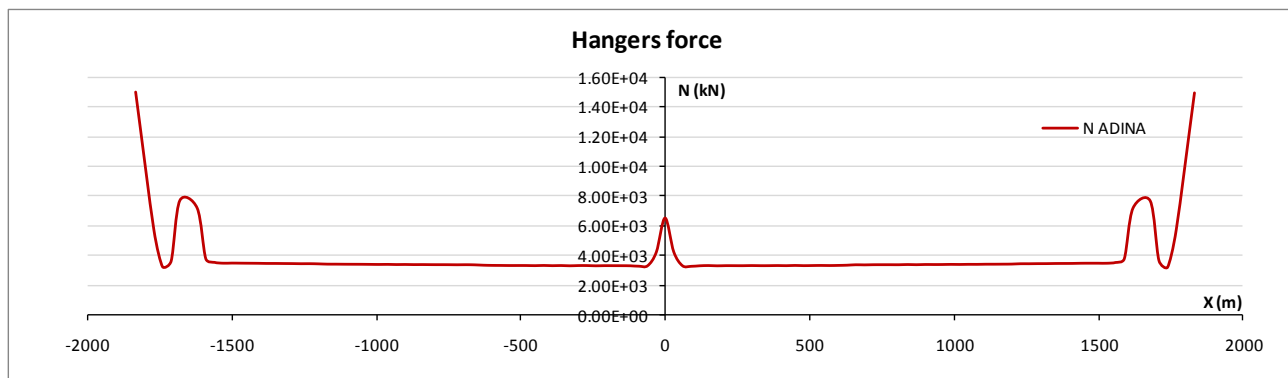
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**Cable displacement**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	0.020	0.035	0.002	Sicilia tower - Top
70	0	-26.00	81.10	0.000	0.007	-1.045	Mid span
125	1650	-26.00	382.60	-0.018	0.034	-0.001	Calabria tower -Top

**Cable forces**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.22E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.23E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.28E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.26E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.18E+06		Mid span
121	1635	-26	377	1.26E+06		Top Calabria tower (main span)
122	1665	-26	377	1.27E+06		Top Calabria tower (side span)
131	2382	-26	140	1.22E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.22E+06		Calabria splay saddle (anchorage side)



**Forces at the base of the towers legs**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-1.15E+01	-1.00E+03	1.20E+06	Sicilia Tower
3747	-1650	39.23	18	-1.13E+01	1.01E+03	1.20E+06	Sicilia Tower
3877	1650	-39.23	18	7.70E+00	-9.52E+02	1.16E+06	Calabria Tower
3980	1650	39.23	18	7.83E+00	9.56E+02	1.16E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	7.98E+03	-2.38E+04	-1.38E+02	Sicilia Tower
3747	-1650	39.23	18	-8.72E+03	-2.37E+04	1.32E+02	Sicilia Tower
3877	1650	-39.23	18	7.33E+03	2.04E+04	1.14E+02	Calabria Tower
3980	1650	39.23	18	-8.01E+03	2.04E+04	-1.19E+02	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.50E+04
Tie-down - Calabria	1.49E+04
Splay saddle Sicilia	3.50E+05
Splay saddle Calabria	3.52E+05
Link - Sicilia tower	-1.75E+00
Link - Calabria tower	-1.11E+00

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-0.007	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.007	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.007	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.003	Road box girder Calabria side
2088	1858.4	0.00	61.65	0.004	Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.003	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.006	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.006	Road box girder mid span
540	-1650	-18.70	54.45	0.003	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.003	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.003	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.003	Road box girder tower Calabria side

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• **OUTPUT IBDAS**

**Load Case**

**1351**      Reference condition + LC1  
**C3**        C3 = Free-Free

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,063	0,031	-0,006
0,000	-26,000	81,100	0,006	0,007	-1,218
1650,000	-26,000	379,000	-0,048	0,030	-0,006

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1211,711
-2512,875	-26,000	81,464	1232,143
-1665,000	-26,000	376,141	1289,506
-1635,000	-26,000	377,065	1255,613
-15,000	-26,000	81,149	1177,423
1635,000	-26,000	377,068	1255,553
1665,000	-26,000	376,560	1275,993
1911,375	-26,000	285,745	1249,783
2470,065	-26,000	111,514	1207,069

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,746
1833,000	-26,000	179,846	14,615

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,003
-1858,380	0,000	51,013	0,002
-1819,750	18,722	52,026	0,003
1819,750	-18,722	62,409	0,005
1858,380	0,000	61,647	0,007
1819,750	18,722	62,409	0,005

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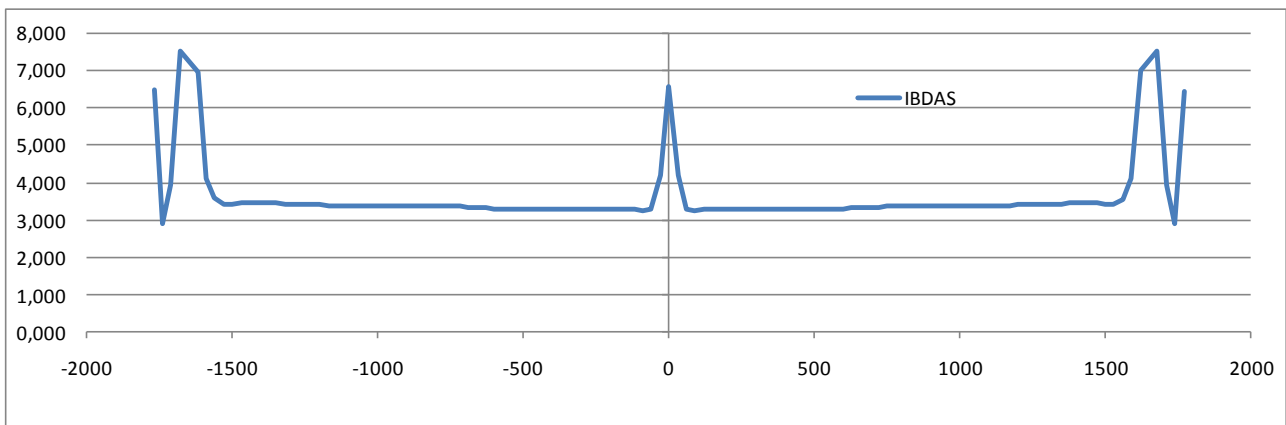
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s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,006
0,000	0,000	74,342	0,000
0,000	18,722	74,432	-0,006
-1650,000	-18,704	54,450	0,000
-1650,000	0,000	54,132	-0,001
-1650,000	18,704	54,450	-0,003
1650,000	-18,704	63,730	0,000
1650,000	0,000	63,412	-0,002
1650,000	18,704	63,730	-0,003

### Hanger Forces



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
		Validazione del modello globale agli elementi finiti	<i>Codice documento</i> PS0005_F0	<i>Rev</i> F0

**CONFRONTI TRA MODELLO ADINA E MODELLO IBDAS**

**LC1**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	0.000	0.000	0.001	Sicilia tower - Top
70	0	-26	81.1	-0.001	0.001	0.000	Mid span
125	1650	-26	382.6	0.000	0.000	0.000	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	-0.002		Road box girder Sicilia side
1542	-1858.4	0	51.01	-0.001		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.002		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.001		Road box girder Calabria side
2088	1858.4	0	61.65	0.002		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.001		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			U <sub>y</sub> (m)	
	X	Y	Z		
769	0	-18.72	74.43	0.004	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.004	Road box girder mid span
540	-1650	-18.7	54.45	0.000	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	0.000	Road box girder tower Sicilia side
998	1650	-18.7	63.73	0.000	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.7	63.73	0.000	Road box girder tower Calabria side

### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
6.04	-6.03	-0.02	0.01	0.00	-0.22	Sicilia Tower
6.04	-6.03	-0.02	0.01	0.00	0.22	Sicilia Tower
5.82	-5.82	0.01	-0.01	0.00	-0.21	Calabria Tower
5.83	-5.82	0.01	-0.01	0.00	0.21	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-0.08	-0.52	-42.11	41.28	Sicilia Tower
0.08	0.52	-42.11	41.28	Sicilia Tower
-0.08	-0.60	31.40	-31.20	Calabria Tower
0.08	0.60	31.40	-31.20	Calabria Tower

### Δ Cables Forces

Δ	Δ/RC	
0.08	0.01%	Sicilia splay saddle (anchorage side)
0.00	0.00%	Sicilia splay saddle (span side)
-0.01	0.00%	Sicilia tower - Top (side span)
0.01	0.00%	Sicilia tower - Top (main span)
0.01	0.00%	Mid span
0.00	0.00%	Top Calabria tower (main span)
0.00	0.00%	Top Calabria tower (side span)
0.00	0.00%	Calabria splay saddle (span side)
0.09	0.01%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

Δ	Δ/RC	
0.001	0.01%	Tie-down - Sicilia
0.001	0.01%	Tie-down - Calabria

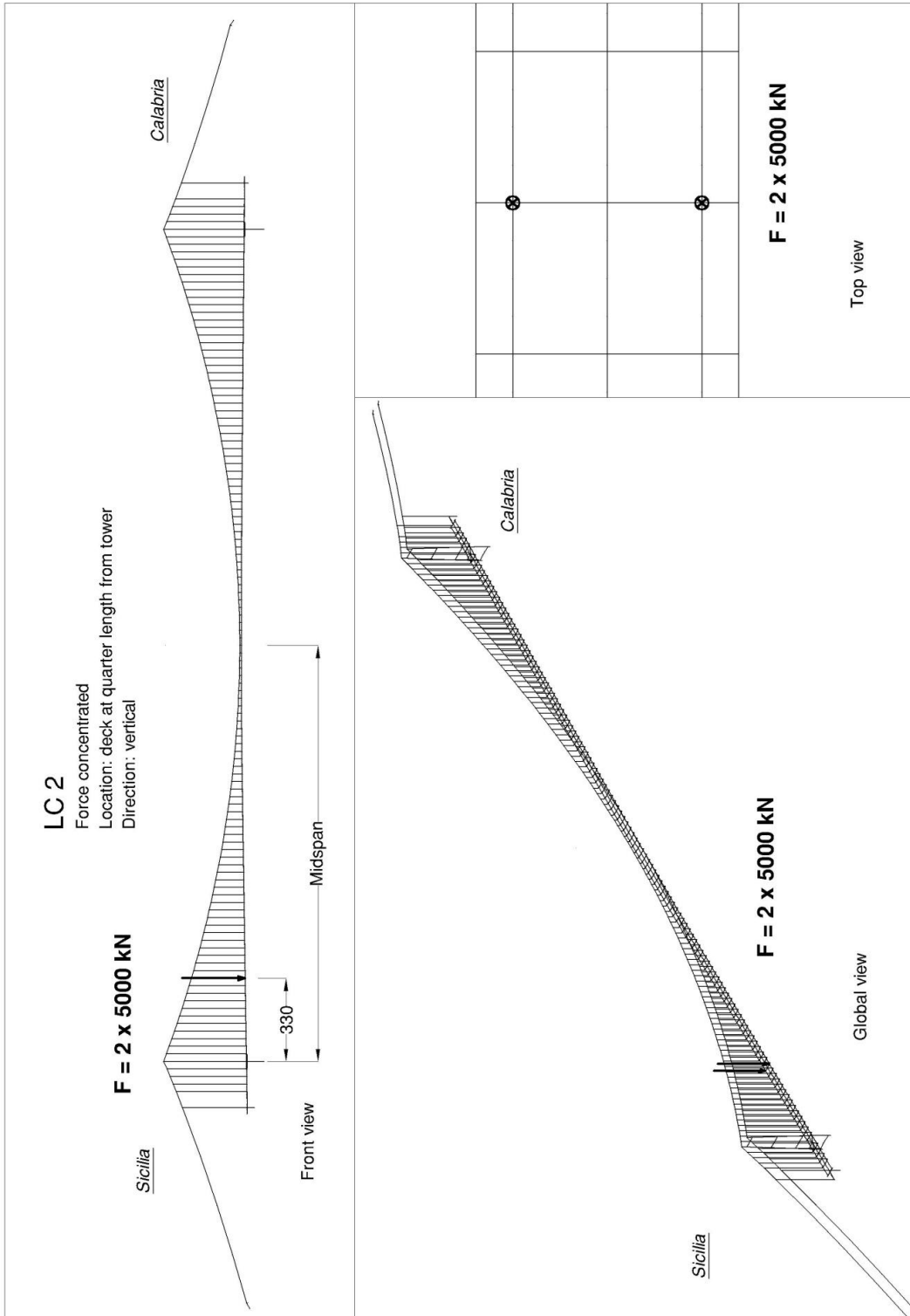
Validazione del modello globale agli  
elementi finiti

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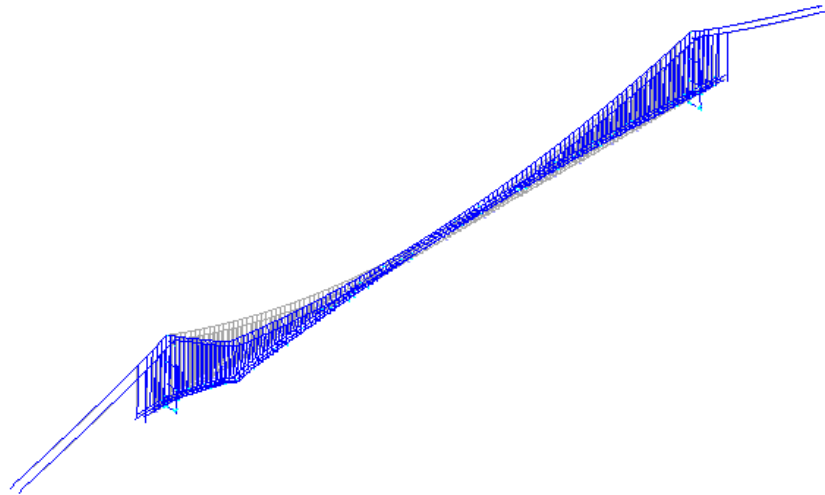
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**6.2 LC2 – Forza verticale posizionata a 1/10 dalla torre (buffer free-free)**



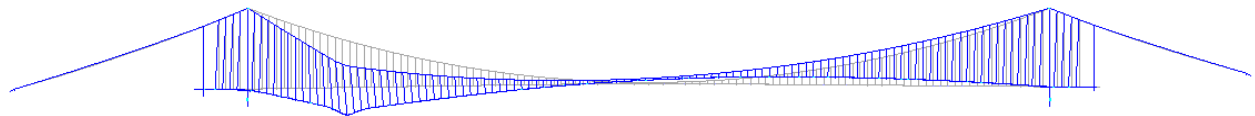
- **OUTPUT ADINA**



3d view



Plane view



Elevation XZ plane



Elevation YZ plane

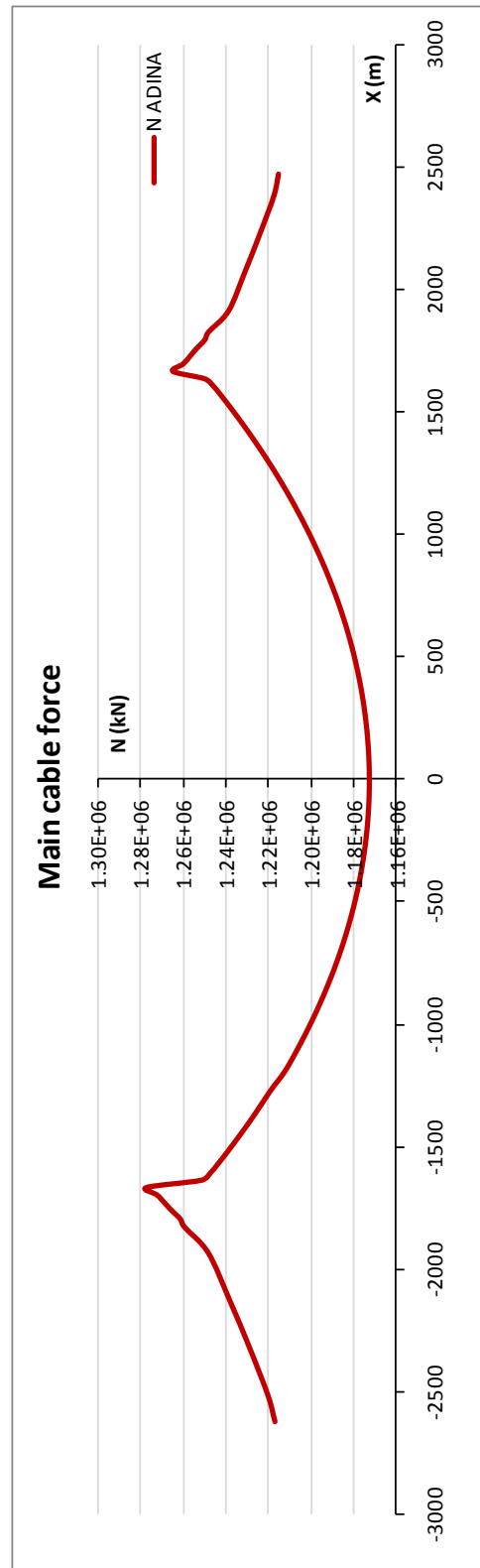
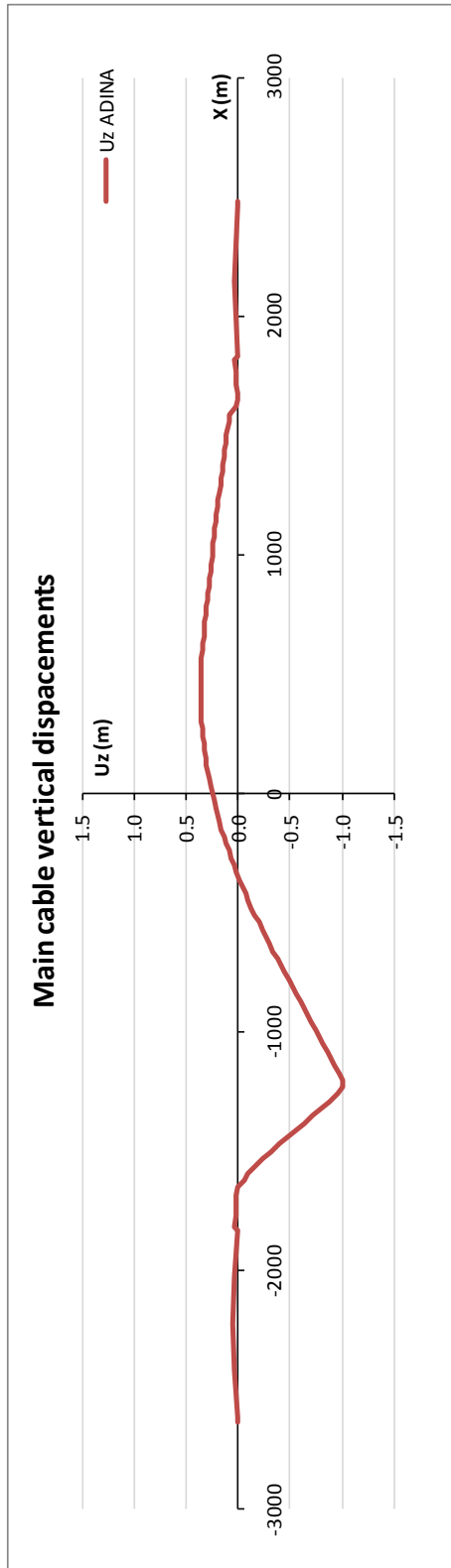


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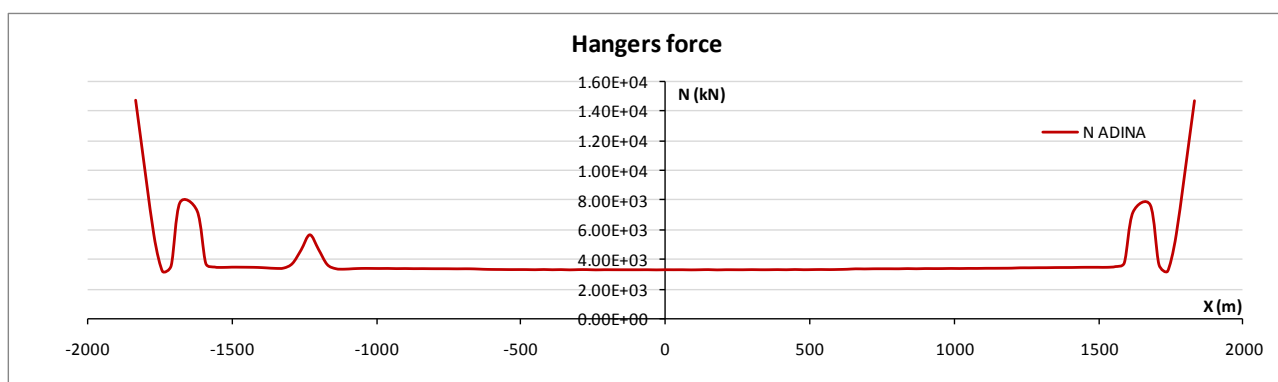


### Cable displacement

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	0.000	0.035	0.002	Sicilia tower - Top
70	0	-26.00	81.10	-0.117	0.006	0.249	Mid span
125	1650	-26.00	382.60	-0.002	0.034	0.001	Calabria tower -Top

### Cable forces

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.22E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.22E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.28E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Top Calabria tower (main span)
122	1665	-26	377	1.27E+06		Top Calabria tower (side span)
131	2382	-26	140	1.22E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.22E+06		Calabria splay saddle (anchorage side)



### Forces at the base of the towers legs

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-3.50E-01	-1.00E+03	1.20E+06	Sicilia Tower
3747	-1650	39.23	18	-1.82E-01	1.01E+03	1.20E+06	Sicilia Tower
3877	1650	-39.23	18	9.59E-01	-9.51E+02	1.15E+06	Calabria Tower
3980	1650	39.23	18	1.09E+00	9.56E+02	1.15E+06	Calabria Tower

Validazione del modello globale agli  
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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	-3.50E-01	-1.00E+03	-6.27E+00	Sicilia Tower
3747	-1650	39.23	18	-1.82E-01	1.01E+03	2.13E-02	Sicilia Tower
3877	1650	-39.23	18	9.59E-01	-9.51E+02	1.26E+01	Calabria Tower
3980	1650	39.23	18	1.09E+00	9.56E+02	-1.72E+01	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.47E+04
Tie-down - Calabria	1.47E+04
Splay saddle Sicilia	3.48E+05
Splay saddle Calabria	3.50E+05
Link - Sicilia tower	-1.75E+00
Link - Calabria tower	-1.12E+00

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-0.125	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.126	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.125	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.127	Road box girder Calabria side
2088	1858.4	0.00	61.65	-0.127	Railway box girder Calabria side
1541	1817.8	18.72	62.43	-0.127	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.004	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.004	Road box girder mid span
540	-1650	-18.70	54.45	0.003	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.003	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.003	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.003	Road box girder tower Calabria side

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• **OUTPUT IBDAS**

**Load Case**

**1352**      Reference condition + LC2  
**C3**        C3 = Free-Free

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,041	0,031	-0,006
0,000	-26,000	81,100	-0,092	0,006	0,072
1650,000	-26,000	379,000	-0,030	0,030	-0,005

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1205,538
-2512,875	-26,000	81,464	1225,966
-1665,000	-26,000	376,141	1283,218
-1635,000	-26,000	377,065	1250,818
-15,000	-26,000	81,149	1171,372
1635,000	-26,000	377,068	1249,325
1665,000	-26,000	376,560	1269,730
1911,375	-26,000	285,745	1243,629
2470,065	-26,000	111,514	1200,938

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,440
1833,000	-26,000	179,846	14,334

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	-0,096
-1858,380	0,000	51,013	-0,097
-1819,750	18,722	52,026	-0,096
1819,750	-18,722	62,409	-0,105
1858,380	0,000	61,647	-0,103
1819,750	18,722	62,409	-0,105

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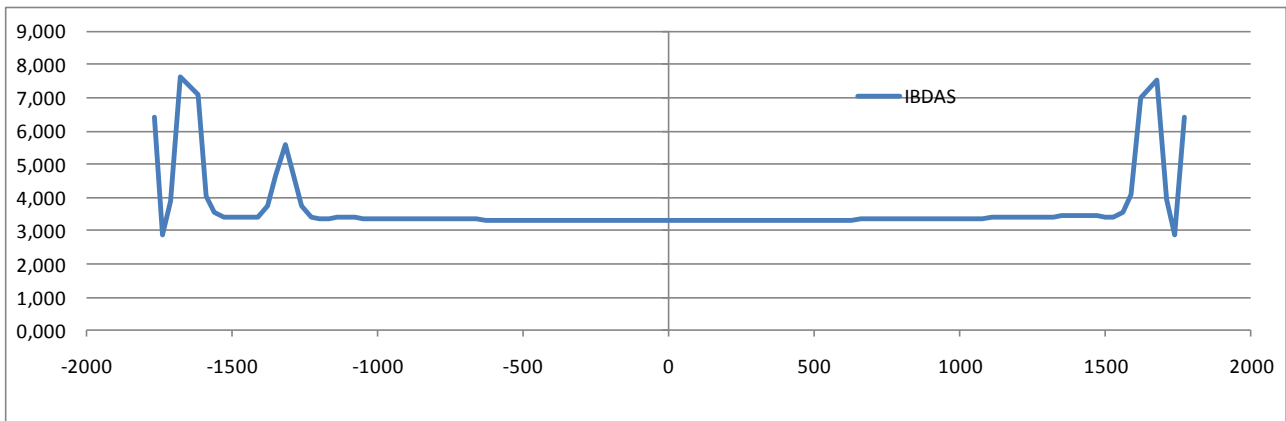
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s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,004
0,000	0,000	74,342	0,000
0,000	18,722	74,432	-0,004
-1650,000	-18,704	54,450	0,000
-1650,000	0,000	54,132	-0,001
-1650,000	18,704	54,450	-0,003
1650,000	-18,704	63,730	0,000
1650,000	0,000	63,412	-0,002
1650,000	18,704	63,730	-0,003

### Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC2**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	0.002	0.000	0.001	Sicilia tower - Top
70	0	-26	81.1	-0.019	0.000	0.004	Mid span
125	1650	-26	382.6	-0.002	0.000	0.001	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			U <sub>x</sub> (m)	Δ Deck Displacements L
	X	Y	Z		
512	-1817.8	-18.72	52.06	-0.021	Road box girder Sicilia side
1542	-1858.4	0	51.01	-0.021	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.021	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.019	Road box girder Calabria side
2088	1858.4	0	61.65	-0.019	Railway box girder Calabria side
1541	1817.8	18.72	62.43	-0.019	Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			U <sub>y</sub> (m)	Δ Deck Displacements T
	X	Y	Z		
769	0	-18.72	74.43	0.000	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	0.000	Road box girder mid span
540	-1650	-18.7	54.45	0.000	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	0.000	Road box girder tower Sicilia side
998	1650	-18.7	63.73	0.000	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.7	63.73	0.000	Road box girder tower Calabria side

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### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
5.95	-5.78	-0.01	0.00	0.00	-0.21	Sicilia Tower
5.95	-5.78	-0.01	0.00	0.00	0.21	Sicilia Tower
2.04	-1.63	0.01	0.00	0.00	-0.06	Calabria Tower
2.05	-1.63	0.01	0.00	0.00	0.06	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
7.91	-0.50	-19.37	14.97	Sicilia Tower
-8.64	0.50	-17.38	14.97	Sicilia Tower
7.26	-0.17	10.03	-10.91	Calabria Tower
-7.93	0.18	11.92	-10.91	Calabria Tower

### Δ Cables Forces

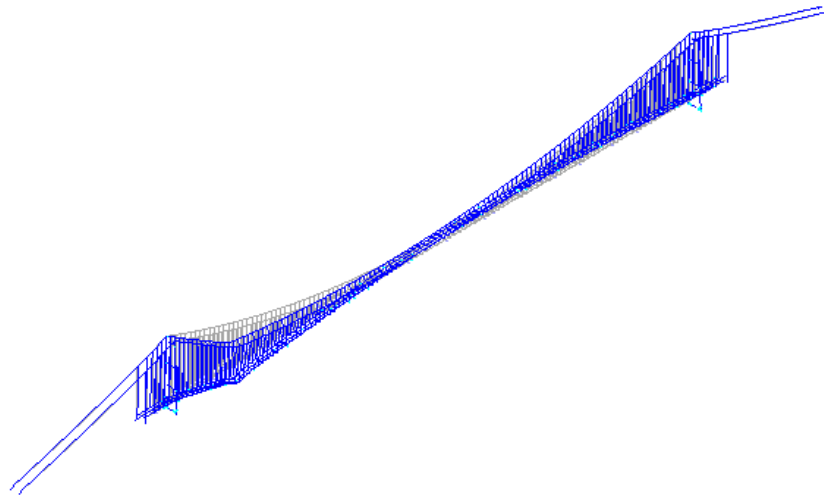
Δ	Δ/RC	
0.83	0.07%	Sicilia splay saddle (anchorage side)
0.80	0.07%	Sicilia splay saddle (span side)
0.81	0.06%	Sicilia tower - Top (side span)
0.67	0.05%	Sicilia tower - Top (main span)
0.75	0.06%	Mid span
0.75	0.06%	Top Calabria tower (main span)
0.81	0.06%	Top Calabria tower (side span)
0.79	0.07%	Calabria splay saddle (span side)
0.84	0.07%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

Δ	Δ/RC	
0.043	0.29%	Tie-down - Sicilia
0.036	0.25%	Tie-down - Calabria

### 6.3 LC2 – Forza verticale posizionata a 1/10 dalla torre (buffer fixed-fixed)

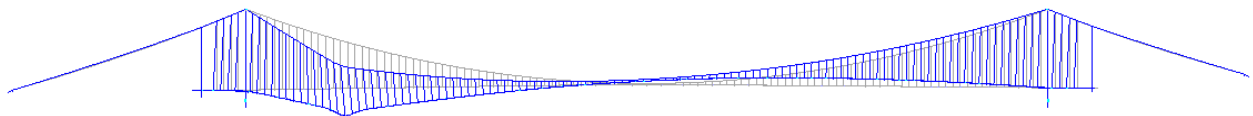
- OUTPUT ADINA



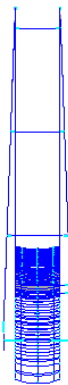
3d view



Plane view

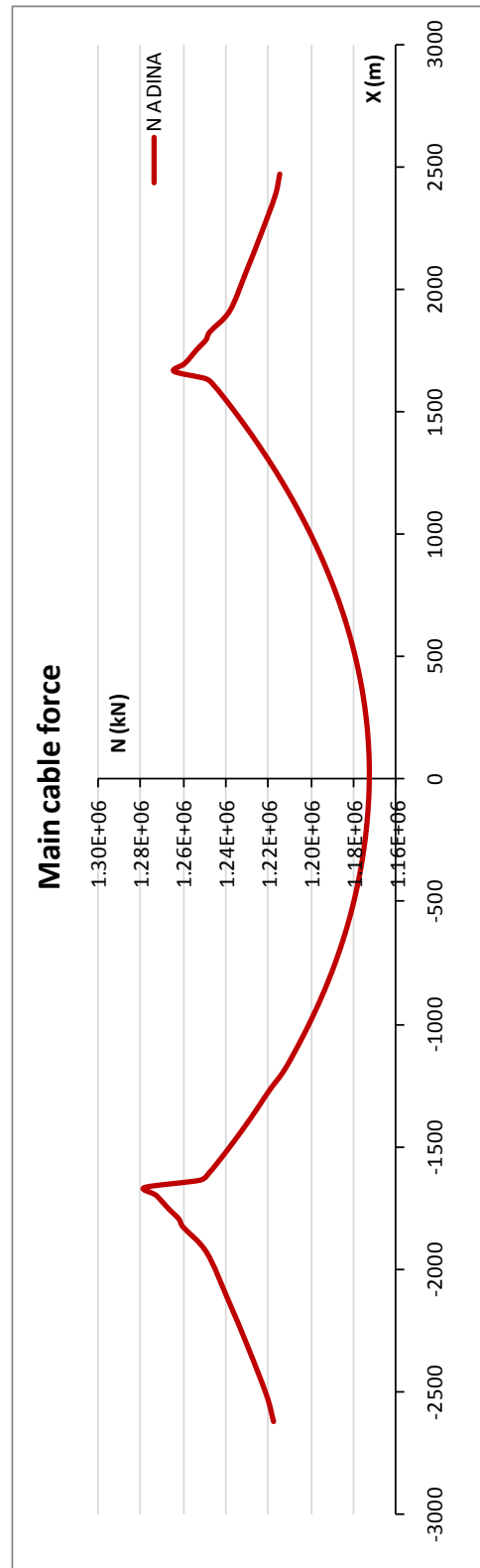
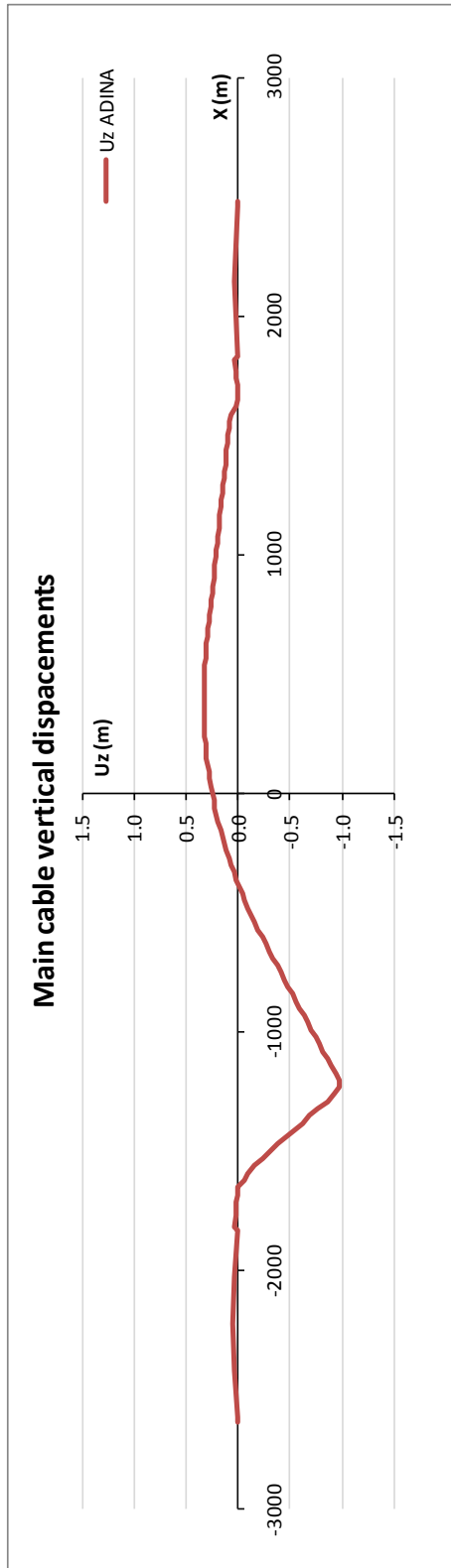


Elevation XZ plane



Elevation YZ plane





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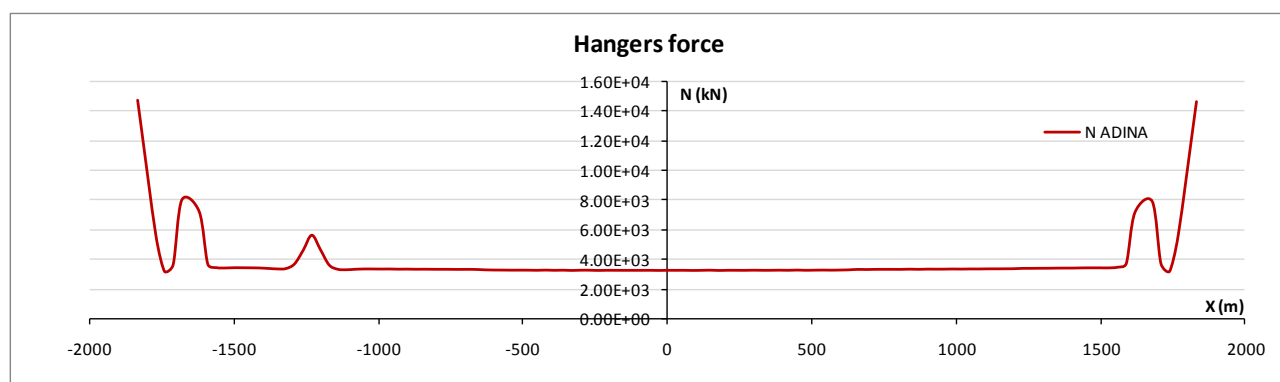
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### Cable displacement

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26.00	382.60	0.002	0.035	0.001	Sicilia tower - Top
70	0	-26.00	81.10	-0.103	0.006	0.249	Mid span
125	1650	-26.00	382.60	0.000	0.034	0.001	Calabria tower -Top

### Cable forces

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.22E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.22E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.28E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Top Calabria tower (main span)
122	1665	-26	377	1.26E+06		Top Calabria tower (side span)
131	2382	-26	140	1.22E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.21E+06		Calabria splay saddle (anchorage side)



### Forces at the base of the towers legs

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	6.37E+02	-2.52E+03	1.20E+06	Sicilia Tower
3747	-1650	39.23	18	5.91E+02	2.54E+03	1.20E+06	Sicilia Tower
3877	1650	-39.23	18	5.60E+02	-1.93E+03	1.15E+06	Calabria Tower
3980	1650	39.23	18	5.92E+02	1.95E+03	1.15E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	4.96E+04	1.35E+04	3.90E+04	Sicilia Tower
3747	-1650	39.23	18	-5.13E+04	1.36E+04	-4.28E+04	Sicilia Tower
3877	1650	-39.23	18	3.80E+04	2.44E+04	-3.61E+04	Calabria Tower
3980	1650	39.23	18	-3.97E+04	2.41E+04	3.94E+04	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.47E+04
Tie-down - Calabria	1.46E+04
Splay saddle Sicilia	3.48E+05
Splay saddle Calabria	3.50E+05
Link - Sicilia tower	-1.52E+02
Link - Calabria tower	-1.51E+02

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-0.001	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.001	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.001	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.003	Road box girder Calabria side
2088	1858.4	0.00	61.65	-0.002	Railway box girder Calabria side
1541	1817.8	18.72	62.43	-0.003	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.004	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.004	Road box girder mid span
540	-1650	-18.70	54.45	0.002	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.003	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.002	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.003	Road box girder tower Calabria side

• **OUTPUT IBDAS**

**Load Case**

**1352**      Reference condition + LC2  
**C1**        C1 = Fixed-Fixed

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,043	0,031	-0,006
0,000	-26,000	81,100	-0,081	0,006	0,071
1650,000	-26,000	379,000	-0,029	0,030	-0,004

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1206,037
-2512,875	-26,000	81,464	1226,466
-1665,000	-26,000	376,141	1283,722
-1635,000	-26,000	377,065	1251,284
-15,000	-26,000	81,149	1171,389
1635,000	-26,000	377,068	1248,831
1665,000	-26,000	376,560	1269,217
1911,375	-26,000	285,745	1243,120
2470,065	-26,000	111,514	1200,430

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,464
1833,000	-26,000	179,846	14,312

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,005
-1858,380	0,000	51,013	0,004
-1819,750	18,722	52,026	0,006
1819,750	-18,722	62,409	-0,002
1858,380	0,000	61,647	-0,001
1819,750	18,722	62,409	-0,002

Validazione del modello globale agli  
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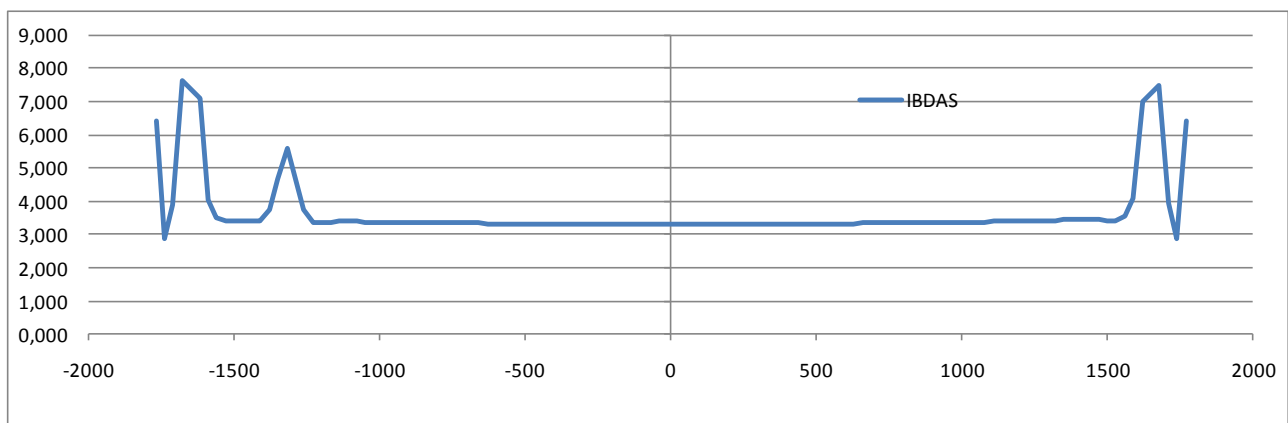
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s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,004
0,000	0,000	74,342	0,000
0,000	18,722	74,432	-0,004
-1650,000	-18,704	54,450	0,000
-1650,000	0,000	54,132	-0,001
-1650,000	18,704	54,450	-0,003
1650,000	-18,704	63,730	0,000
1650,000	0,000	63,412	-0,002
1650,000	18,704	63,730	-0,003

### Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC2 (fixed-fixed)**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26	382.6	0.002	0.000	0.000	Sicilia tower - Top
70	0	-26	81.1	-0.016	0.000	0.005	Mid span
125	1650	-26	382.6	-0.002	0.000	0.000	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	0.002		Road box girder Sicilia side
1542	-1858.4	0	51.01	0.003		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	0.002		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.003		Road box girder Calabria side
2088	1858.4	0	61.65	0.004		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.003		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	0.000		Road box girder mid span
1815	0	0	74.34	0.000		Railway box girder mid span
1284	0	18.72	74.43	0.000		Road box girder mid span
540	-1650	-18.7	54.45	-0.001		Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	0.000		Road box girder tower Sicilia side
998	1650	-18.7	63.73	-0.001		Road box girder tower Calabria side
2043	1650	0	63.41	0.000		Railway box girder tower Calabria side
1513	1650	18.7	63.73	0.000		Road box girder tower Calabria side

Validazione del modello globale agli  
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### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
6.68	-6.05	0.63	0.01	-1.52	-0.22	Sicilia Tower
6.69	-6.05	0.58	0.01	1.53	0.22	Sicilia Tower
2.13	-1.37	0.56	-0.01	-0.98	-0.21	Calabria Tower
2.14	-1.37	0.60	-0.01	0.99	0.21	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-41.71	-0.52	-4.82	4.13	Sicilia Tower
42.62	0.52	-4.77	3.89	Sicilia Tower
-30.79	-0.60	35.37	-29.45	Calabria Tower
31.77	0.60	35.02	-29.61	Calabria Tower

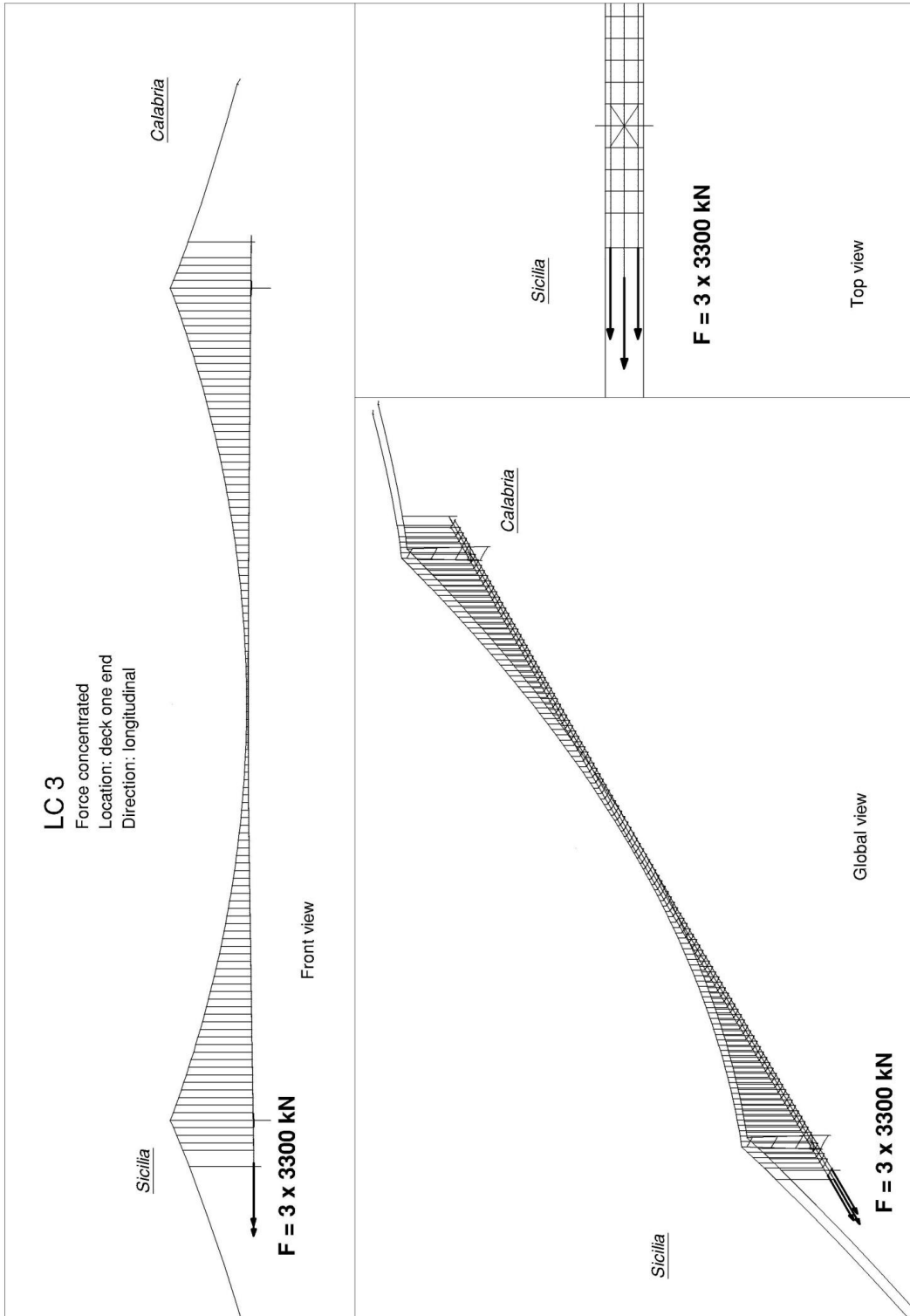
### Δ Cables Forces

Δ	Δ/RC	
-4.70	-0.39%	Sicilia splay saddle (anchorage side)
-4.74	-0.39%	Sicilia splay saddle (span side)
-4.72	-0.37%	Sicilia tower - Top (side span)
-3.54	-0.28%	Sicilia tower - Top (main span)
-5.26	-0.45%	Mid span
-6.07	-0.49%	Top Calabria tower (main span)
-5.95	-0.47%	Top Calabria tower (side span)
-5.97	-0.49%	Calabria splay saddle (span side)
-5.91	-0.49%	Calabria splay saddle (anchorage side)



### Δ Tie-down Forces

Δ	Δ/RC	
-0.290	-2.00%	Tie-down - Sicilia
-0.331	-2.28%	Tie-down - Calabria

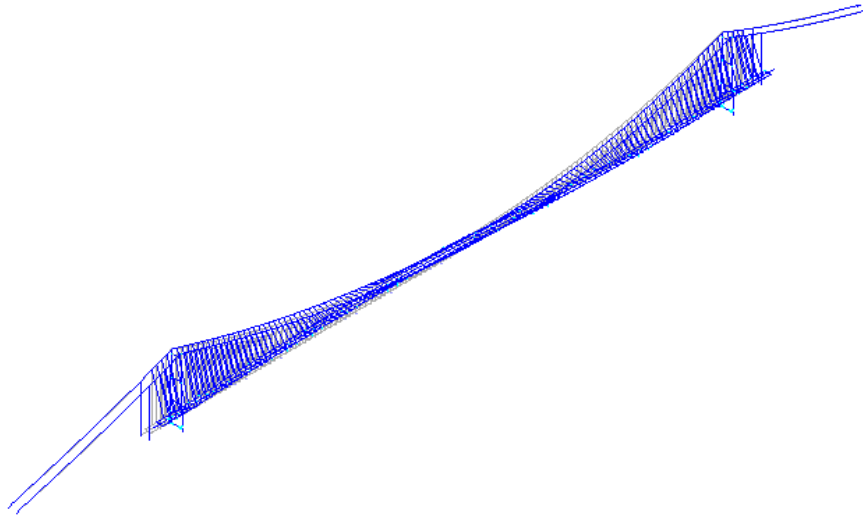
**6.4 LC3 – Forze longitudinali ad un estremo dell’impalcato (buffer free-free)**





		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
Validazione del modello globale agli elementi finiti		<i>Codice documento</i> PS0005_F0	<i>Rev</i> F0	<i>Data</i> 20-06-2011

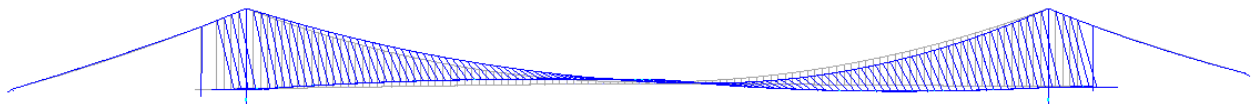
• **OUTPUT ADINA**



3d view



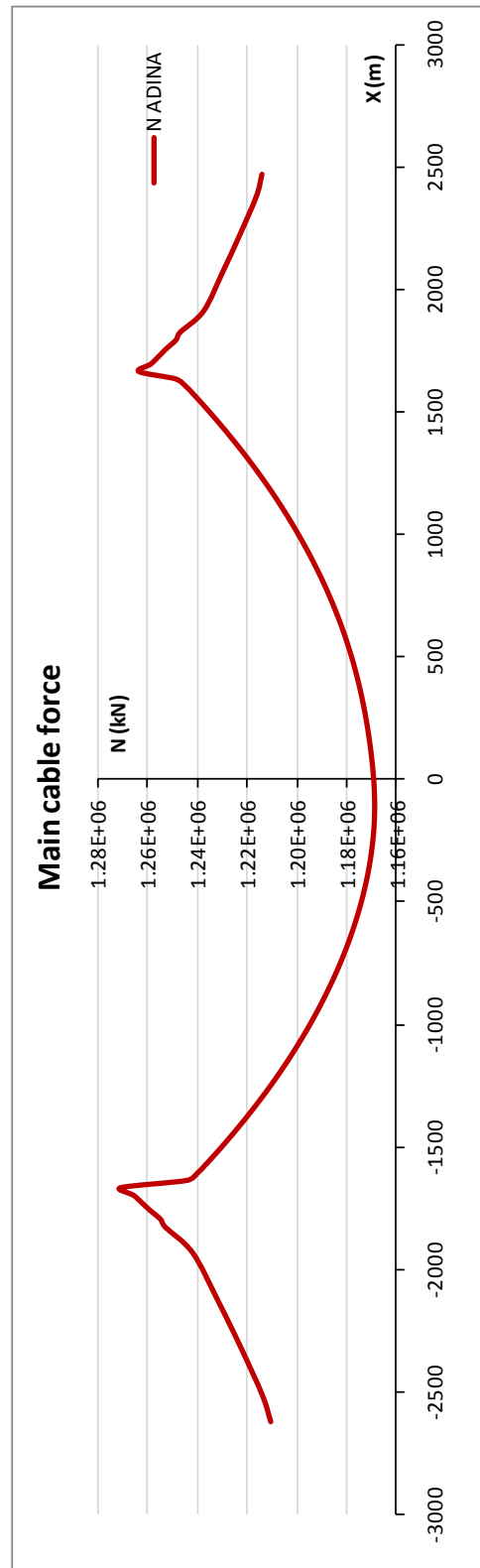
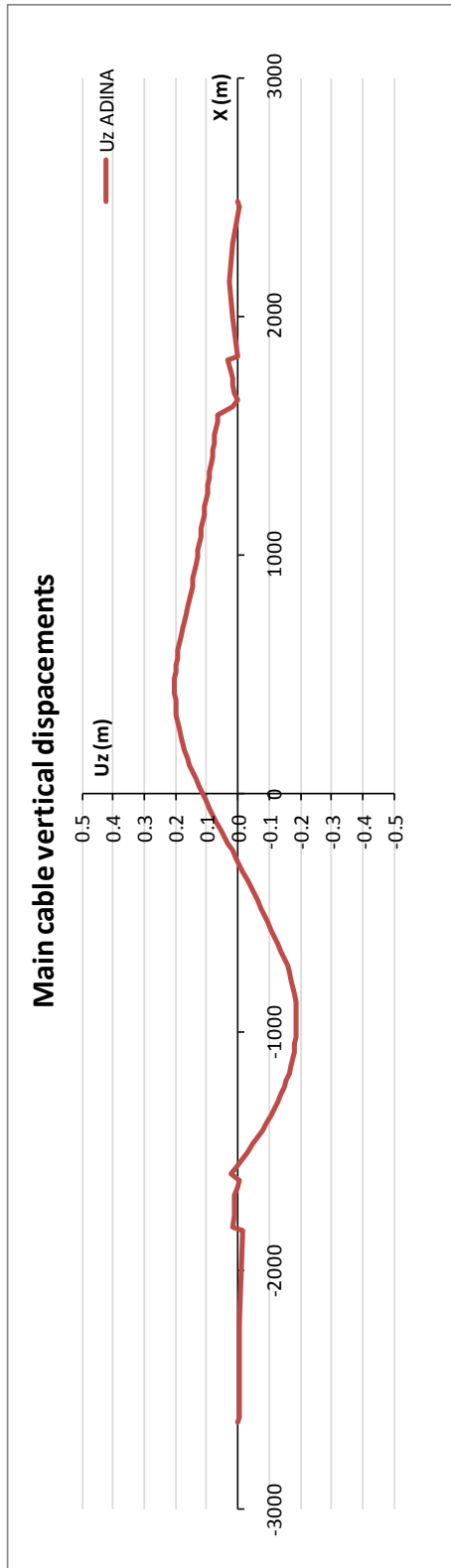
Plane view



Elevation XZ plane



Elevation YZ plane



Validazione del modello globale agli elementi finiti

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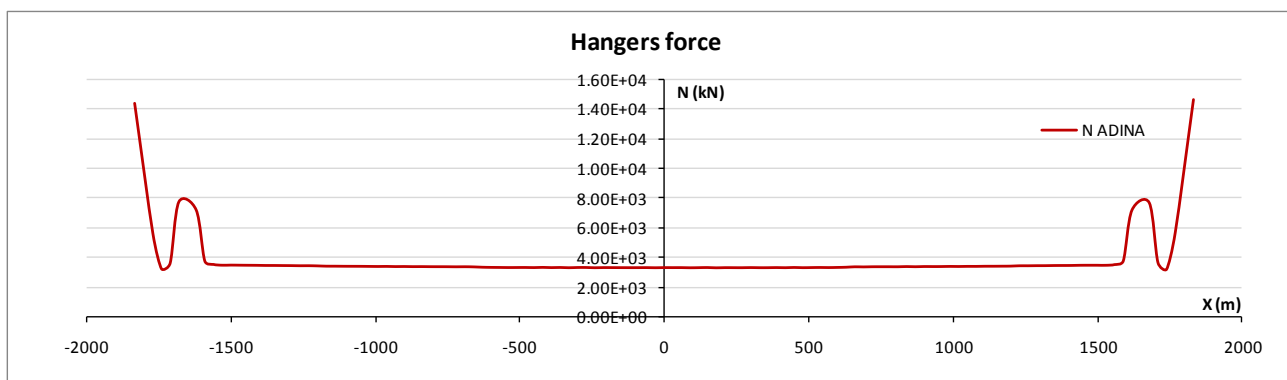
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**Cable displacement**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26.00	382.60	-0.024	0.035	0.004	Sicilia tower - Top
70	0	-26.00	81.10	-0.062	0.006	0.115	Mid span
125	1650	-26.00	382.60	0.002	0.034	0.001	Calabria tower -Top

**Cable forces**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.21E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.21E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.27E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.24E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Top Calabria tower (main span)
122	1665	-26	377	1.26E+06		Top Calabria tower (side span)
131	2382	-26	140	1.22E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.21E+06		Calabria splay saddle (anchorage side)



**Forces at the base of the towers legs**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	1.45E+01	-1.00E+03	1.19E+06	Sicilia Tower
3747	-1650	39.23	18	1.46E+01	1.01E+03	1.19E+06	Sicilia Tower
3877	1650	-39.23	18	-8.38E-01	-9.51E+02	1.15E+06	Calabria Tower
3980	1650	39.23	18	-7.08E-01	9.55E+02	1.15E+06	Calabria Tower

Validazione del modello globale agli elementi finiti

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	7.89E+03	2.92E+04	1.62E+02	Sicilia Tower
3747	-1650	39.23	18	-8.63E+03	2.92E+04	-1.68E+02	Sicilia Tower
3877	1650	-39.23	18	7.27E+03	-1.98E+03	-1.35E+01	Calabria Tower
3980	1650	39.23	18	-7.95E+03	-1.96E+03	8.87E+00	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.44E+04
Tie-down - Calabria	1.46E+04
Splay saddle Sicilia	3.47E+05
Splay saddle Calabria	3.50E+05
Link - Sicilia tower	-1.76E+00
Link - Calabria tower	-1.12E+00

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-0.550	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.551	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.550	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.488	Road box girder Calabria side
2088	1858.4	0.00	61.65	-0.487	Railway box girder Calabria side
1541	1817.8	18.72	62.43	-0.488	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.004	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.004	Road box girder mid span
540	-1650	-18.70	54.45	0.002	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.003	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.003	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.003	Road box girder tower Calabria side

Validazione del modello globale agli  
elementi finiti

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- **OUTPUT IBDAS**

### Load Case

**1353**      Reference condition + LC3  
**C3**        C3 = Free-Free

### Cable Displacements

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,015	0,031	-0,003
0,000	-26,000	81,100	-0,086	0,007	-0,060
1650,000	-26,000	379,000	-0,032	0,030	-0,005

### Cable Forces

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1198,493
-2512,875	-26,000	81,464	1218,917
-1665,000	-26,000	376,141	1276,061
-1635,000	-26,000	377,065	1242,809
-15,000	-26,000	81,149	1168,334
1635,000	-26,000	377,068	1250,084
1665,000	-26,000	376,560	1270,527
1911,375	-26,000	285,745	1244,456
2470,065	-26,000	111,514	1201,762

### Special Elements

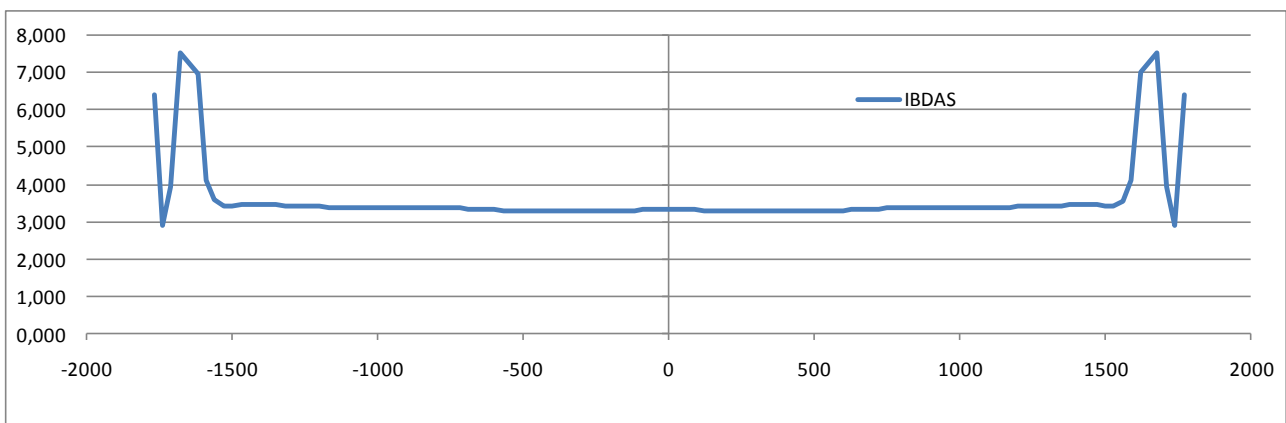
s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,059
1833,000	-26,000	179,846	14,366



### Deck Displacements

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	-0,820
-1858,380	0,000	51,013	-0,824
-1819,750	18,722	52,026	-0,822
1819,750	-18,722	62,409	-0,733
1858,380	0,000	61,647	-0,732
1819,750	18,722	62,409	-0,732

s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,004
0,000	0,000	74,342	0,000
0,000	18,722	74,432	-0,004
-1650,000	-18,704	54,450	0,006
-1650,000	0,000	54,132	0,005
-1650,000	18,704	54,450	0,004
1650,000	-18,704	63,730	0,005
1650,000	0,000	63,412	0,004
1650,000	18,704	63,730	0,002

### Hanger Forces



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
		Validazione del modello globale agli elementi finiti	<i>Codice documento</i> PS0005_F0	<i>Rev</i> F0

**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC3**

**Δ Cable Displacements**

**Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	0.005	0.000	0.000	Sicilia tower - Top
70	0	-26	81.1	0.030	0.000	0.002	Mid span
125	1650	-26	382.6	0.004	0.000	0.001	Calabria tower -Top

**Δ Deck Displacements L**

**Deck Displacements**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	0.279		Road box girder Sicilia side
1542	-1858.4	0	51.01	0.281		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	0.280		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.249		Road box girder Calabria side
2088	1858.4	0	61.65	0.249		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.247		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	0.000		Road box girder mid span
1815	0	0	74.34	0.000		Railway box girder mid span
1284	0	18.72	74.43	0.000		Road box girder mid span
540	-1650	-18.7	54.45	0.005		Road box girder tower Sicilia side
1587	-1650	0	54.13	0.006		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	0.006		Road box girder tower Sicilia side
998	1650	-18.7	63.73	0.006		Road box girder tower Calabria side
2043	1650	0	63.41	0.006		Railway box girder tower Calabria side
1513	1650	18.7	63.73	0.006		Road box girder tower Calabria side

### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
-1.26	1.94	0.01	-0.01	0.00	0.07	Sicilia Tower
-1.26	1.91	0.01	-0.01	0.00	-0.08	Sicilia Tower
1.37	-2.07	0.00	0.00	0.00	-0.07	Calabria Tower
1.38	-2.10	0.00	0.00	0.00	0.06	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
0.02	0.17	10.80	-16.10	Sicilia Tower
-0.02	0.10	10.80	-16.11	Sicilia Tower
-0.02	-0.18	9.01	-13.59	Calabria Tower
0.02	0.49	9.01	-13.59	Calabria Tower

### Δ Cables Forces

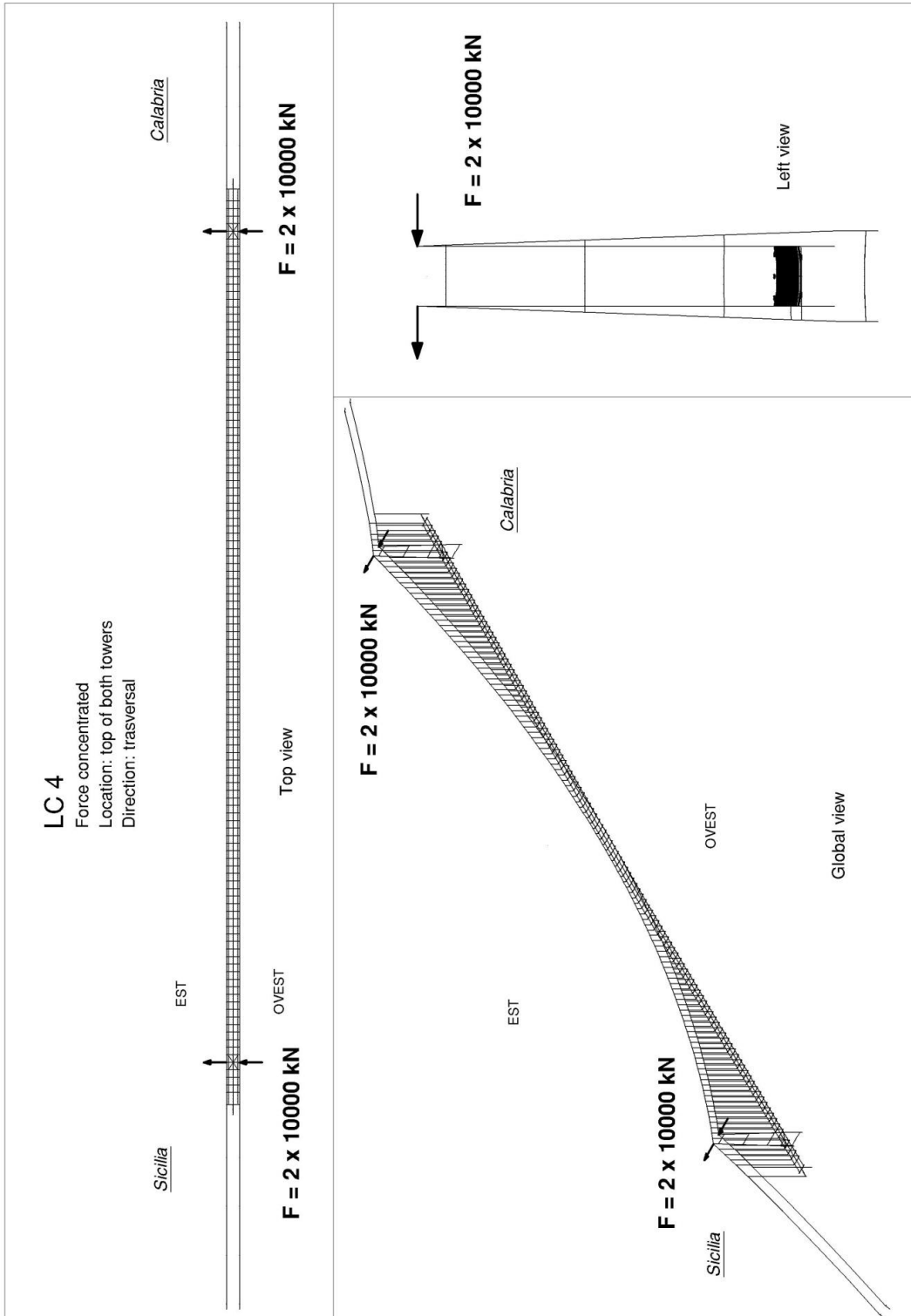
Δ	Δ/RC	
1.24	0.10%	Sicilia splay saddle (anchorage side)
1.26	0.10%	Sicilia splay saddle (span side)
1.27	0.10%	Sicilia tower - Top (side span)
1.17	0.09%	Sicilia tower - Top (main span)
-0.03	0.00%	Mid span
-1.33	-0.11%	Top Calabria tower (main span)
-1.42	-0.11%	Top Calabria tower (side span)
-1.41	-0.12%	Calabria splay saddle (span side)
-1.39	-0.11%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

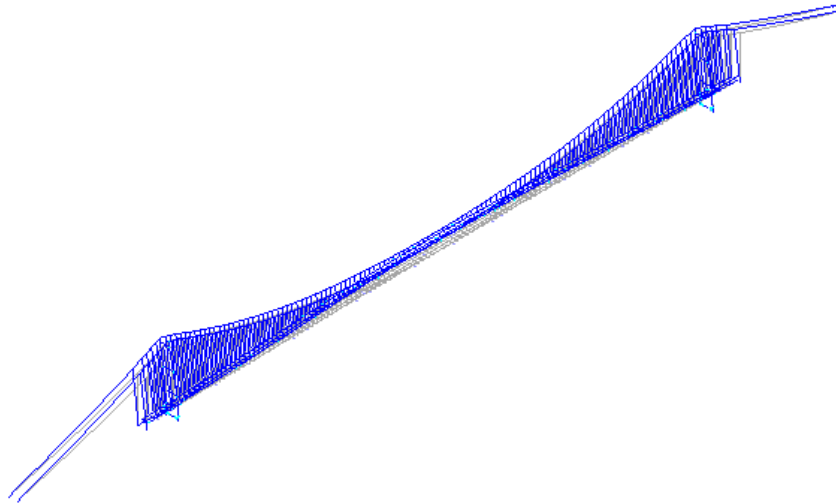
Δ	Δ/RC	
1.174	8.09%	Tie-down - Sicilia
-1.082	-7.46%	Tie-down - Calabria



**6.5 LC4 – Forza concentrata in sommità alle torri (buffer free-free)**



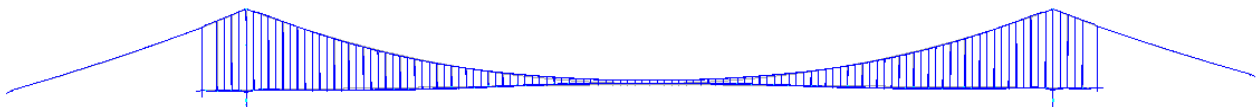
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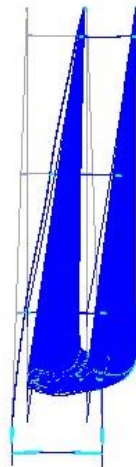
3d view



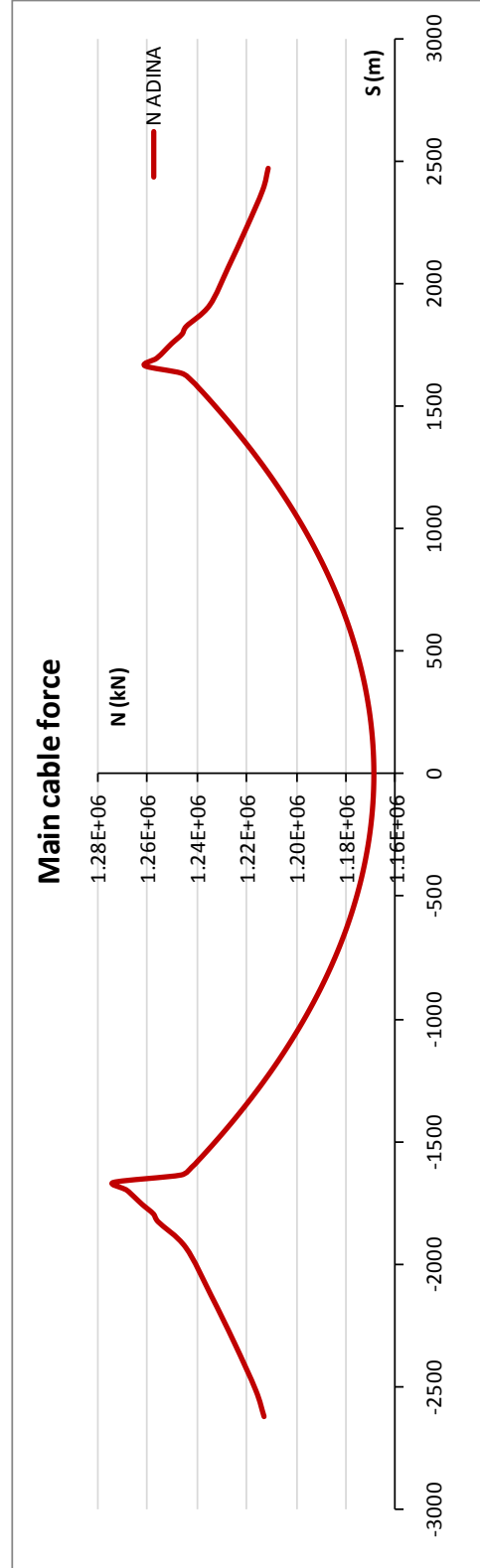
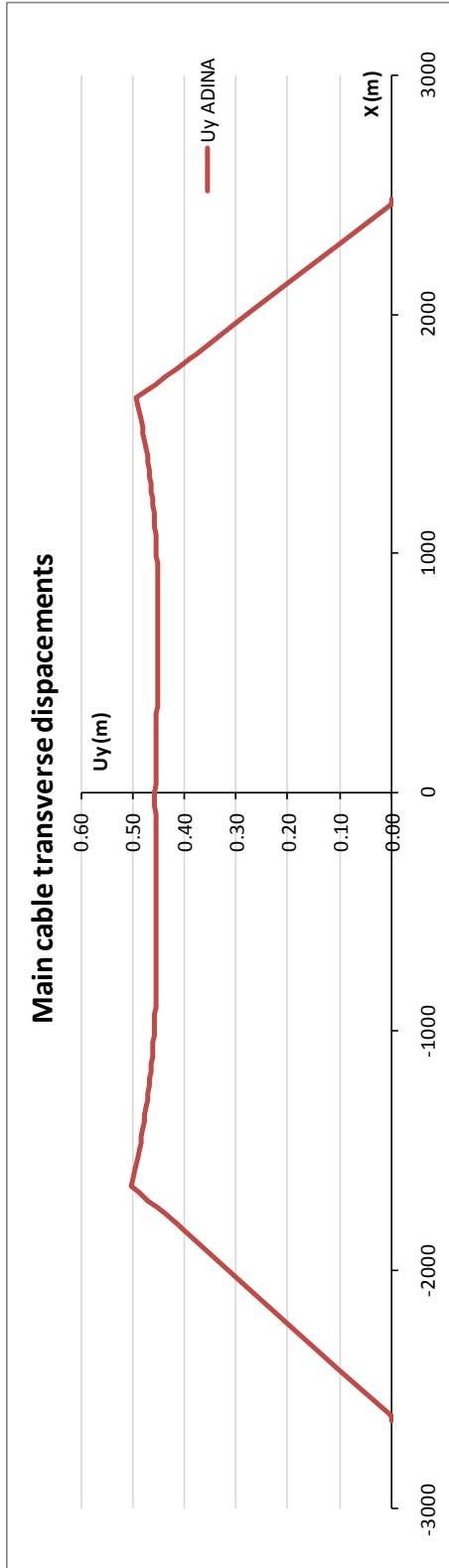
Plane view



Elevation XZ plane



Elevation YZ plane

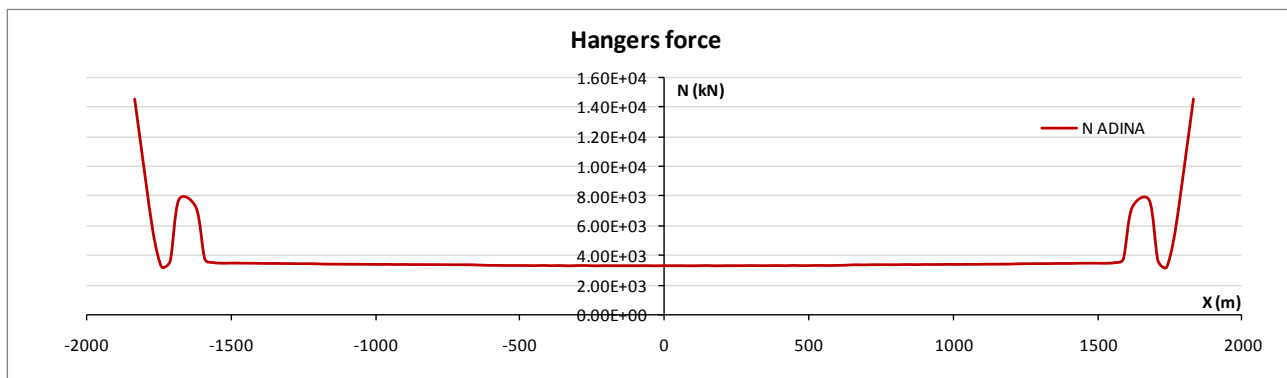


**Cable displacements**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	-0.016	0.503	0.005	Sicilia tower - Top
70	0	-26.00	81.10	-0.004	0.456	0.122	Mid span
125	1650	-26.00	382.60	0.010	0.493	0.002	Calabria tower - Top

**Cable force**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.21E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.22E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.27E+06		Sicilia tower – Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower – Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Calabria tower – Top (main span)
122	1665	-26	377	1.26E+06		Calabria tower – Top (side span)
131	2382	-26	140	1.21E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.21E+06		Calabria splay saddle (anchorage side)



**Force at the base of the towers legs**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	2.37E+01	-7.42E+03	1.11E+06	Sicilia Tower
3747	-1650	39.23	18	-5.57E+00	-5.58E+03	1.28E+06	Sicilia Tower
3877	1650	-39.23	18	-1.43E+01	-7.29E+03	1.06E+06	Calabria Tower
3980	1650	39.23	18	5.61E+00	-5.50E+03	1.24E+06	Calabria Tower

Validazione del modello globale agli  
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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	5.14E+05	2.03E+04	5.61E+02	Sicilia Tower
3747	-1650	39.23	18	5.01E+05	1.65E+04	3.53E+02	Sicilia Tower
3877	1650	-39.23	18	5.00E+05	-1.23E+04	-3.66E+02	Calabria Tower
3980	1650	39.23	18	4.90E+05	-9.70E+03	-2.41E+02	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.45E+04
Tie-down - Calabria	1.45E+04
Splay saddle Sicilia	3.47E+05
Splay saddle Calabria	3.49E+05
Link - Sicilia tower	-3.36E+02
Link - Calabria tower	-3.18E+02

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	0.000	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.003	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.004	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.007	Road box girder Calabria side
2088	1858.4	0.00	61.65	-0.004	Railway box girder Calabria side
1541	1817.8	18.72	62.43	-0.002	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.460	Road box girder mid span
1815	0	0	74.34	0.456	Railway box girder mid span
1284	0	18.72	74.43	0.452	Road box girder mid span
540	-1650	-18.70	54.45	0.024	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.019	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	0.017	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.028	Road box girder tower Calabria side
2043	1650	0	63.41	0.023	Railway box girder tower Calabria side
1513	1650	18.70	63.73	0.021	Road box girder tower Calabria side

- **OUTPUT IBDAS**

**Load Case**

**1354**      Reference condition + LC4  
**C3**        C3 = Free-Free

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,029	-0,432	-0,006
0,000	-26,000	81,100	0,003	-0,448	-0,058
1650,000	-26,000	379,000	-0,021	-0,424	-0,006

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1202,158
-2512,875	-26,000	81,464	1222,585
-1665,000	-26,000	376,141	1279,754
-1635,000	-26,000	377,065	1246,255
-15,000	-26,000	81,149	1168,269
1635,000	-26,000	377,068	1246,197
1665,000	-26,000	376,560	1266,328
1911,375	-26,000	285,745	1240,277
2470,065	-26,000	111,514	1197,597

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,244
1833,000	-26,000	179,846	14,177

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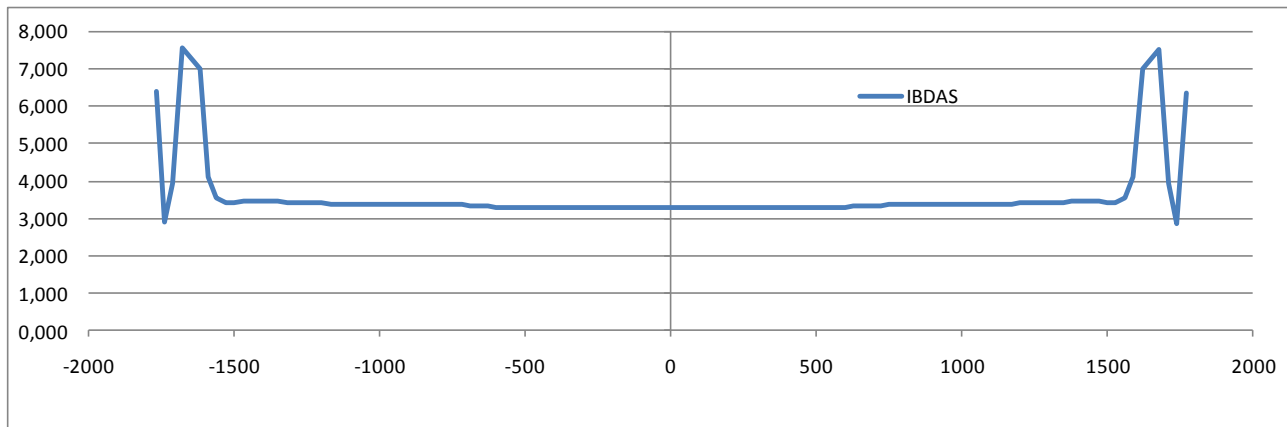
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### Deck Displacements

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,004
-1858,380	0,000	51,013	0,005
-1819,750	18,722	52,026	0,009
1819,750	-18,722	62,409	0,002
1858,380	0,000	61,647	0,000
1819,750	18,722	62,409	-0,004

s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	-0,457
0,000	0,000	74,342	-0,461
0,000	18,722	74,432	-0,465
-1650,000	-18,704	54,450	-0,026
-1650,000	0,000	54,132	-0,025
-1650,000	18,704	54,450	-0,029
1650,000	-18,704	63,730	-0,030
1650,000	0,000	63,412	-0,029
1650,000	18,704	63,730	-0,033

### Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC4**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	-0.002	0.005	0.004	Sicilia tower - Top
70	0	-26	81.1	-0.001	-0.004	0.007	Mid span
125	1650	-26	382.6	0.000	0.005	0.003	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	0.004		Road box girder Sicilia side
1542	-1858.4	0	51.01	0.000		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.004		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.006		Road box girder Calabria side
2088	1858.4	0	61.65	0.000		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.005		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	-0.005		Road box girder mid span
1815	0	0	74.34	-0.005		Railway box girder mid span
1284	0	18.72	74.43	-0.005		Road box girder mid span
540	-1650	-18.7	54.45	-0.005		Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.005		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	-0.006		Road box girder tower Sicilia side
998	1650	-18.7	63.73	-0.004		Road box girder tower Calabria side
2043	1650	0	63.41	-0.005		Railway box girder tower Calabria side
1513	1650	18.7	63.73	-0.005		Road box girder tower Calabria side



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### Towers Forces

ADINA <b>Fz (MN)</b>	IBDAS <b>Fz (MN)</b>	ADINA <b>Fx (MN)</b>	IBDAS <b>Fx (MN)</b>	ADINA <b>Fy (MN)</b>	IBDAS <b>Fy (MN)</b>	
-86.22	-85.04	0.01	0.01	-6.42	-9.26	Sicilia Tower
86.23	85.04	-0.01	-0.01	-6.58	-9.57	Sicilia Tower
-85.18	-83.99	-0.01	-0.01	-6.34	-9.19	Calabria Tower
85.19	83.99	0.01	0.01	-6.46	-9.46	Calabria Tower

ADINA <b>Mx (MN)</b>	IBDAS <b>Mx (MN)</b>	ADINA <b>My (MN)</b>	IBDAS <b>My (MN)</b>	
-505.60	507.34	1.89	-0.26	Sicilia Tower
-510.11	512.60	-1.91	0.27	Sicilia Tower
-493.21	494.73	-1.31	0.46	Calabria Tower
-497.59	499.98	1.26	-0.41	Calabria Tower



### Δ Cables Forces

Δ	Δ/RC	
0.06	0.01%	Sicilia splay saddle (anchorage side)
0.06	0.01%	Sicilia splay saddle (span side)
0.08	0.01%	Sicilia tower - Top (side span)
-0.03	0.00%	Sicilia tower - Top (main span)
-0.04	0.00%	Mid span
-0.03	0.00%	Top Calabria tower (main span)
0.05	0.00%	Top Calabria tower (side span)
0.04	0.00%	Calabria splay saddle (span side)
0.04	0.00%	Calabria splay saddle (anchorage side)

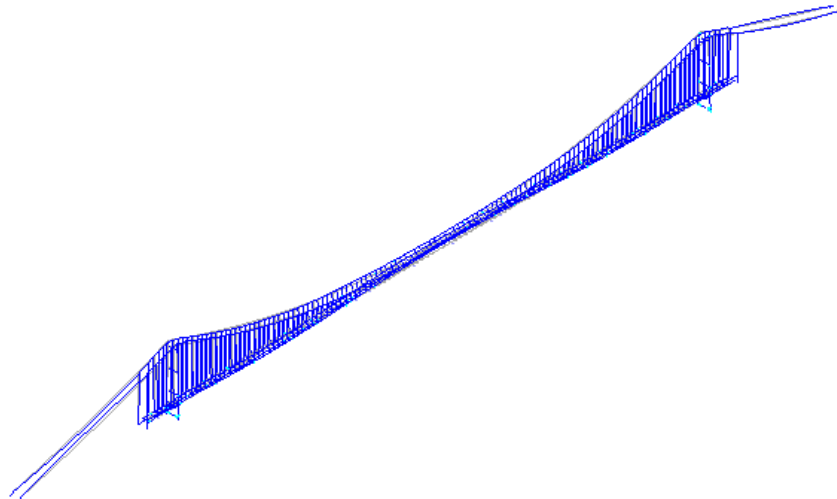
### Δ Tie-down Forces

Δ	Δ/RC	
0.021	0.15%	Tie-down - Sicilia
0.014	0.10%	Tie-down - Calabria



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
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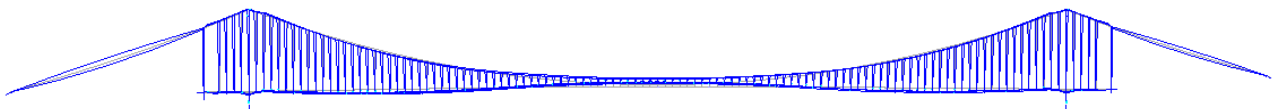
• **OUTPUT ADINA**



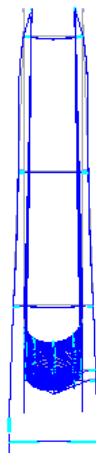
3d view



Plane view



Elevation XZ plane



Elevation YZ plane

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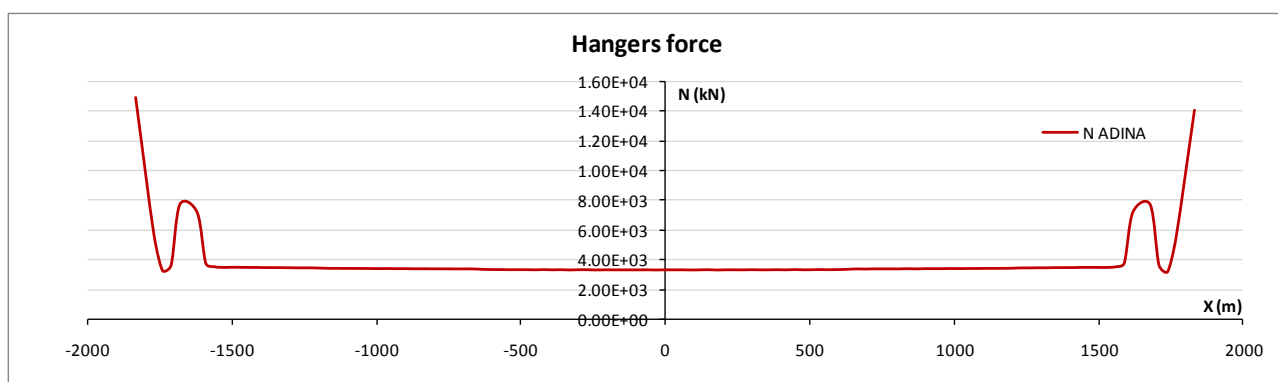
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**Cable displacement**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26.00	382.60	0.017	0.034	0.003	Sicilia tower - Top
70	0	-26.00	81.10	0.024	0.006	0.109	Mid span
125	1650	-26.00	382.60	0.037	0.034	0.002	Calabria tower -Top

**Cable force**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.22E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.23E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.28E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Top Calabria tower (main span)
122	1665	-26	377	1.25E+06		Top Calabria tower (side span)
131	2382	-26	140	1.20E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.20E+06		Calabria splay saddle (anchorage side)



**Forces at the base of the towers legs**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-5.24E+02	-1.09E+03	1.19E+06	Sicilia Tower
3747	-1650	39.23	18	5.43E+02	9.26E+02	1.19E+06	Sicilia Tower
3877	1650	-39.23	18	-4.32E+02	-8.70E+02	1.15E+06	Calabria Tower
3980	1650	39.23	18	4.23E+02	1.03E+03	1.15E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	1.28E+04	-5.96E+04	-1.98E+04	Sicilia Tower
3747	-1650	39.23	18	-3.79E+03	9.65E+04	-2.00E+04	Sicilia Tower
3877	1650	-39.23	18	2.52E+03	-7.35E+04	-1.54E+04	Calabria Tower
3980	1650	39.23	18	-1.26E+04	5.15E+04	-1.53E+04	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.50E+04
Tie-down - Calabria	1.41E+04
Splay saddle Sicilia	3.49E+05
Splay saddle Calabria	3.52E+05
Link - Sicilia tower	-2.10E+00
Link - Calabria tower	-2.69E+00

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-0.002	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.003	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.002	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.004	Road box girder Calabria side
2088	1858.4	0.00	61.65	-0.004	Railway box girder Calabria side
1541	1817.8	18.72	62.43	-0.004	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.003	Road box girder mid span
1815	0	0	74.34	-0.001	Railway box girder mid span
1284	0	18.72	74.43	-0.005	Road box girder mid span
540	-1650	-18.70	54.45	0.004	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.003	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.003	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.004	Road box girder tower Calabria side

• **OUTPUT IBDAS**

**Load Case**

**1355**      Reference condition + LC5  
**C3**        C3 = Free-Free

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	-0,002	0,032	-0,003
0,000	-26,000	81,100	-0,024	0,007	-0,044
1650,000	-26,000	379,000	-0,046	0,030	-0,005

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1193,583
-2512,875	-26,000	81,464	1214,003
-1665,000	-26,000	376,141	1270,991
-1635,000	-26,000	377,065	1246,457
-15,000	-26,000	81,149	1168,317
1635,000	-26,000	377,068	1246,087
1665,000	-26,000	376,560	1275,527
1911,375	-26,000	285,745	1249,313
2470,065	-26,000	111,514	1206,601

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	13,817
1833,000	-26,000	179,846	14,589

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,006
-1858,380	0,000	51,013	0,005
-1819,750	18,722	52,026	0,006
1819,750	-18,722	62,409	-0,001
1858,380	0,000	61,647	0,000
1819,750	18,722	62,409	-0,001

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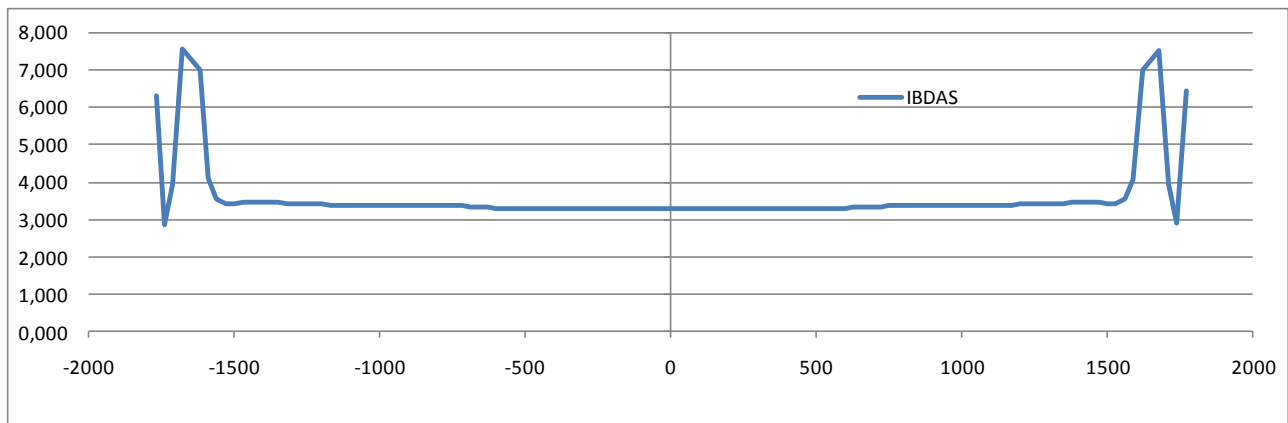
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s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,004
0,000	0,000	74,342	0,000
0,000	18,722	74,432	-0,004
-1650,000	-18,704	54,450	0,000
-1650,000	0,000	54,132	-0,002
-1650,000	18,704	54,450	-0,003
1650,000	-18,704	63,730	0,000
1650,000	0,000	63,412	-0,002
1650,000	18,704	63,730	-0,003

### Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC5**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	-0.001	0.000	-0.001	Sicilia tower - Top
70	0	-26	81.1	0.000	0.000	-0.020	Mid span
125	1650	-26	382.6	-0.001	0.000	0.002	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	0.000		Road box girder Sicilia side
1542	-1858.4	0	51.01	0.000		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	0.000		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.000		Road box girder Calabria side
2088	1858.4	0	61.65	0.000		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.000		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	-0.001		Road box girder mid span
1815	0	0	74.34	-0.001		Railway box girder mid span
1284	0	18.72	74.43	-0.001		Road box girder mid span
540	-1650	-18.7	54.45	0.001		Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	0.000		Road box girder tower Sicilia side
998	1650	-18.7	63.73	0.000		Road box girder tower Calabria side
2043	1650	0	63.41	0.000		Railway box girder tower Calabria side
1513	1650	18.7	63.73	-0.001		Road box girder tower Calabria side



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### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
2.29	2.25	-0.53	-0.55	-0.08	0.00	Sicilia Tower
-2.30	-2.25	0.53	0.55	-0.08	0.00	Sicilia Tower
-2.25	-2.21	-0.43	-0.46	0.08	0.00	Calabria Tower
2.25	2.21	0.43	0.46	0.08	0.00	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-4.85	4.68	-77.96	-81.27	Sicilia Tower
-4.85	4.64	78.12	81.13	Sicilia Tower
4.74	-4.56	-62.54	-67.69	Calabria Tower
4.71	-4.50	62.44	67.78	Calabria Tower

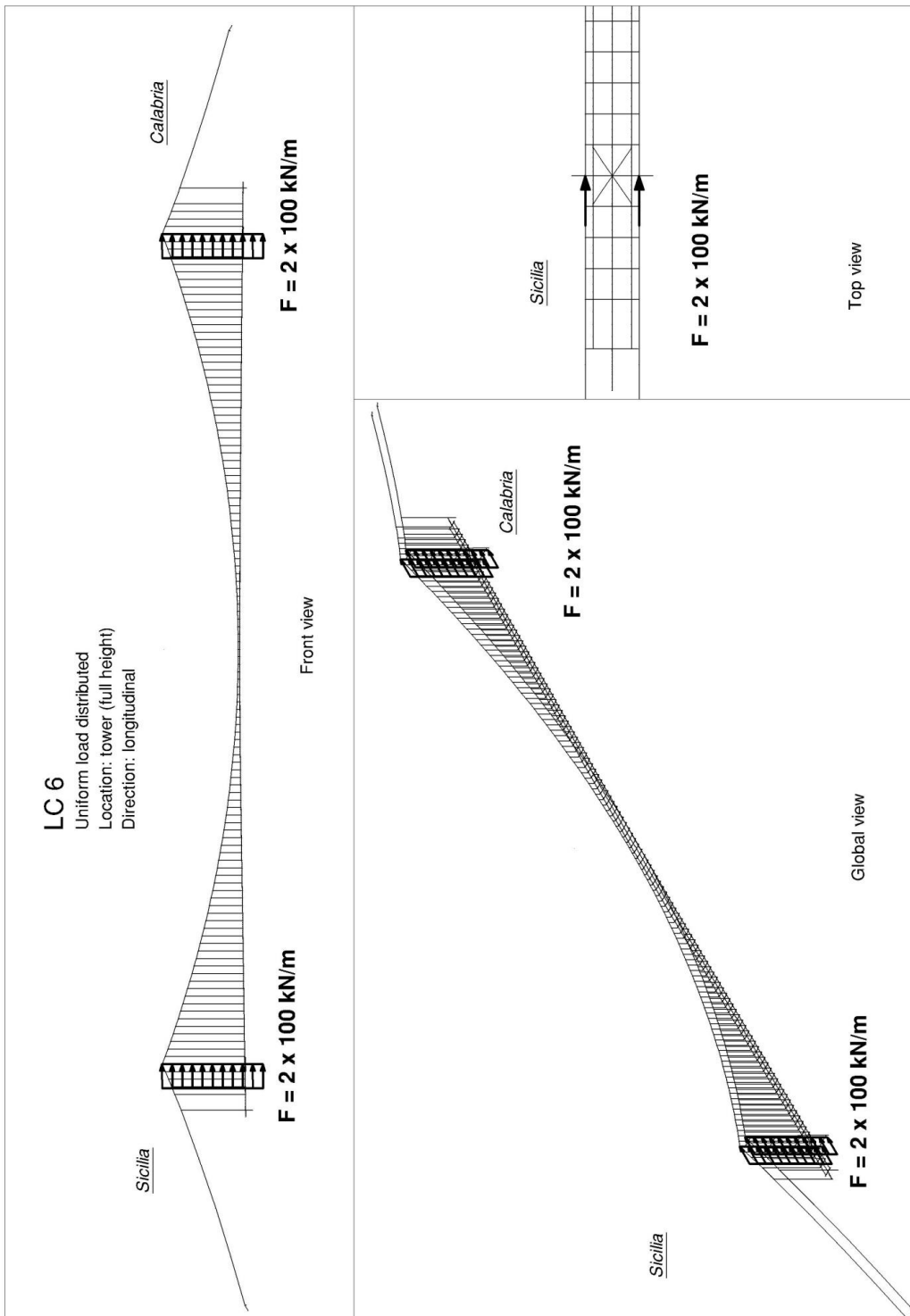
### Δ Cables Forces



Δ	Δ/RC	
0.21	0.02%	Sicilia splay saddle (anchorage side)
0.15	0.01%	Sicilia splay saddle (span side)
0.15	0.01%	Sicilia tower - Top (side span)
0.00	0.00%	Sicilia tower - Top (main span)
0.00	0.00%	Mid span
0.01	0.00%	Top Calabria tower (main span)
-0.16	-0.01%	Top Calabria tower (side span)
-0.15	-0.01%	Calabria splay saddle (span side)
		Calabria splay saddle (anchorage side)
-0.24	-0.02%	

### Δ Tie-down Forces

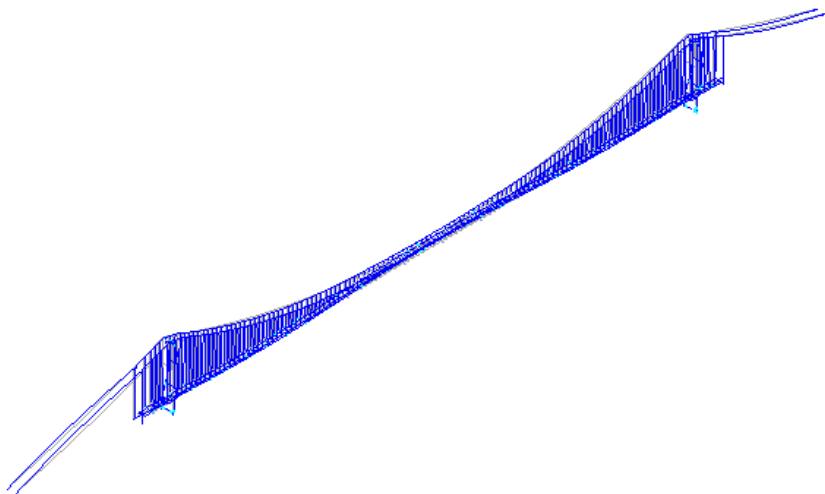
Δ	Δ/RC	
0.007	0.05%	Tie-down - Sicilia
-0.010	-0.07%	Tie-down - Calabria

**6.7 LC6 – Carico longitudinale uniformemente distribuito sulle torri (buffer free-free)**



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
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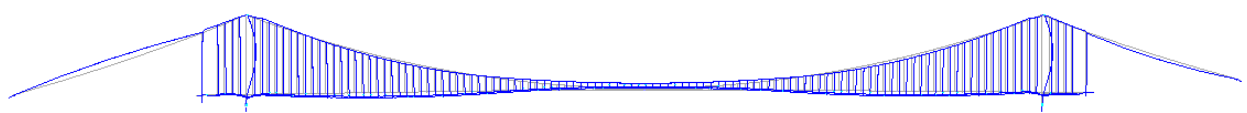
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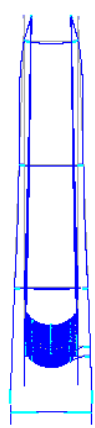
3d view



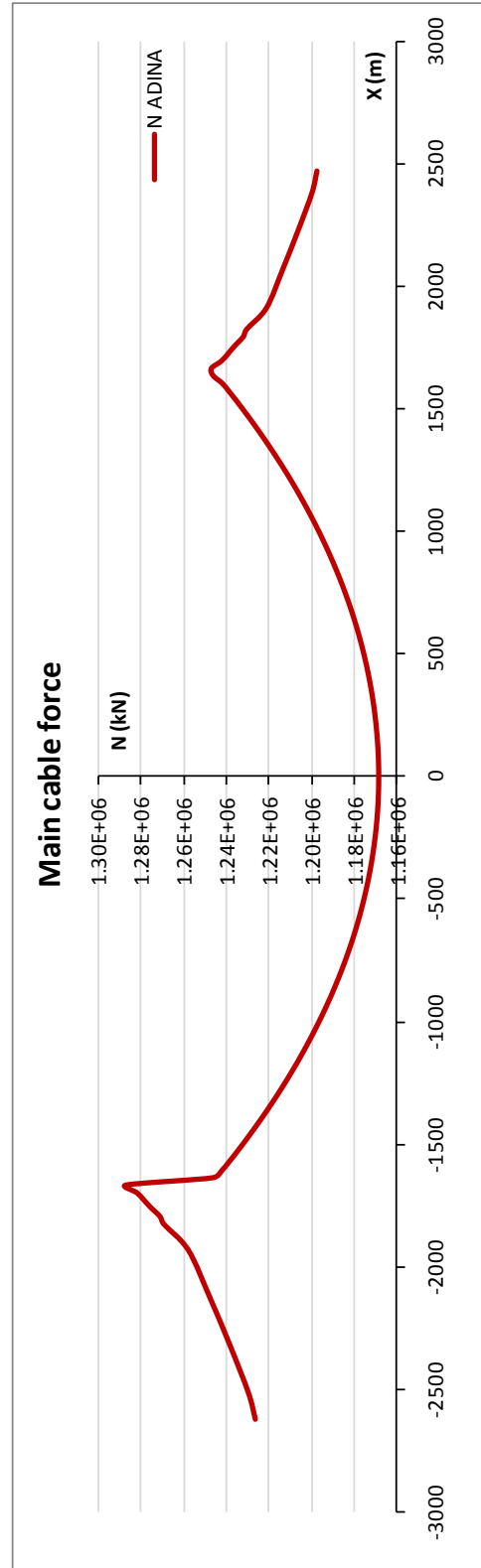
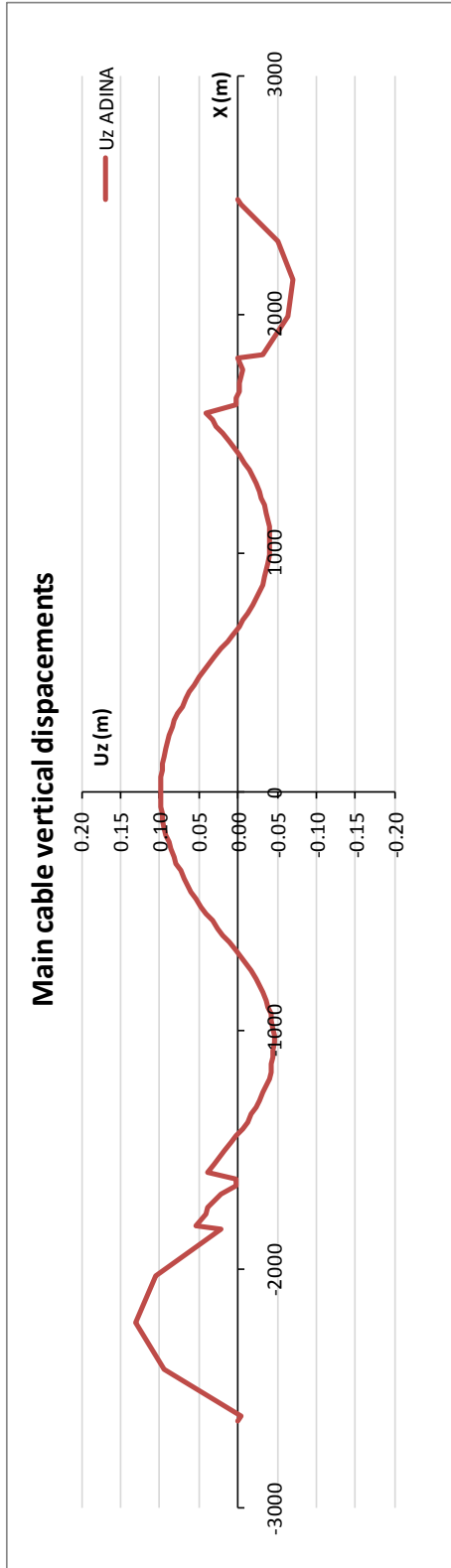
Plan view



Elevation XZ plane



Elevation YZ plane



Validazione del modello globale agli elementi finiti

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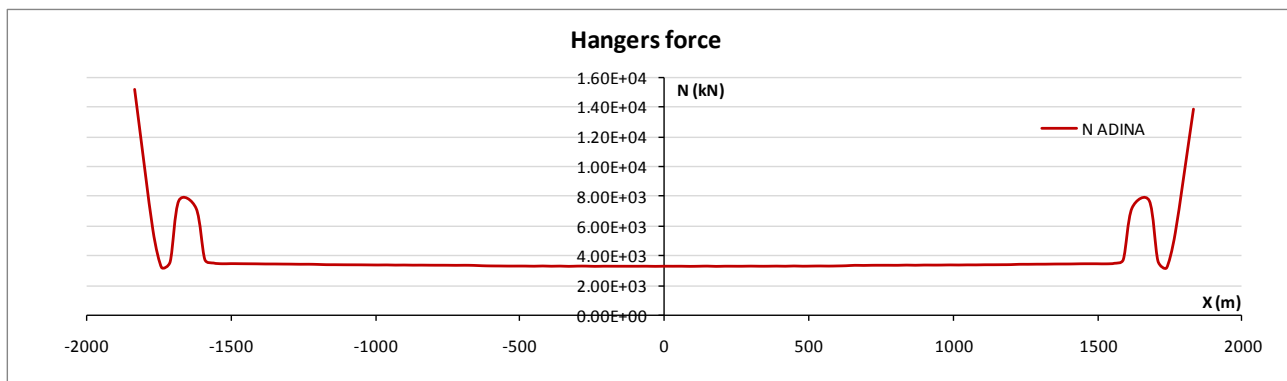
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**Cable displacements**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	0.034	0.035	0.002	Sicilia tower - Top
70	0	-26.00	81.10	0.042	0.006	0.099	Mid span
125	1650	-26.00	382.60	0.050	0.033	0.002	Calabria tower -Top

**Cable forces**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.23E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.23E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.29E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Top Calabria tower (main span)
122	1665	-26	377	1.25E+06		Top Calabria tower (side span)
131	2382	-26	140	1.20E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.20E+06		Calabria splay saddle (anchorage side)



**Forces at the base of the tower leg**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-2.33E+04	-1.01E+03	1.20E+06	Sicilia Tower
3747	-1650	39.23	18	-2.33E+04	1.01E+03	1.20E+06	Sicilia Tower
3877	1650	-39.23	18	-2.34E+04	-9.49E+02	1.15E+06	Calabria Tower
3980	1650	39.23	18	-2.34E+04	9.55E+02	1.15E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	8.01E+03	-1.80E+06	-1.82E+03	Sicilia Tower
3747	-1650	39.23	18	-8.68E+03	-1.80E+06	1.46E+03	Sicilia Tower
3877	1650	-39.23	18	7.16E+03	-1.86E+06	-2.13E+03	Calabria Tower
3980	1650	39.23	18	-7.91E+03	-1.85E+06	1.84E+03	Calabria Tower

### Forces in special element

Element	N (kN)
Tie-down - Sicilia	1.52E+04
Tie-down - Calabria	1.39E+04
Splay saddle Sicilia	3.51E+05
Splay saddle Calabria	3.46E+05
Link - Sicilia tower	-1.75E+00
Link - Calabria tower	-1.14E+00

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	0.042	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	0.042	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	0.042	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.041	Road box girder Calabria side
2088	1858.4	0.00	61.65	0.041	Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.041	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.004	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.004	Road box girder mid span
540	-1650	-18.70	54.45	0.003	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.003	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.003	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.003	Road box girder tower Calabria side

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• **OUTPUT IBDAS**

**Load Case**

**1356**      Reference condition + LC6  
**C3**        C3 = Free-Free

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,085	0,031	-0,006
0,000	-26,000	81,100	0,048	0,006	-0,073
1650,000	-26,000	379,000	0,026	0,030	-0,003

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1215,863
-2512,875	-26,000	81,464	1236,298
-1665,000	-26,000	376,141	1293,747
-1635,000	-26,000	377,065	1246,169
-15,000	-26,000	81,149	1168,175
1635,000	-26,000	377,068	1246,115
1665,000	-26,000	376,560	1252,409
1911,375	-26,000	285,745	1226,585
2470,065	-26,000	111,514	1183,956

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,969
1833,000	-26,000	179,846	13,549

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,051
-1858,380	0,000	51,013	0,050
-1819,750	18,722	52,026	0,051
1819,750	-18,722	62,409	0,045

Validazione del modello globale agli elementi finiti

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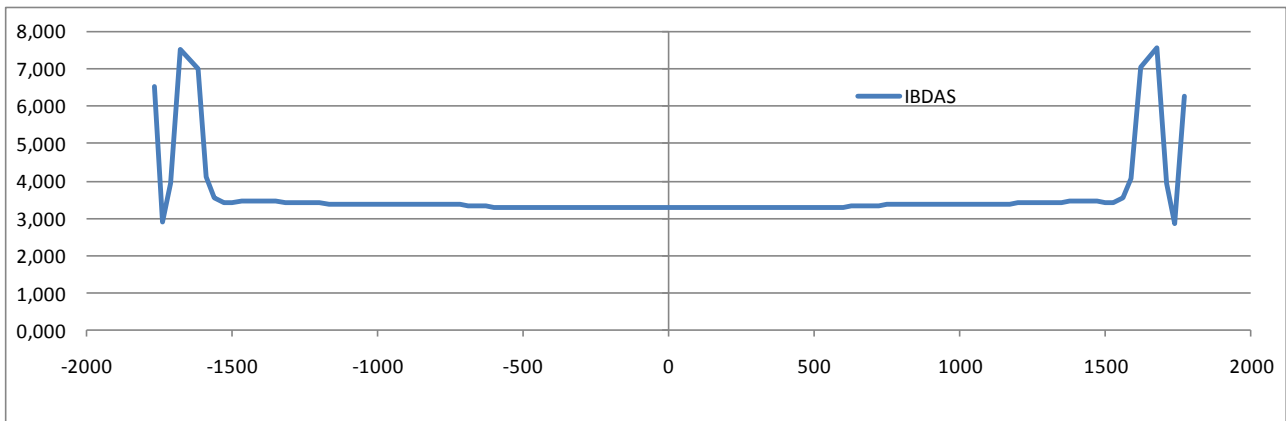
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1858,380	0,000	61,647	0,046
1819,750	18,722	62,409	0,045

s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,004
0,000	0,000	74,342	0,000
0,000	18,722	74,432	-0,004
-1650,000	-18,704	54,450	0,000
-1650,000	0,000	54,132	-0,001
-1650,000	18,704	54,450	-0,003
1650,000	-18,704	63,730	0,000
1650,000	0,000	63,412	-0,002
1650,000	18,704	63,730	-0,003

### Hanger Forces





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**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC6**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	-0.008	0.000	0.001	Sicilia tower - Top
70	0	-26	81.1	0.000	0.000	-0.001	Mid span
125	1650	-26	382.6	-0.007	-0.001	0.000	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	-0.001		Road box girder Sicilia side
1542	-1858.4	0	51.01	0.000		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.001		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.000		Road box girder Calabria side
2088	1858.4	0	61.65	-0.001		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.000		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	0.000		Road box girder mid span
1815	0	0	74.34	0.000		Railway box girder mid span
1284	0	18.72	74.43	0.000		Road box girder mid span
540	-1650	-18.7	54.45	0.000		Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	0.000		Road box girder tower Sicilia side
998	1650	-18.7	63.73	0.000		Road box girder tower Calabria side
2043	1650	0	63.41	0.000		Railway box girder tower Calabria side
1513	1650	18.7	63.73	0.000		Road box girder tower Calabria side

### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
5.02	-5.08	-23.33	23.05	0.00	-0.18	Sicilia Tower
4.98	-5.08	-23.32	23.05	0.00	0.18	Sicilia Tower
-4.76	4.81	-23.37	23.11	0.00	0.17	Calabria Tower
-4.72	4.81	-23.36	23.11	0.00	-0.17	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-0.11	-0.45	-1819.90	1830.43	Sicilia Tower
0.04	0.45	-1818.47	1830.43	Sicilia Tower
0.09	0.47	-1844.65	1841.83	Calabria Tower
-0.02	-0.47	-1843.44	1841.83	Calabria Tower

### Δ Cables Forces

Δ	Δ/RC	
-0.04	0.00%	Sicilia splay saddle (anchorage side)
-0.16	-0.01%	Sicilia splay saddle (span side)
-0.16	-0.01%	Sicilia tower - Top (side span)
0.01	0.00%	Sicilia tower - Top (main span)
0.00	0.00%	Mid span
-0.01	0.00%	Top Calabria tower (main span)
0.19	0.01%	Top Calabria tower (side span)
0.20	0.02%	Calabria splay saddle (span side)
		Calabria splay saddle (anchorage side)
0.05	0.00%	

### Δ Tie-down Forces

Δ	Δ/RC	
-0.007	-0.04%	Tie-down - Sicilia
0.007	0.05%	Tie-down - Calabria

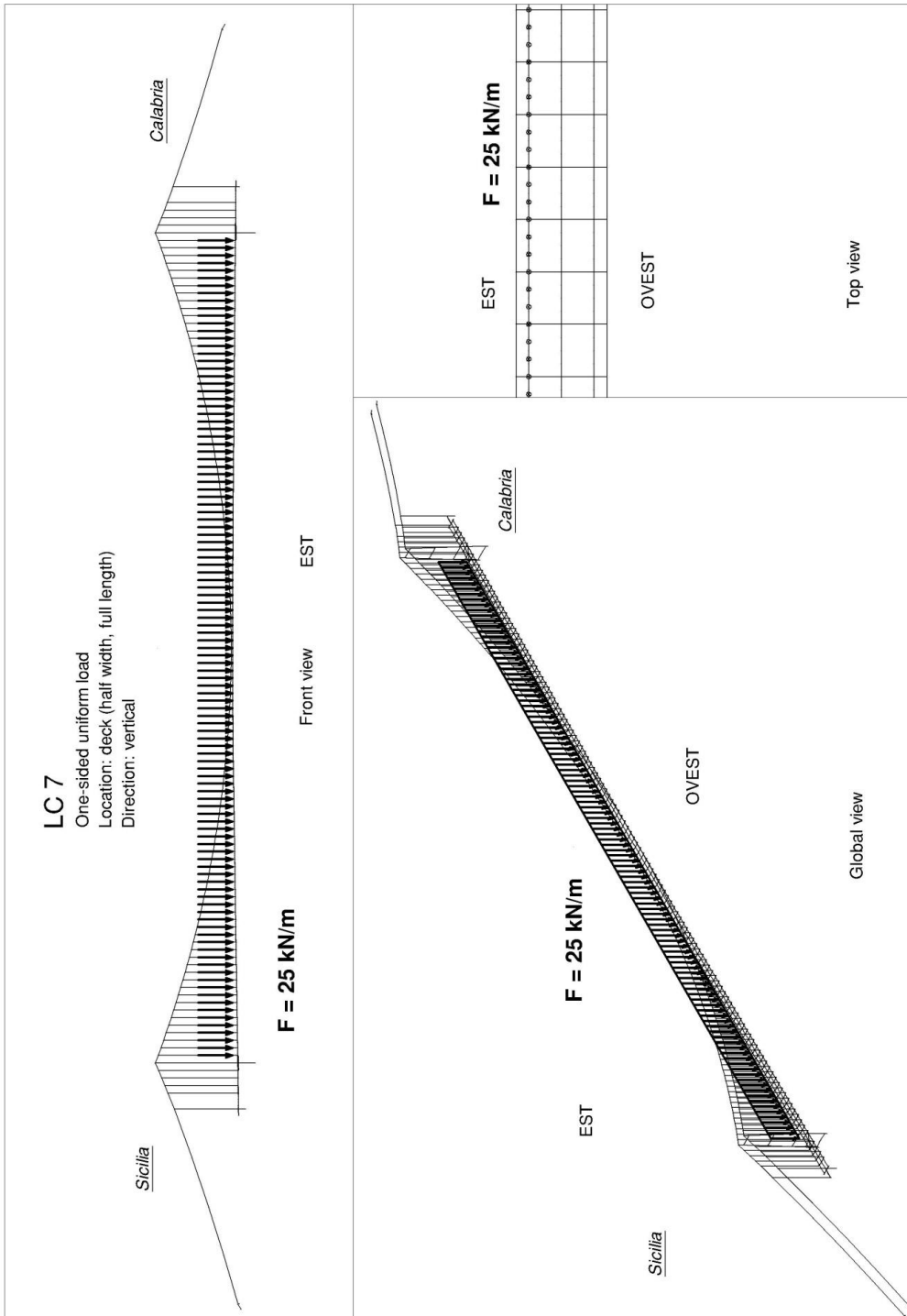
Validazione del modello globale agli  
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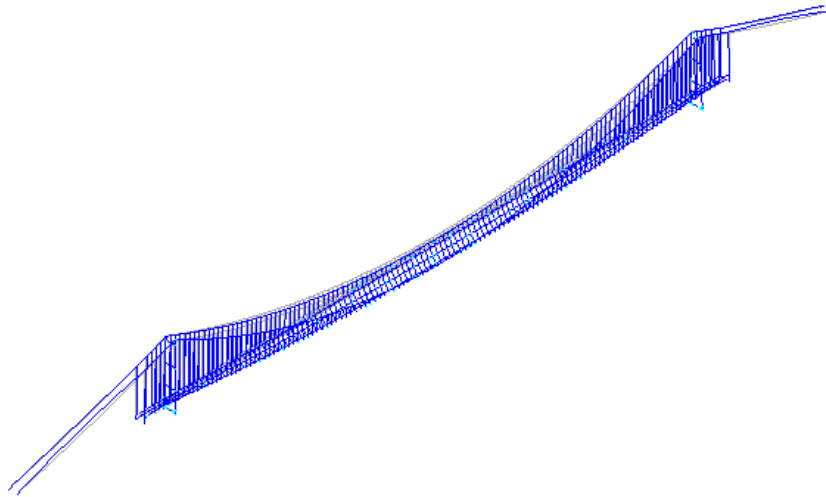
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**6.8 LC7 – Carico uniforme distribuito sul singolo impalcato stradale (buffer free-free)**



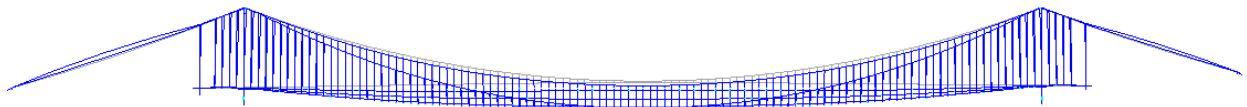
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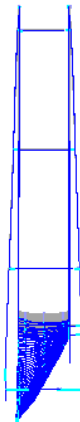
3d view



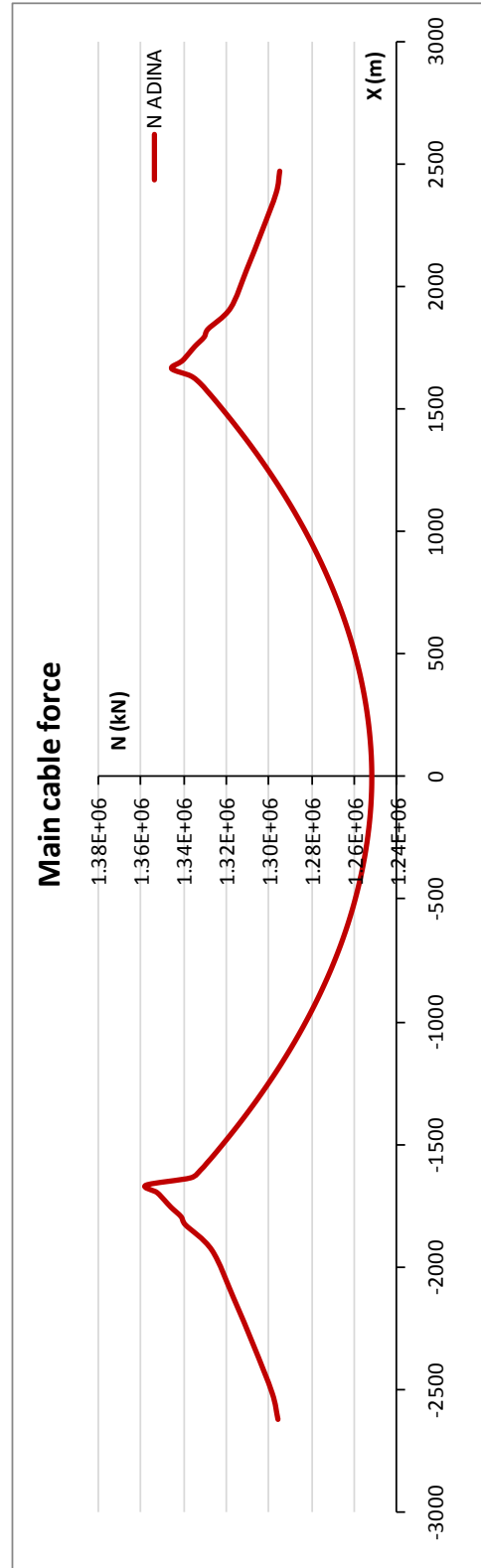
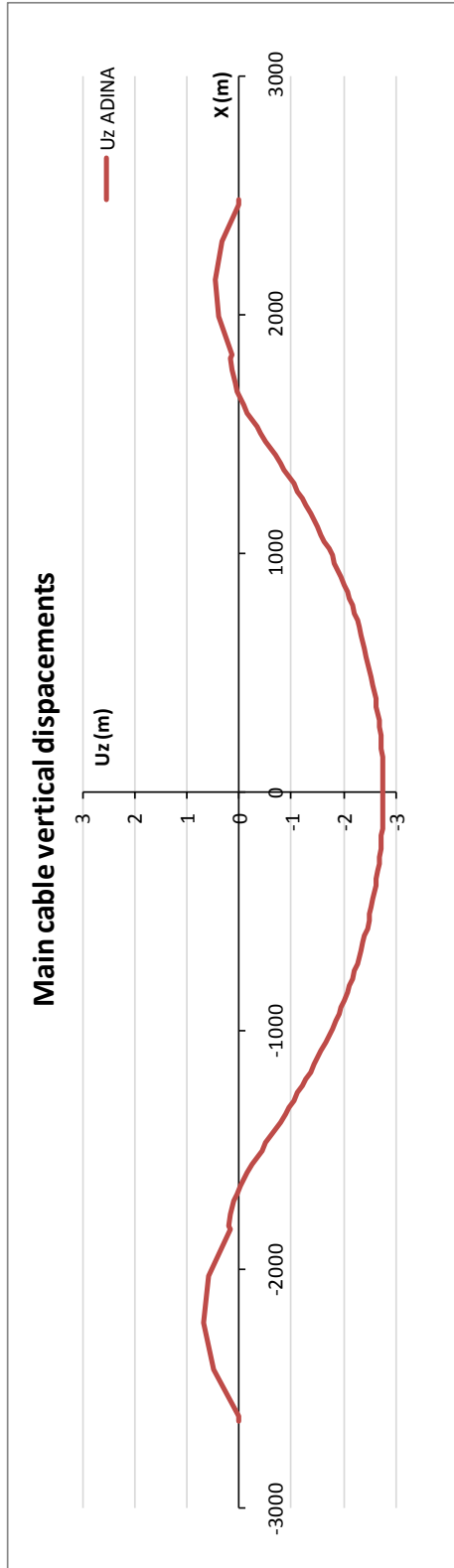
Plane view



Elevation XZ plane



Elevation YZ plane

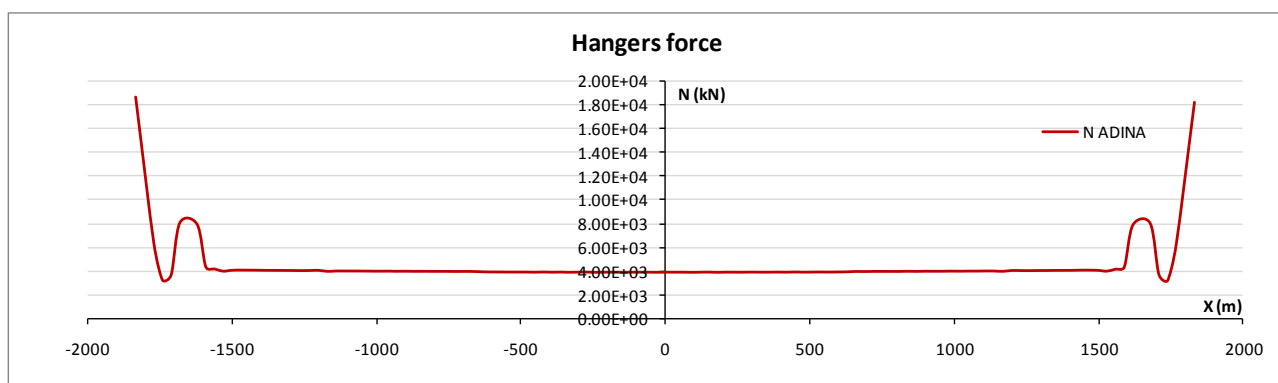


**Cable displacement**

Element t	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	0.288	0.031	-0.015	Sicilia tower - Top
70	0	-26.00	81.10	0.025	-0.026	-2.762	Mid span
125	1650	-26.00	382.60	-0.236	0.031	-0.017	Calabria tower -Top

**Cable forces**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.30E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.30E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.36E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.34E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.25E+06		Mid span
121	1635	-26	377	1.34E+06		Top Calabria tower (main span)
122	1665	-26	377	1.35E+06		Top Calabria tower (side span)
131	2382	-26	140	1.30E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.30E+06		Calabria splay saddle (anchorage side)



**Forces at the base of towers legs**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-1.92E+03	-1.67E+03	1.25E+06	Sicilia Tower
3747	-1650	39.23	18	1.78E+03	2.70E+02	1.21E+06	Sicilia Tower
3877	1650	-39.23	18	1.52E+03	-1.62E+03	1.21E+06	Calabria Tower
3980	1650	39.23	18	-1.44E+03	2.35E+02	1.17E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	4.79E+04	-4.79E+05	-7.08E+04	Sicilia Tower
3747	-1650	39.23	18	3.22E+04	6.60E+04	-6.84E+04	Sicilia Tower
3877	1650	-39.23	18	4.69E+04	3.75E+05	5.45E+04	Calabria Tower
3980	1650	39.23	18	3.23E+04	-6.06E+04	5.27E+04	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.86E+04
Tie-down - Calabria	1.82E+04
Splay saddle Sicilia	3.67E+05
Splay saddle Calabria	3.54E+05
Link - Sicilia tower	-1.04E+02
Link - Calabria tower	-8.97E+01

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-0.007	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.008	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.008	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.030	Road box girder Calabria side
2088	1858.4	0.00	61.65	0.031	Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.031	Road box girder Calabria side

Node	Coordinate (m)			Displ. T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	-0.032	Road box girder mid span
1815	0	0	74.34	-0.032	Railway box girder mid span
1284	0	18.72	74.43	-0.040	Road box girder mid span
540	-1650	-18.70	54.45	0.000	Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.004	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.007	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.000	Road box girder tower Calabria side
2043	1650	0	63.41	-0.003	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.006	Road box girder tower Calabria side

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• **OUTPUT IBDAS**

**Load Case**

**1357**      Reference condition + LC7  
**C3**        C3 = Free-Free

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,324	0,027	-0,023
0,000	-26,000	81,100	0,031	0,001	-2,894
1650,000	-26,000	379,000	-0,260	0,028	-0,022

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1284,086
-2512,875	-26,000	81,464	1304,557
-1665,000	-26,000	376,141	1363,487
-1635,000	-26,000	377,065	1335,990
-15,000	-26,000	81,149	1250,827
1635,000	-26,000	377,068	1336,020
1665,000	-26,000	376,560	1350,587
1911,375	-26,000	285,745	1323,051
2470,065	-26,000	111,514	1280,083

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	18,343
1833,000	-26,000	179,846	17,821

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,002
-1858,380	0,000	51,013	0,001
-1819,750	18,722	52,026	0,002
1819,750	-18,722	62,409	0,033
1858,380	0,000	61,647	0,034
1819,750	18,722	62,409	0,033



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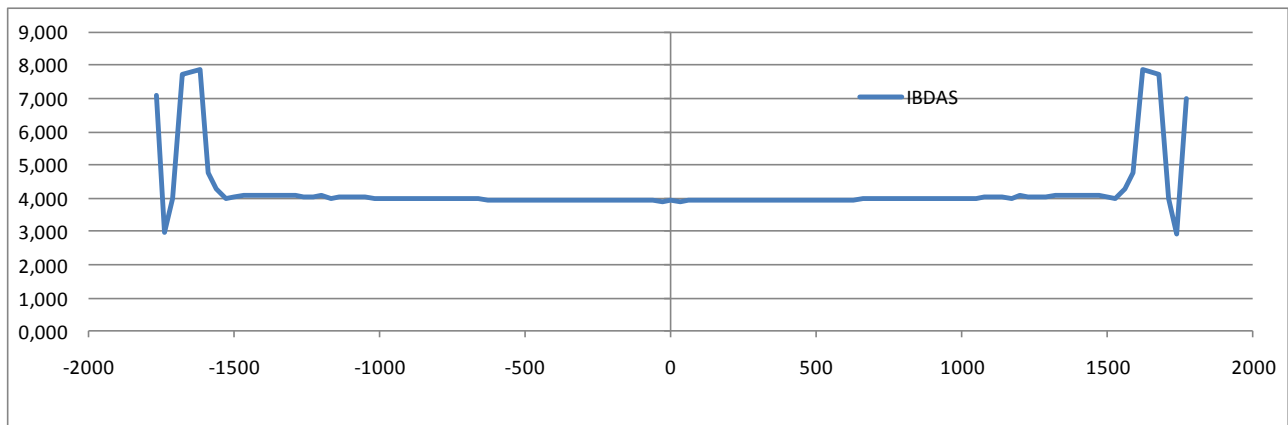
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s[m]	y[m]	z[m]	uy[m]
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0,000	0,000	74,342	-0,022
0,000	18,722	74,432	-0,048
-1650,000	-18,704	54,450	-0,004
-1650,000	0,000	54,132	-0,005
-1650,000	18,704	54,450	-0,006
1650,000	-18,704	63,730	-0,004
1650,000	0,000	63,412	-0,005
1650,000	18,704	63,730	-0,006

### Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC7**

**△ Cable Displacements**

Element	Coordinate (m)			△ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	0.008	-0.008	0.001	Sicilia tower - Top
70	0	-26	81.1	0.000	-0.038	-0.040	Mid span
125	1650	-26	382.6	-0.006	-0.005	0.000	Calabria tower -Top

**△ Deck Displacements L**

Node	Coordinate (m)			△ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	-0.001		Road box girder Sicilia side
1542	-1858.4	0	51.01	-0.001		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.002		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.000		Road box girder Calabria side
2088	1858.4	0	61.65	0.002		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.001		Road box girder Calabria side

**△ Deck Displacements T**

Node	Coordinate (m)			△ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	-0.046		Road box girder mid span
1815	0	0	74.34	-0.054		Railway box girder mid span
1284	0	18.72	74.43	-0.080		Road box girder mid span
540	-1650	-18.7	54.45	-0.007		Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.007		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	-0.008		Road box girder tower Sicilia side
998	1650	-18.7	63.73	-0.006		Road box girder tower Calabria side
2043	1650	0	63.41	-0.006		Railway box girder tower Calabria side
1513	1650	18.7	63.73	-0.006		Road box girder tower Calabria side

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### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
58.42	-57.89	-1.93	1.67	-0.67	-1.42	Sicilia Tower
21.20	-21.55	1.77	-1.59	-0.74	1.44	Sicilia Tower
56.92	-56.48	1.52	-1.35	-0.67	-1.37	Calabria Tower
20.26	-20.65	-1.44	1.31	-0.72	1.38	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-39.99	-41.49	-497.52	469.20	Sicilia Tower
-40.81	-35.24	47.65	-28.56	Sicilia Tower
-39.60	-41.42	385.95	-368.06	Calabria Tower
-40.24	-33.96	-49.64	34.19	Calabria Tower

### Δ Cables Forces

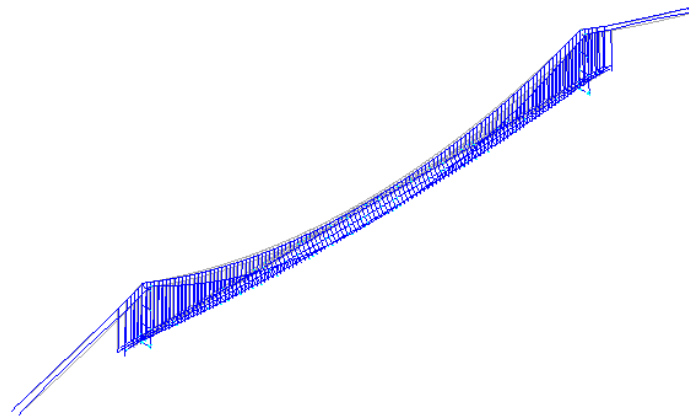
Δ	Δ/RC	
1.31	0.11%	Sicilia splay saddle (anchorage side)
0.65	0.05%	Sicilia splay saddle (span side)
0.75	0.06%	Sicilia tower - Top (side span)
0.84	0.07%	Sicilia tower - Top (main span)
0.85	0.07%	Mid span
0.81	0.06%	Top Calabria tower (main span)
0.82	0.07%	Top Calabria tower (side span)
0.73	0.06%	Calabria splay saddle (span side)
1.57	0.13%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

Δ	Δ/RC	
0.026	0.18%	Tie-down - Sicilia
0.032	0.22%	Tie-down - Calabria

## 6.9 LC7 – Carico uniformemente distribuito sul solo impalco stradale (buffer fixed-fixed)

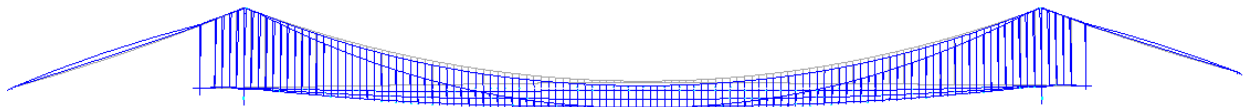
- OUTPUT ADINA



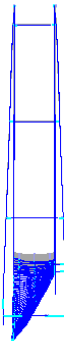
3d view



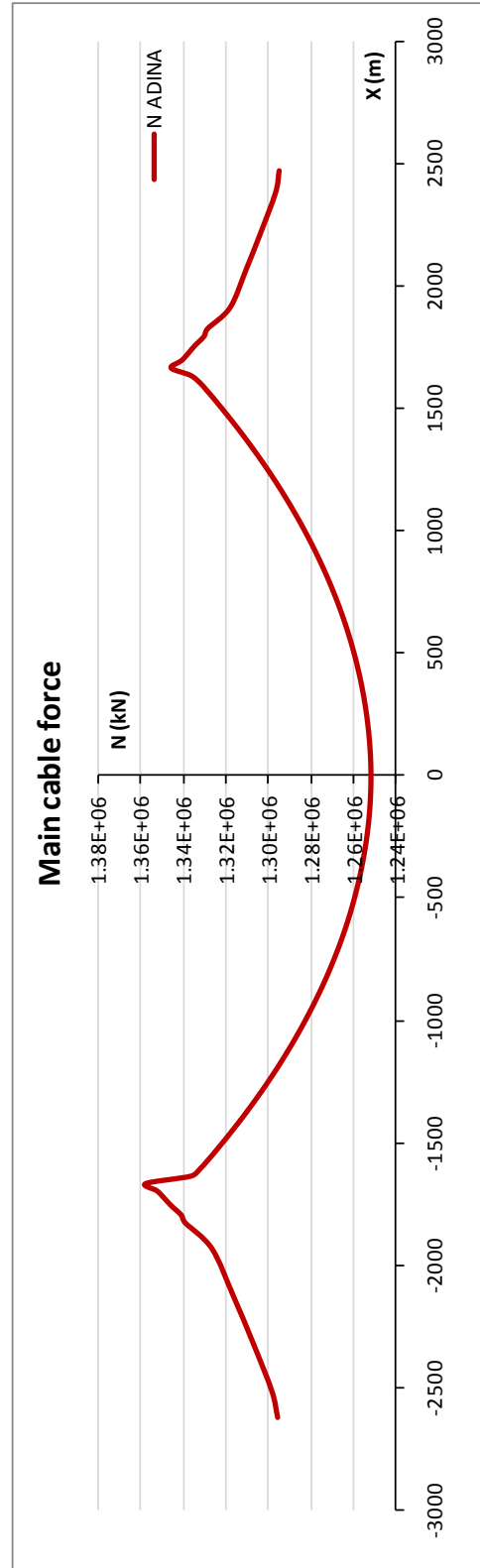
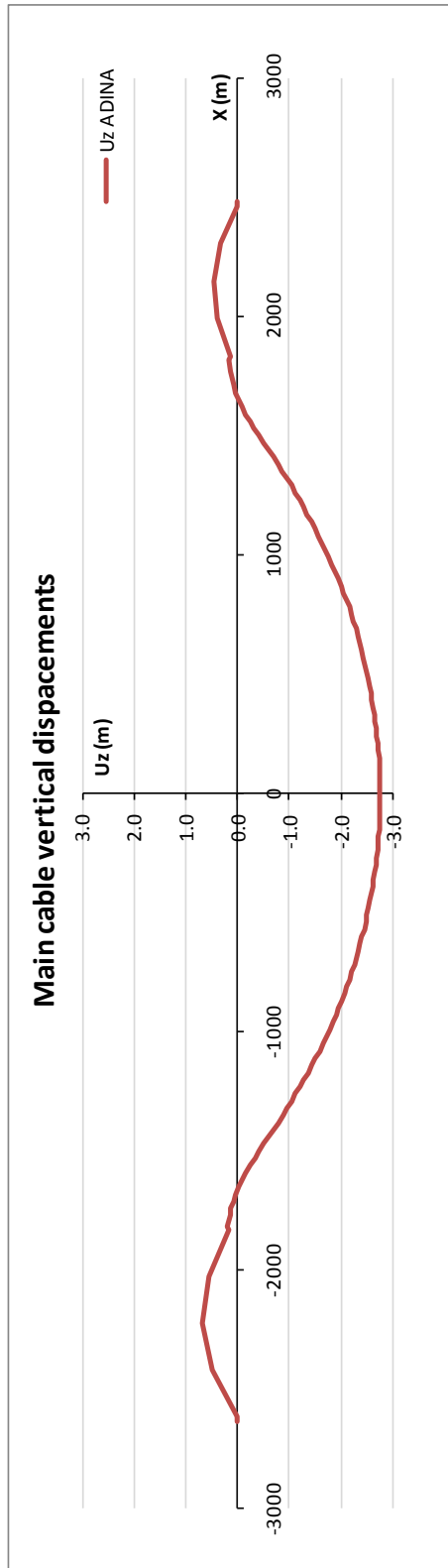
Plane view



Elevation XZ plane



Elevation YZ plane

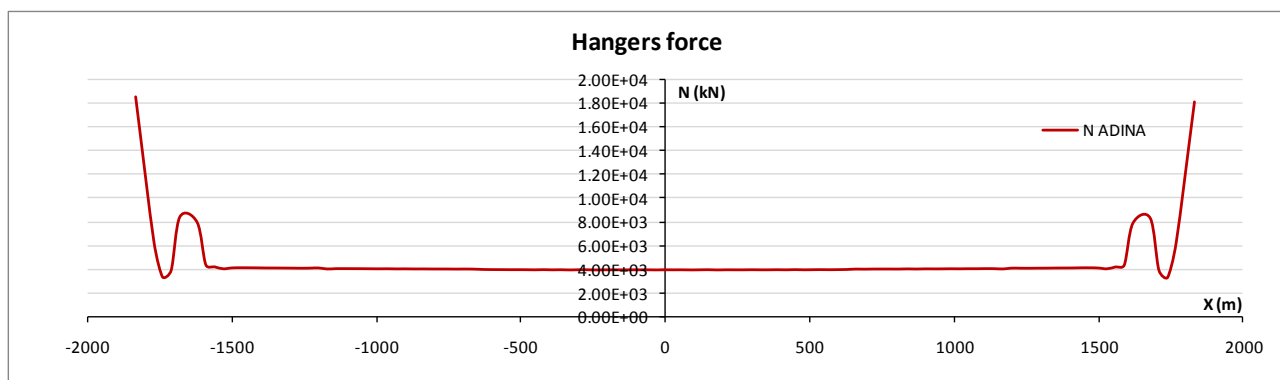


**Cable displacements**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	0.287	0.031	-0.015	Sicilia tower - Top
70	0	-26.00	81.10	0.023	-0.026	-2.757	Mid span
125	1650	-26.00	382.60	-0.236	0.031	-0.017	Calabria tower -Top

**Cable forces**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.30E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.30E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.36E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.34E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.25E+06		Mid span
121	1635	-26	377	1.34E+06		Top Calabria tower (main span)
122	1665	-26	377	1.35E+06		Top Calabria tower (side span)
131	2382	-26	140	1.30E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.30E+06		Calabria splay saddle (anchorage side)



**Forces at the base of the towers legs**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-2.32E+02	-3.75E+03	1.25E+06	Sicilia Tower
3747	-1650	39.23	18	3.09E+03	2.10E+03	1.21E+06	Sicilia Tower
3877	1650	-39.23	18	-4.42E+02	-3.49E+03	1.21E+06	Calabria Tower
3980	1650	39.23	18	-2.72E+03	1.81E+03	1.17E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	1.04E+05	-4.33E+05	-2.22E+04	Sicilia Tower
3747	-1650	39.23	18	-1.31E+04	8.89E+04	-9.04E+04	Sicilia Tower
3877	1650	-39.23	18	1.05E+05	3.04E+05	1.53E+04	Calabria Tower
3980	1650	39.23	18	-1.17E+04	-9.39E+04	7.04E+04	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.85E+04
Tie-down - Calabria	1.81E+04
Splay saddle Sicilia	3.67E+05
Splay saddle Calabria	3.54E+05
Link - Sicilia tower	3.16E+02
Link - Calabria tower	2.57E+02

### Deck displacements

Node	Coordinate (m)			Displ. L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	0.000	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.001	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	0.000	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.000	Road box girder Calabria side
2088	1858.4	0.00	61.65	0.001	Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.000	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	-0.031	Road box girder mid span
1815	0	0	74.34	-0.031	Railway box girder mid span
1284	0	18.72	74.43	-0.039	Road box girder mid span
540	-1650	-18.70	54.45	-0.003	Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.006	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.009	Road box girder tower Sicilia side
998	1650	-18.70	63.73	-0.002	Road box girder tower Calabria side
2043	1650	0	63.41	-0.005	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.008	Road box girder tower Calabria side

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• **OUTPUT IBDAS**

**Load Case**

**1357**      Reference condition + LC7  
**C1**        C1 = Fixed-Fixed

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,324	0,027	-0,023
0,000	-26,000	81,100	0,029	0,001	-2,891
1650,000	-26,000	379,000	-0,260	0,028	-0,022

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1283,924
-2512,875	-26,000	81,464	1304,395
-1665,000	-26,000	376,141	1363,329
-1635,000	-26,000	377,065	1335,851
-15,000	-26,000	81,149	1250,751
1635,000	-26,000	377,068	1336,043
1665,000	-26,000	376,560	1350,589
1911,375	-26,000	285,745	1323,050
2470,065	-26,000	111,514	1280,082

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	18,334
1833,000	-26,000	179,846	17,822

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,006
-1858,380	0,000	51,013	0,005
-1819,750	18,722	52,026	0,006
1819,750	-18,722	62,409	0,000
1858,380	0,000	61,647	0,001
1819,750	18,722	62,409	0,000



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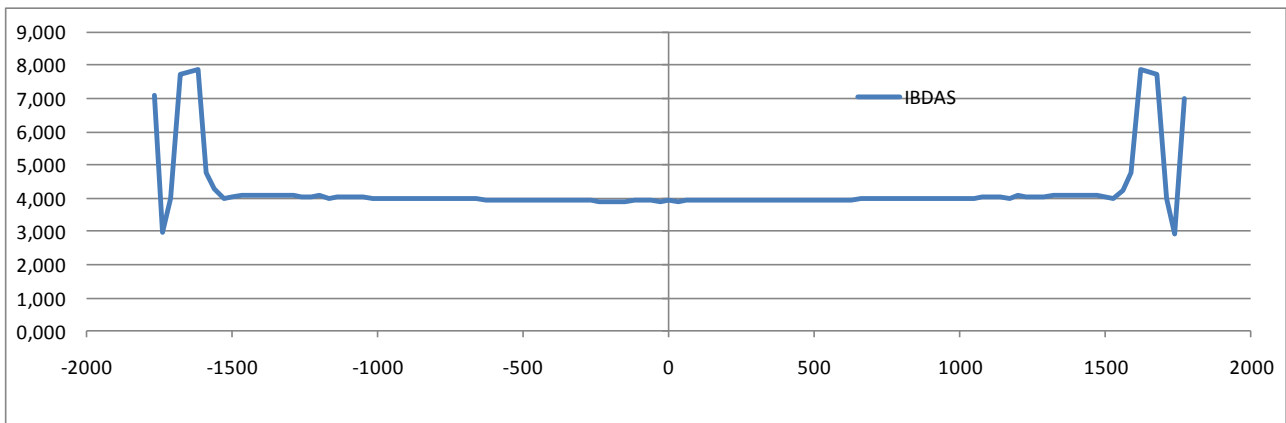
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s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	-0,006
0,000	0,000	74,342	-0,022
0,000	18,722	74,432	-0,048
-1650,000	-18,704	54,450	-0,004
-1650,000	0,000	54,132	-0,005
-1650,000	18,704	54,450	-0,007
1650,000	-18,704	63,730	-0,004
1650,000	0,000	63,412	-0,005
1650,000	18,704	63,730	-0,007

### Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**  
**LC7 (fixed-fixed)**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	0.007	-0.008	0.001	Sicilia tower - Top
70	0	-26	81.1	0.000	-0.038	-0.039	Mid span
125	1650	-26	382.6	-0.006	-0.005	0.000	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	0.002		Road box girder Sicilia side
1542	-1858.4	0	51.01	0.002		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	0.002		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.003		Road box girder Calabria side
2088	1858.4	0	61.65	0.004		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.003		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	-0.045		Road box girder mid span
1815	0	0	74.34	-0.053		Railway box girder mid span
1284	0	18.72	74.43	-0.079		Road box girder mid span
540	-1650	-18.7	54.45	-0.010		Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.009		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	-0.010		Road box girder tower Sicilia side
998	1650	-18.7	63.73	-0.008		Road box girder tower Calabria side
2043	1650	0	63.41	-0.008		Railway box girder tower Calabria side
1513	1650	18.7	63.73	-0.008		Road box girder tower Calabria side

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### Towers Forces

ADINA <b>Fz (MN)</b>	IBDAS <b>Fz (MN)</b>	ADINA <b>Fx (MN)</b>	IBDAS <b>Fx (MN)</b>	ADINA <b>Fy (MN)</b>	IBDAS <b>Fy (MN)</b>	
58.71	-57.83	-0.24	0.25	-2.75	-1.42	Sicilia Tower
21.41	-21.49	3.08	-3.01	1.09	1.44	Sicilia Tower
57.27	-56.49	-0.44	0.21	-2.54	-1.37	Calabria Tower
20.57	-20.66	-2.72	2.88	0.86	1.38	Calabria Tower

ADINA <b>Mx (MN)</b>	IBDAS <b>Mx (MN)</b>	ADINA <b>My (MN)</b>	IBDAS <b>My (MN)</b>	
-96.49	-41.48	-451.53	425.86	Sicilia Tower
4.42	-35.24	70.55	-72.64	Sicilia Tower
-97.52	-41.43	315.40	-308.23	Calabria Tower
3.74	-33.97	-82.99	94.49	Calabria Tower

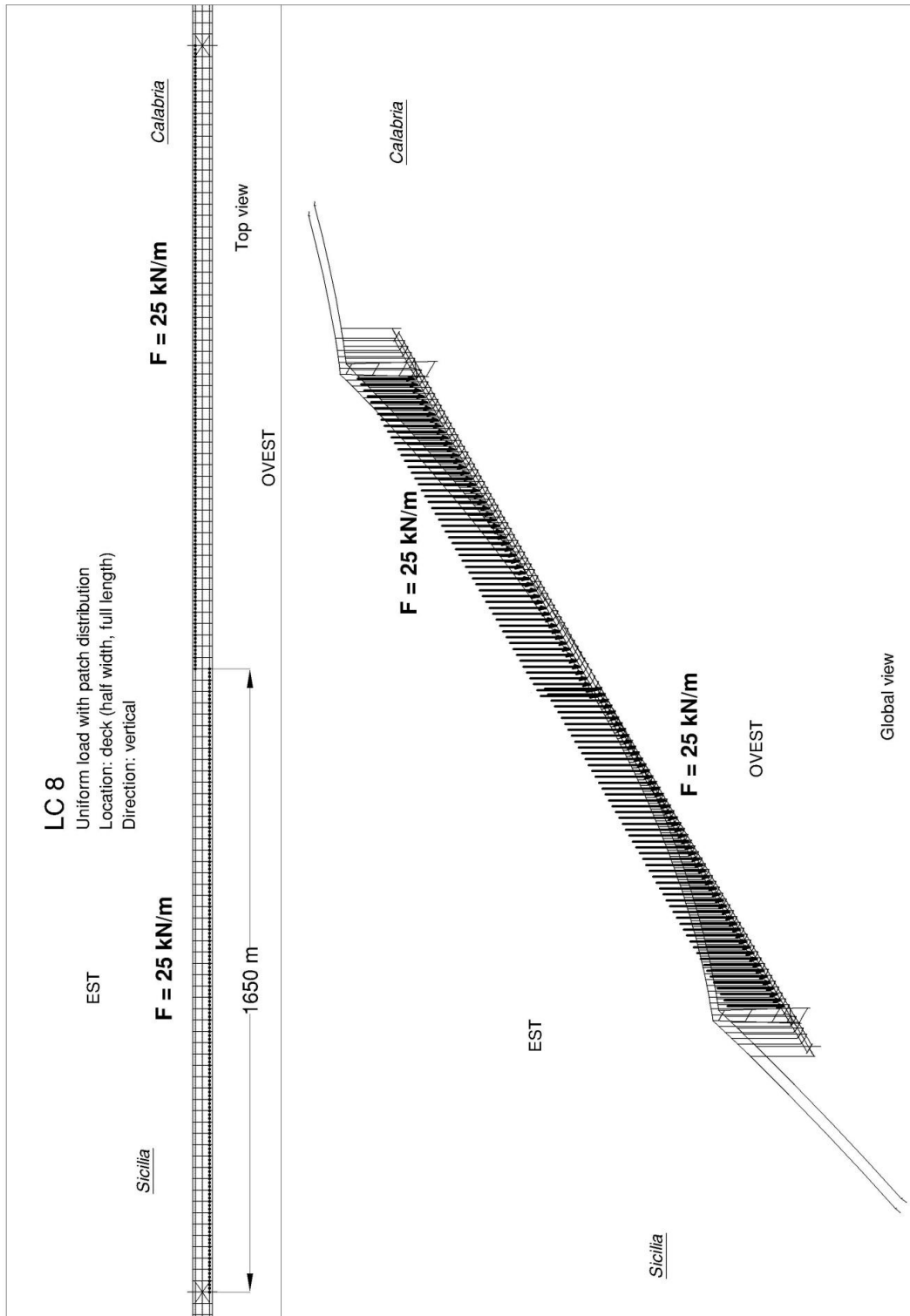
### Δ Cables Forces



Δ	Δ/RC	
1.29	0.11%	Sicilia splay saddle (anchorage side)
0.63	0.05%	Sicilia splay saddle (span side)
0.91	0.07%	Sicilia tower - Top (side span)
0.82	0.07%	Sicilia tower - Top (main span)
0.83	0.07%	Mid span
0.76	0.06%	Top Calabria tower (main span)
0.90	0.07%	Top Calabria tower (side span)
0.67	0.06%	Calabria splay saddle (span side)
1.51	0.12%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

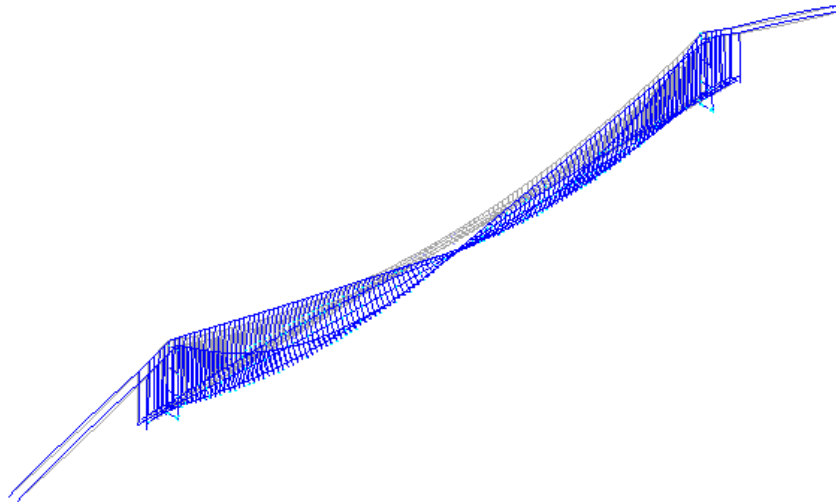
Δ	Δ/RC	
-0.066	-0.45%	Tie-down - Sicilia
-0.055	-0.38%	Tie-down - Calabria

**6.10 LC8 – Carico distribuito con disposizione a scacchiera (buffer free-free)**



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
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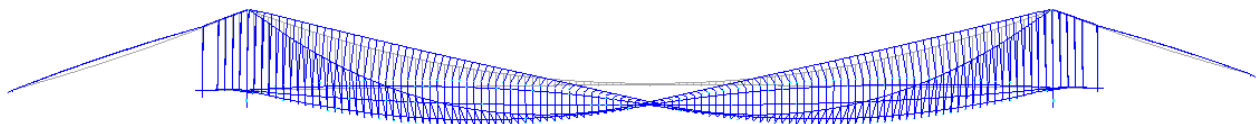
- **OUTPUT ADINA**



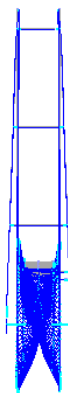
3d view



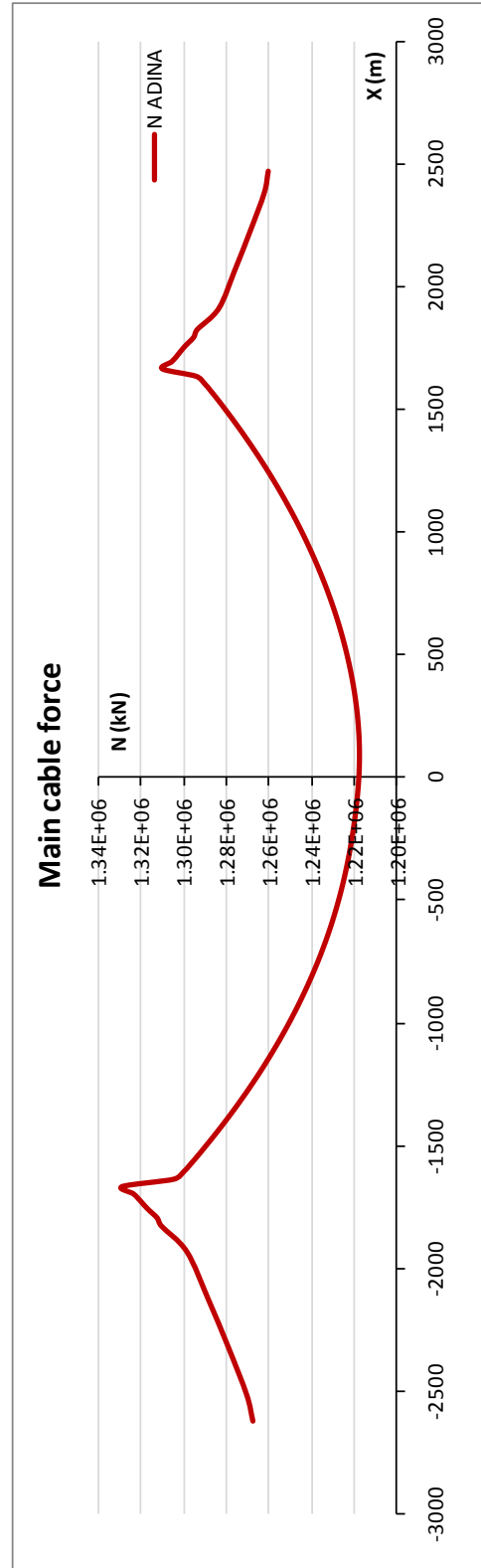
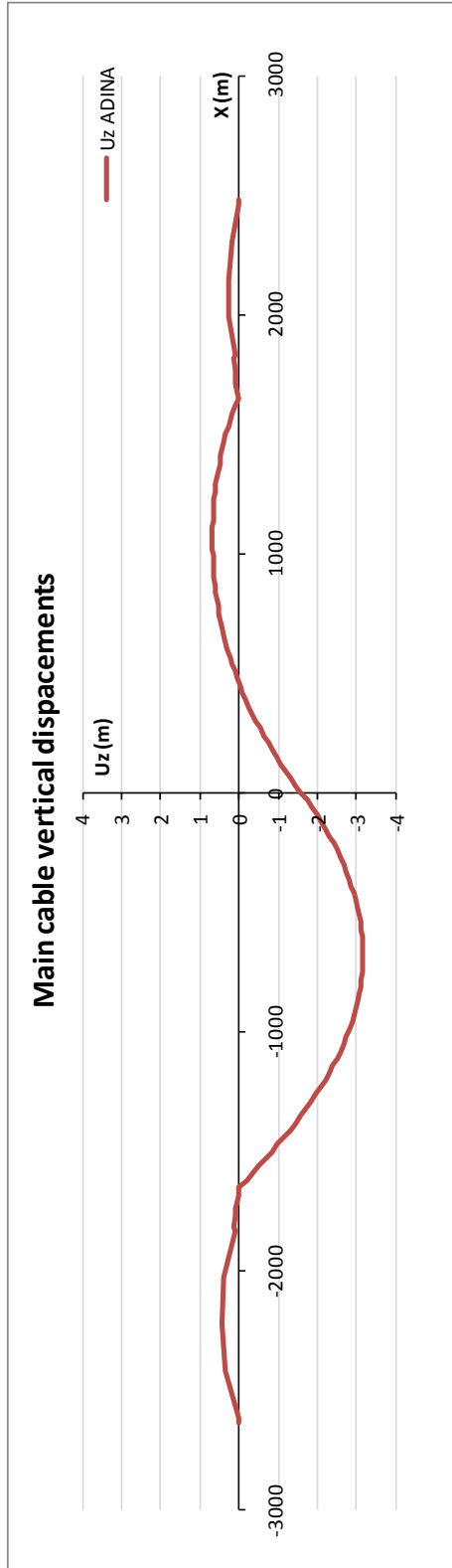
Plan view



Elevation XZ plane



Elevation YZ plane



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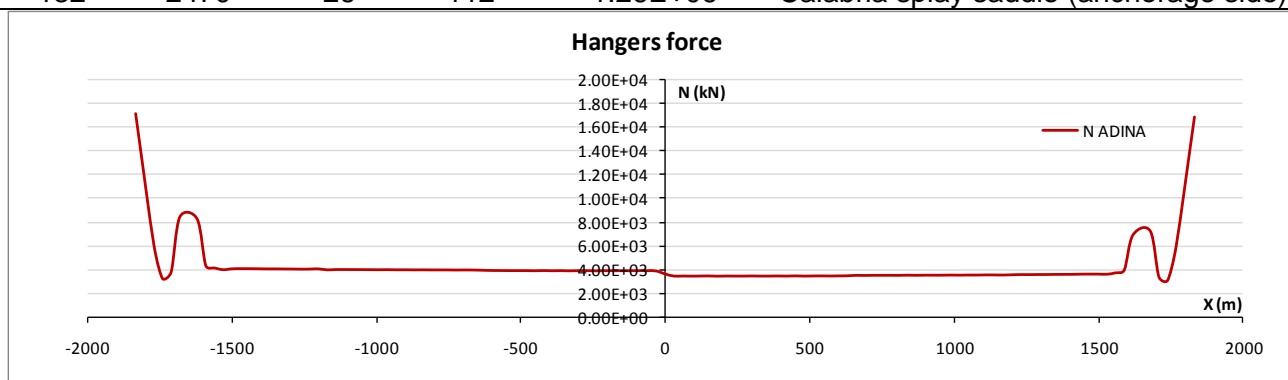
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### Cable displacements

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	0.185	0.034	-0.011	Sicilia tower - Top
70	0	-26.00	81.10	-0.414	-0.001	-1.592	Mid span
125	1650	-26.00	382.60	-0.135	0.036	-0.009	Calabria tower -Top

### Cable forces

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.27E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.27E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.33E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.30E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.22E+06		Mid span
121	1635	-26	377	1.29E+06		Top Calabria tower (main span)
122	1665	-26	377	1.31E+06		Top Calabria tower (side span)
131	2382	-26	140	1.26E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.26E+06		Calabria splay saddle (anchorage side)



### Forces at the base of the towers legs

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-2.23E+02	-1.25E+03	1.24E+06	Sicilia Tower
3747	-1650	39.23	18	6.18E+01	5.52E+02	1.23E+06	Sicilia Tower
3877	1650	-39.23	18	-7.84E+01	-7.00E+02	1.18E+06	Calabria Tower
3980	1650	39.23	18	1.68E+02	1.40E+03	1.19E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	2.30E+04	-2.29E+05	-6.62E+03	Sicilia Tower
3747	-1650	39.23	18	1.03E+04	-1.87E+05	-4.24E+03	Sicilia Tower
3877	1650	-39.23	18	-7.65E+03	1.40E+05	-3.61E+03	Calabria Tower
3980	1650	39.23	18	-2.86E+04	1.77E+05	-5.42E+03	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.71E+04
Tie-down - Calabria	1.69E+04
Splay saddle Sicilia	3.60E+05
Splay saddle Calabria	3.63E+05
Link - Sicilia tower	-2.73E+02
Link - Calabria tower	2.54E+02

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-0.008	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.008	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.007	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.030	Road box girder Calabria side
2088	1858.4	0.00	61.65	0.031	Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.031	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	-0.003	Road box girder mid span
1815	0	0	74.34	-0.007	Railway box girder mid span
1284	0	18.72	74.43	-0.011	Road box girder mid span
540	-1650	-18.70	54.45	-0.010	Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.014	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.017	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.016	Road box girder tower Calabria side
2043	1650	0	63.41	0.013	Railway box girder tower Calabria side
1513	1650	18.70	63.73	0.010	Road box girder tower Calabria side



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• **OUTPUT IBDAS**

**Load Case**

**1358**      **Reference condition + LC8**  
**C3**        **C3 = Free-Free**

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,208	0,034	-0,015
0,000	-26,000	81,100	0,435	0,024	-1,781
1650,000	-26,000	379,000	-0,179	0,031	-0,018

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1251,471
-2512,875	-26,000	81,464	1271,925
-1665,000	-26,000	376,141	1329,975
-1635,000	-26,000	377,065	1294,489
-15,000	-26,000	81,149	1217,173
1635,000	-26,000	377,068	1304,698
1665,000	-26,000	376,560	1321,584
1911,375	-26,000	285,745	1294,457
2470,065	-26,000	111,514	1251,585

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	16,859
1833,000	-26,000	179,846	16,540

**Deck Displacements**

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,004
-1858,380	0,000	51,013	0,003
-1819,750	18,722	52,026	0,003
1819,750	-18,722	62,409	0,032
1858,380	0,000	61,647	0,032
1819,750	18,722	62,409	0,031

Validazione del modello globale agli elementi finiti

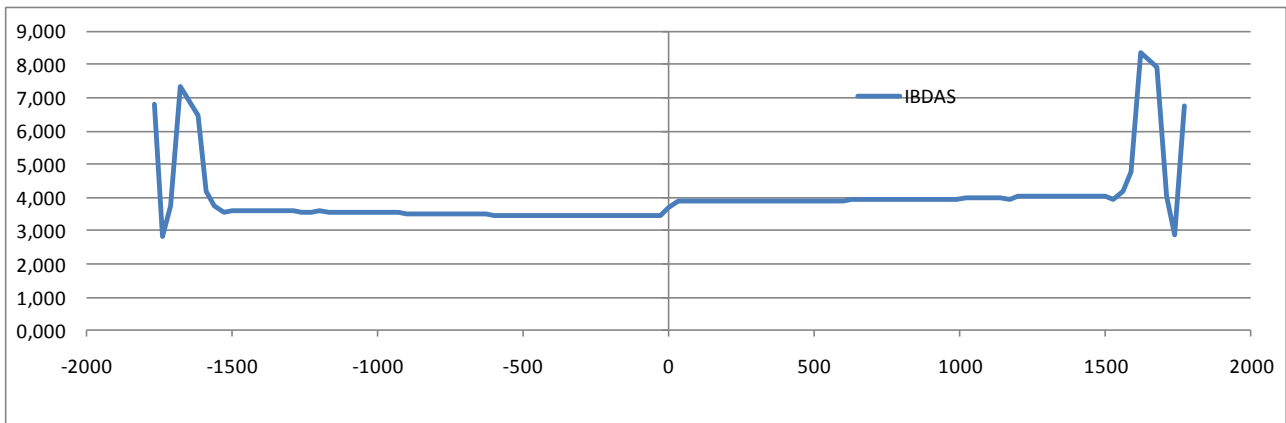
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s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,011
0,000	0,000	74,342	0,007
0,000	18,722	74,432	0,002
-1650,000	-18,704	54,450	0,012
-1650,000	0,000	54,132	0,010
-1650,000	18,704	54,450	0,009
1650,000	-18,704	63,730	-0,012
1650,000	0,000	63,412	-0,013
1650,000	18,704	63,730	-0,015

### Hanger Forces



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
		Validazione del modello globale agli elementi finiti	<i>Codice documento</i> PS0005_F0	<i>Rev</i> F0

**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC8**

**△ Cable Displacements**

Element	Coordinate (m)			△ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	0.020	0.002	-0.003	Sicilia tower - Top
70	0	-26	81.1	-0.022	0.010	0.016	Mid span
125	1650	-26	382.6	0.013	0.003	0.004	Calabria tower -Top

**△ Deck Displacements L**

Node	Coordinate (m)			△ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	-0.004		Road box girder Sicilia side
1542	-1858.4	0	51.01	-0.003		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.002		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.002		Road box girder Calabria side
2088	1858.4	0	61.65	0.003		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.003		Road box girder Calabria side

**△ Deck Displacements T**

Node	Coordinate (m)			△ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	0.000		Road box girder mid span
1815	0	0	74.34	0.000		Railway box girder mid span
1284	0	18.72	74.43	-0.001		Road box girder mid span
540	-1650	-18.7	54.45	-0.001		Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.003		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	-0.002		Road box girder tower Sicilia side
998	1650	-18.7	63.73	0.001		Road box girder tower Calabria side
2043	1650	0	63.41	0.002		Railway box girder tower Calabria side
1513	1650	18.7	63.73	0.001		Road box girder tower Calabria side

### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
45.93	-33.89	-0.23	-0.09	-0.25	-1.44	Sicilia Tower
33.65	-45.70	0.05	0.18	-0.46	1.32	Sicilia Tower
32.44	-44.52	-0.07	-0.14	0.25	-1.34	Calabria Tower
44.70	-32.75	0.17	0.08	0.45	1.45	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-15.09	10.31	-247.80	202.18	Sicilia Tower
-18.95	18.85	-205.41	242.22	Sicilia Tower
14.90	-17.94	151.06	-185.05	Calabria Tower
20.72	-11.60	187.63	-151.53	Calabria Tower

### Δ Cables Forces

Δ	Δ/RC	
5.30	0.44%	Sicilia splay saddle (anchorage side)
4.86	0.40%	Sicilia splay saddle (span side)
5.40	0.42%	Sicilia tower - Top (side span)
10.07	0.81%	Sicilia tower - Top (main span)
-0.03	0.00%	Mid span
-10.58	-0.85%	Top Calabria tower (main span)
-5.98	-0.47%	Top Calabria tower (side span)
-5.49	-0.45%	Calabria splay saddle (span side)
-4.98	-0.41%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

Δ	Δ/RC	
0.032	0.22%	Tie-down - Sicilia
-0.005	-0.03%	Tie-down - Calabria

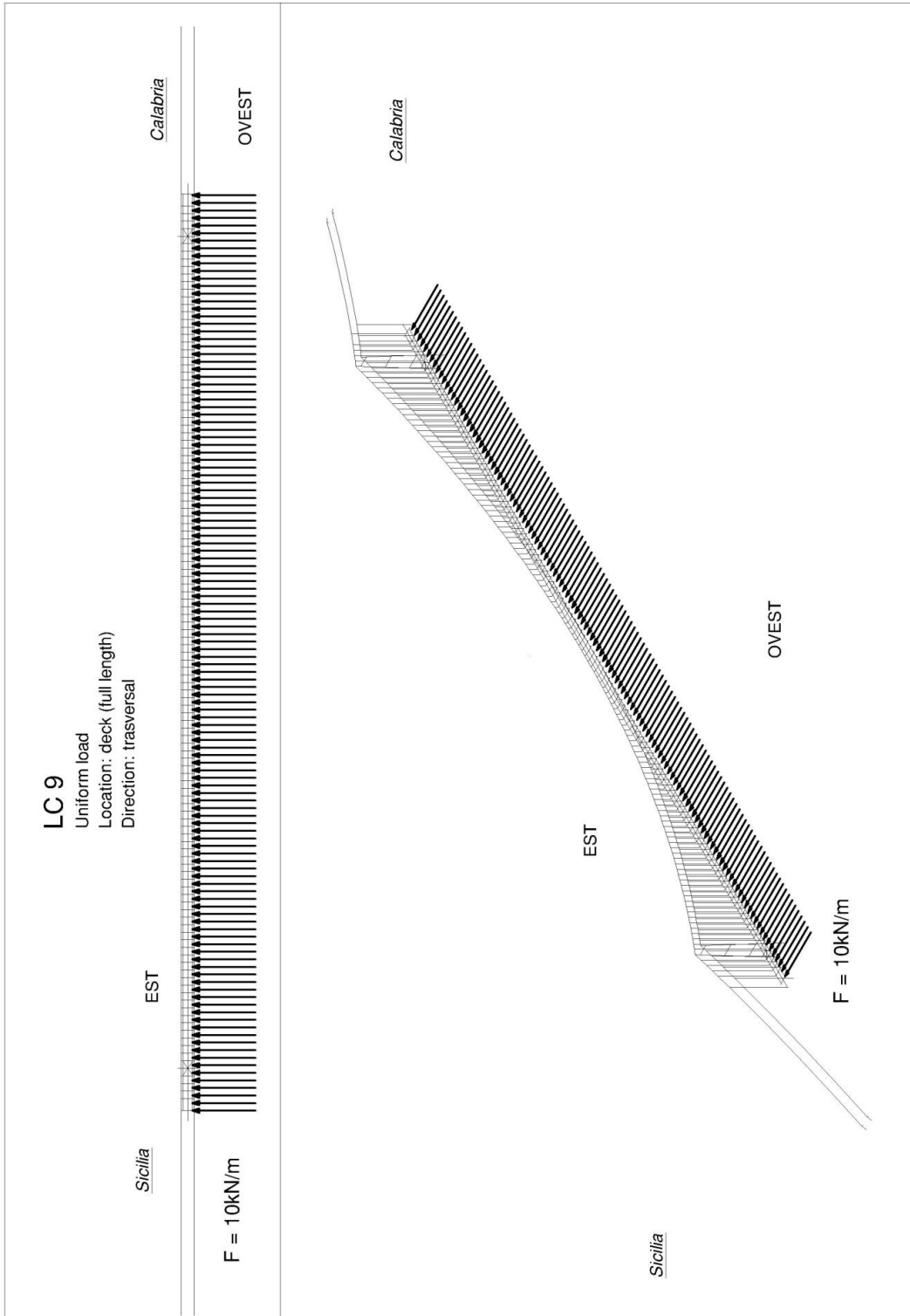
Validazione del modello globale agli  
elementi finiti

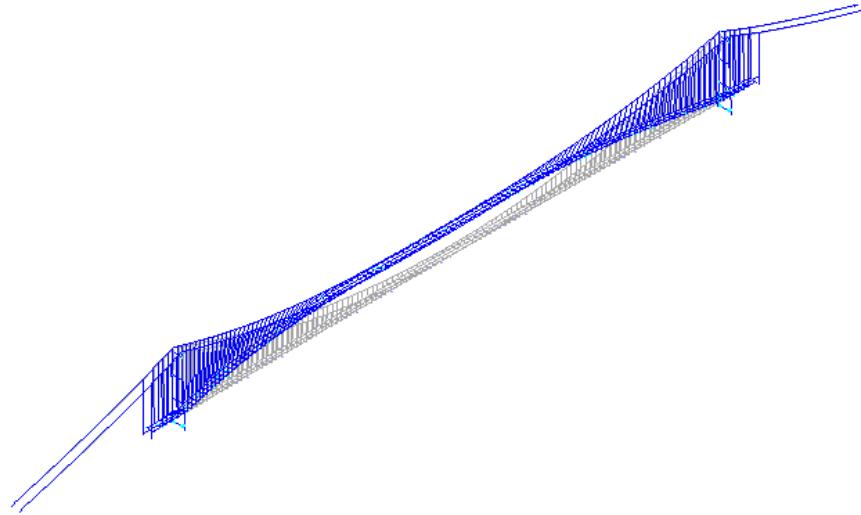
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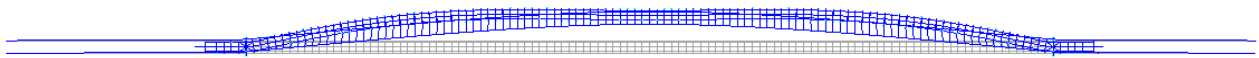
Data  
20-06-2011

**6.11 LC9 – Carico distribuito trasversalmente sull'impalcato (free-free buffers)**

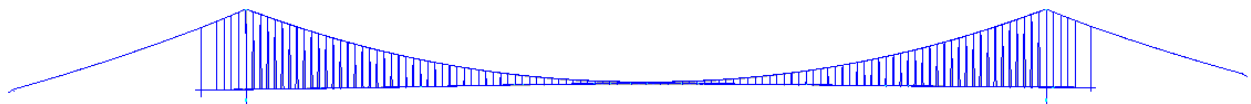




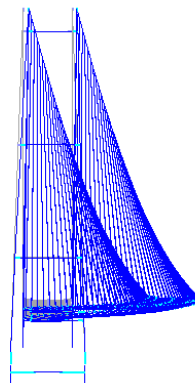
3d view



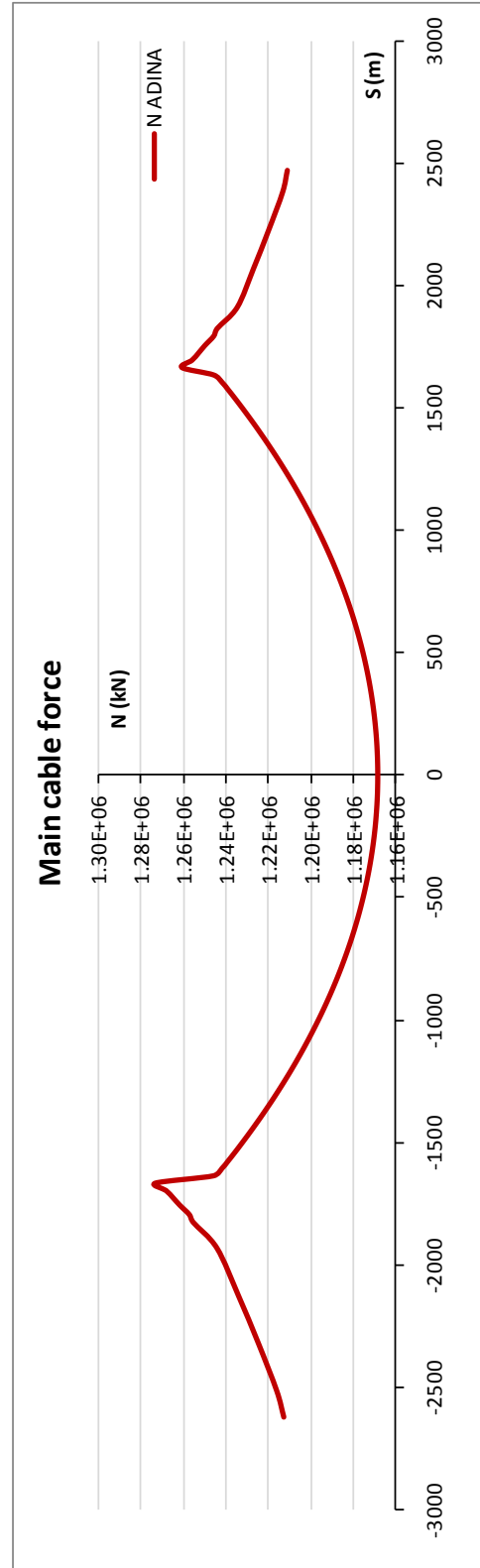
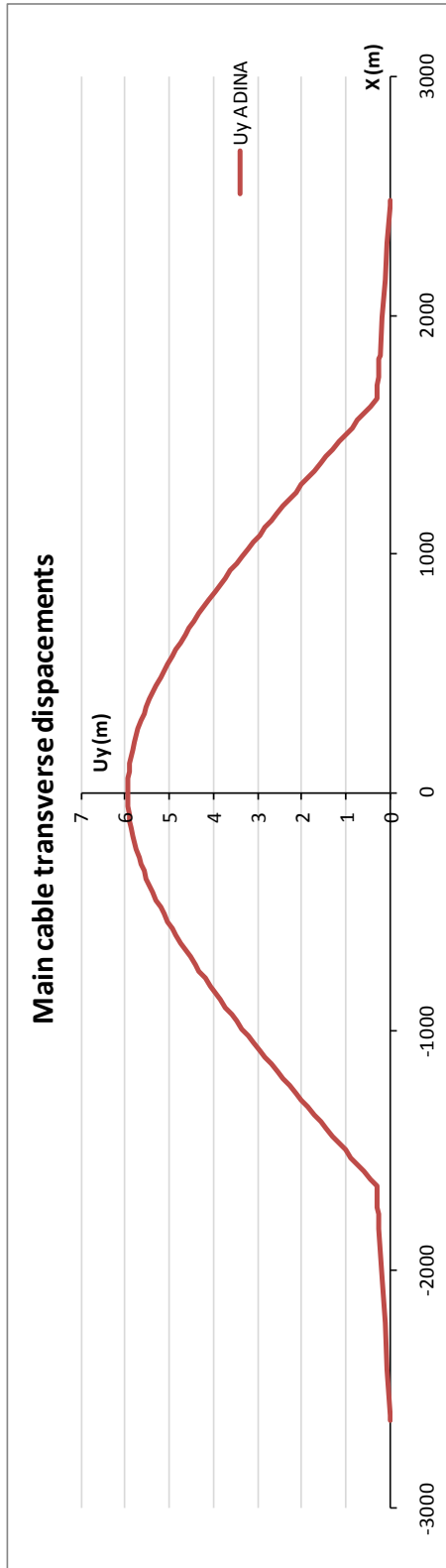
Plane view



Elevation XZ plane



Elevation YZ plane



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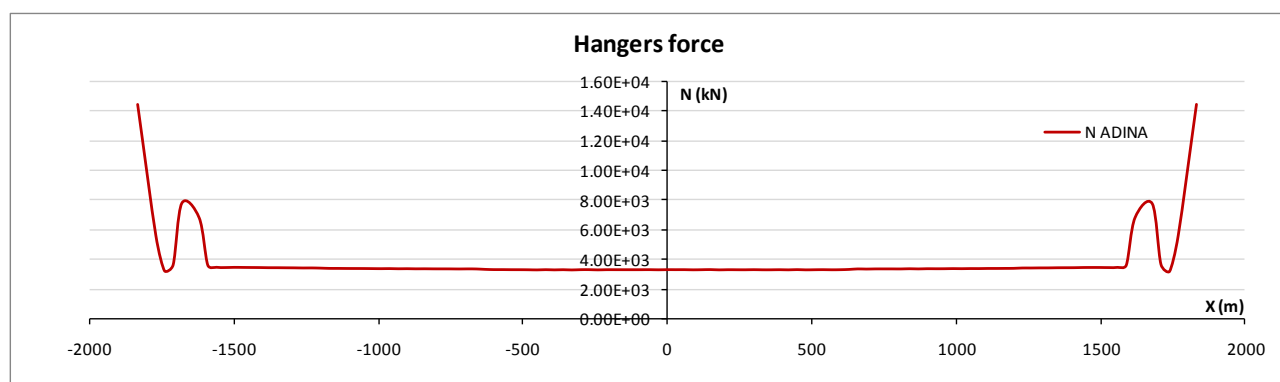
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**Cable displacement**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	-0.017	0.306	0.005	Sicilia tower - Top
70	0	-26.00	81.10	-0.004	5.948	0.149	Mid span
125	1650	-26.00	382.60	0.011	0.303	0.002	Calabria tower - Top

**Cable forces**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.21E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.22E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.27E+06		Sicilia tower – Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower – Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Calabria tower – Top (main span)
122	1665	-26	377	1.26E+06		Calabria tower – Top (side span)
131	2382	-26	140	1.21E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.21E+06		Calabria splay saddle (anchorage side)



**Forces at the base of the tower leg**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	3.90E+01	-5.44E+03	1.14E+06	Sicilia Tower
3747	-1650	39.23	18	-2.15E+01	-1.10E+04	1.24E+06	Sicilia Tower
3877	1650	-39.23	18	-2.65E+01	-5.80E+03	1.10E+06	Calabria Tower
3980	1650	39.23	18	1.83E+01	-1.04E+04	1.20E+06	Calabria Tower



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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	3.45E+05	2.19E+04	1.18E+03	Sicilia Tower
3747	-1650	39.23	18	4.98E+05	1.33E+04	9.79E+02	Sicilia Tower
3877	1650	-39.23	18	3.66E+05	-1.36E+04	-8.33E+02	Calabria Tower
3980	1650	39.23	18	5.23E+05	-7.24E+03	-7.15E+02	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.45E+04
Tie-down - Calabria	1.45E+04
Splay saddle - Sicilia	3.47E+05
Splay saddle - Calabria	3.49E+05
Link - Sicilia tower	-9.35E+03
Link - Calabria tower	-9.27E+03

### Deck displacements

Node	Coordinate (m)			Displacement L direction		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	0.004		Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-0.002		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.007		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.011		Road box girder Calabria side
2088	1858.4	0.00	61.65	-0.004		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.001		Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	6.475		Road box girder mid span
1815	0	0	74.34	6.471		Railway box girder mid span
1284	0	18.72	74.43	6.466		Road box girder mid span
540	-1650	-18.70	54.45	0.054		Road box girder tower Sicilia side
1587	-1650	0	54.13	0.009		Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	0.047		Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.059		Road box girder tower Calabria side
2043	1650	0	63.41	0.015		Railway box girder tower Calabria side
1513	1650	18.70	63.73	0.052		Road box girder tower Calabria side

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• **OUTPUT IBDAS**

**Load Case**

**1359**      Reference condition + LC9  
**C3**        C3 = Free-Free

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,030	-0,250	-0,006
0,000	-26,000	81,100	0,003	-6,119	0,000
1650,000	-26,000	379,000	-0,022	-0,247	-0,005

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1202,538
-2512,875	-26,000	81,464	1222,966
-1665,000	-26,000	376,141	1280,178
-1635,000	-26,000	377,065	1246,737
-15,000	-26,000	81,149	1168,700
1635,000	-26,000	377,068	1246,672
1665,000	-26,000	376,560	1266,743
1911,375	-26,000	285,745	1240,649
2470,065	-26,000	111,514	1197,968

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,246
1833,000	-26,000	179,846	14,174

Validazione del modello globale agli  
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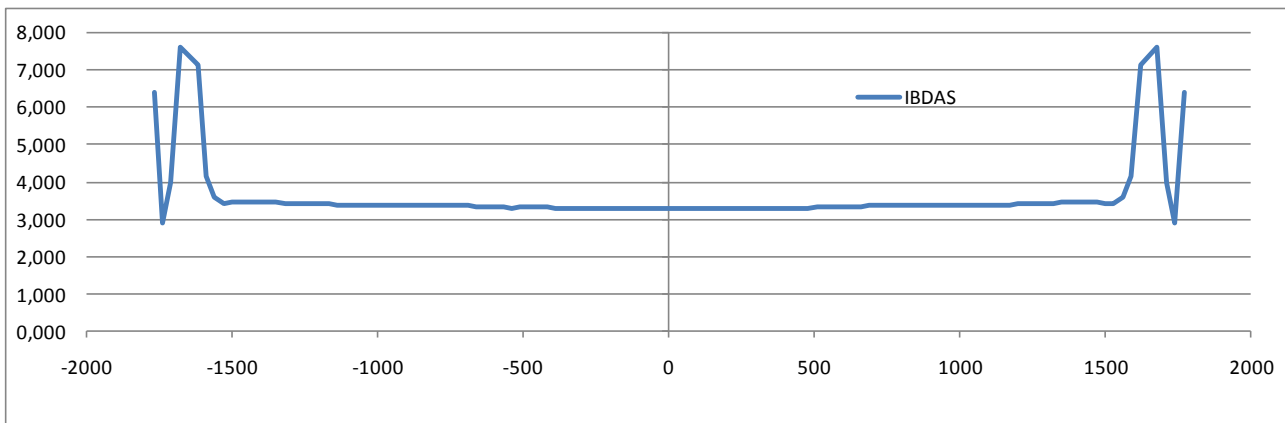
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## Deck Displacements

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,031
-1858,380	0,000	51,013	0,035
-1819,750	18,722	52,026	0,042
1819,750	-18,722	62,409	-0,024
1858,380	0,000	61,647	-0,029
1819,750	18,722	62,409	-0,036

s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	-6,648
0,000	0,000	74,342	-6,653
0,000	18,722	74,432	-6,657
-1650,000	-18,704	54,450	-0,186
-1650,000	0,000	54,132	-0,140
-1650,000	18,704	54,450	-0,190
1650,000	-18,704	63,730	-0,189
1650,000	0,000	63,412	-0,145
1650,000	18,704	63,730	-0,194

## Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC9**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	-0.004	-0.009	0.004	Sicilia tower - Top
70	0	-26	81.1	-0.002	-0.184	-0.024	Mid span
125	1650	-26	382.6	0.002	-0.008	0.002	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	-0.019		Road box girder Sicilia side
1542	-1858.4	0	51.01	-0.030		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.041		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.017		Road box girder Calabria side
2088	1858.4	0	61.65	0.029		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.040		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	-0.181		Road box girder mid span
1815	0	0	74.34	-0.182		Railway box girder mid span
1284	0	18.72	74.43	-0.183		Road box girder mid span
540	-1650	-18.7	54.45	-0.135		Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.130		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	-0.138		Road box girder tower Sicilia side
998	1650	-18.7	63.73	-0.133		Road box girder tower Calabria side
2043	1650	0	63.41	-0.128		Railway box girder tower Calabria side
1513	1650	18.7	63.73	-0.136		Road box girder tower Calabria side

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### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
-49.38	-51.40	0.03	0.02	-4.43	-6.12	Sicilia Tower
49.77	51.27	-0.03	-0.01	-12.02	-11.42	Sicilia Tower
-49.23	-51.14	-0.02	-0.01	-4.85	-6.40	Calabria Tower
49.59	51.01	0.02	0.01	-11.40	-11.01	Calabria Tower

ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-337.30	339.03	3.55	2.03	Sicilia Tower
-506.33	450.88	-5.04	-0.23	Sicilia Tower
-358.50	350.75	-2.63	-1.32	Calabria Tower
-531.13	466.25	3.72	-0.07	Calabria Tower

### Δ Cables Forces

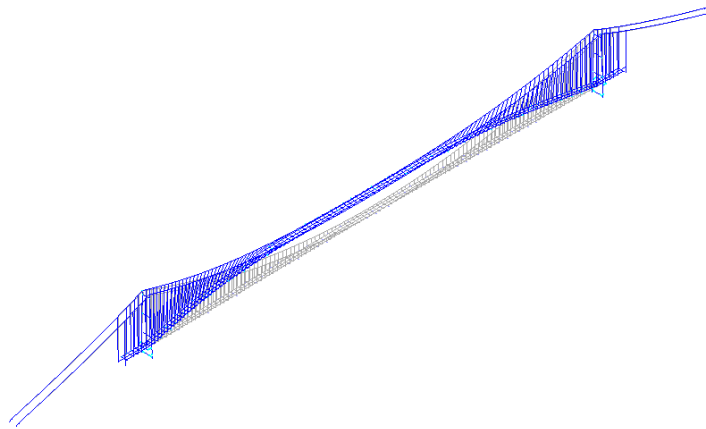
Δ	Δ/RC	
-0.47	-0.04%	Sicilia splay saddle (anchorage side)
-0.47	-0.04%	Sicilia splay saddle (span side)
-0.47	-0.04%	Sicilia tower - Top (side span)
-0.91	-0.07%	Sicilia tower - Top (main span)
-0.73	-0.06%	Mid span
-0.90	-0.07%	Top Calabria tower (main span)
-0.50	-0.04%	Top Calabria tower (side span)
-0.49	-0.04%	Calabria splay saddle (span side)
-0.48	-0.04%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

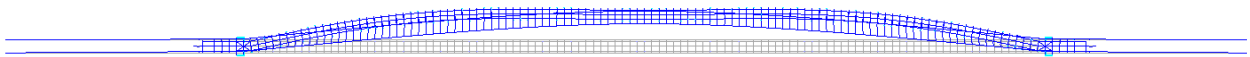
Δ	Δ/RC	
-0.005	-0.04%	Tie-down - Sicilia
-0.005	-0.04%	Tie-down - Calabria

## 6.12 LC9 – Carico trasversale uniformemente distribuito sull'impalcato (fixed-fixed buffers)

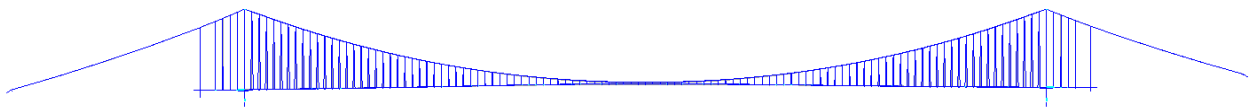
- OUTPUT ADINA



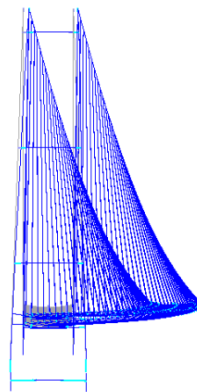
3d view



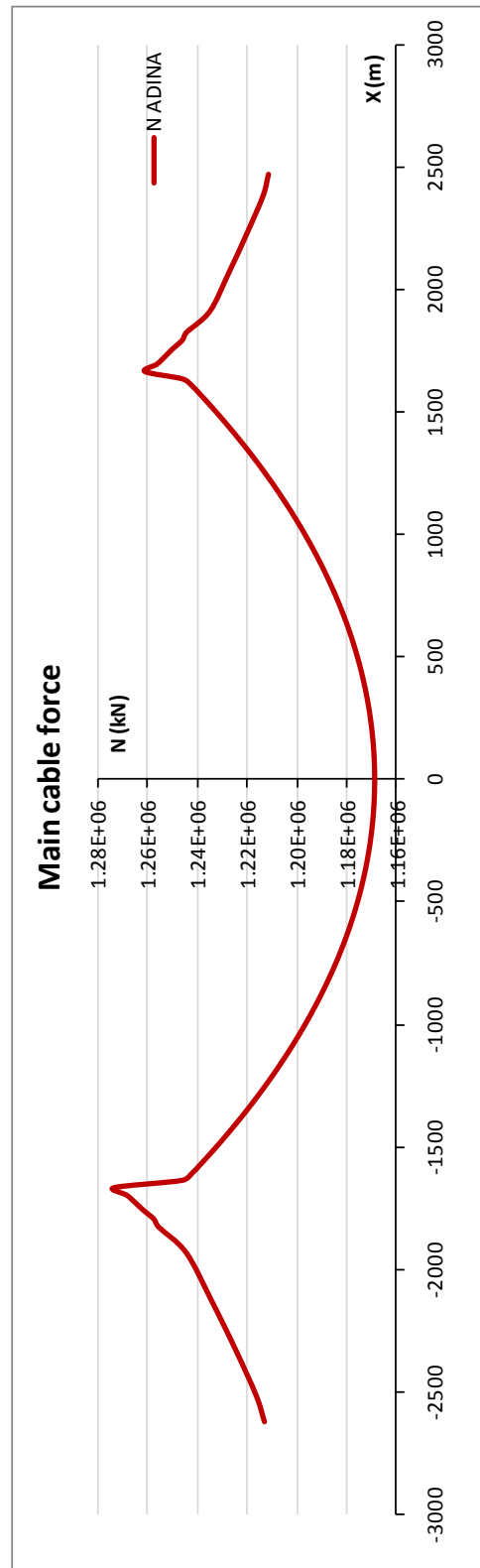
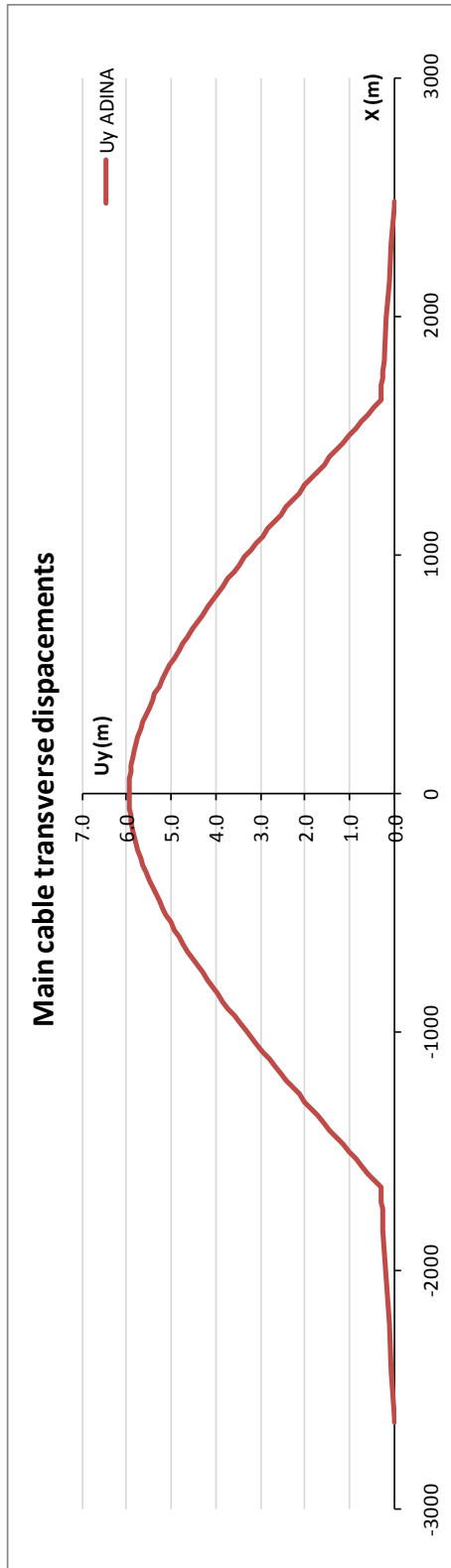
Plane view



Elevation XZ plane



Elevation YZ plane

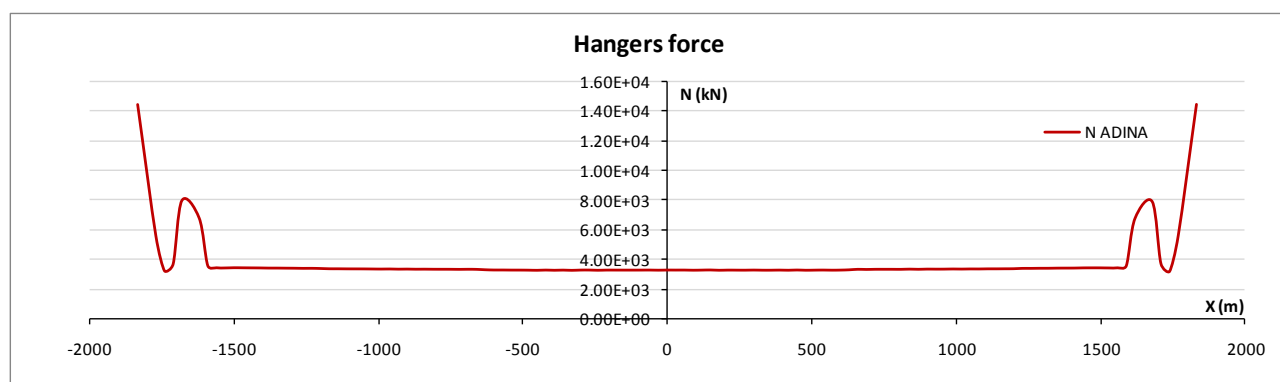


**Cable displacement**

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	-0.016	0.303	0.005	Sicilia tower - Top
70	0	-26.00	81.10	-0.004	5.938	0.148	Mid span
125	1650	-26.00	382.60	0.011	0.300	0.002	Calabria tower -Top

**Cable forces**

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.21E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.22E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.27E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.25E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.17E+06		Mid span
121	1635	-26	377	1.25E+06		Top Calabria tower (main span)
122	1665	-26	377	1.26E+06		Top Calabria tower (side span)
131	2382	-26	140	1.21E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.21E+06		Calabria splay saddle (anchorage side)



**Forces at the base of the tower leg**

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-5.06E+03	-6.61E+03	1.14E+06	Sicilia Tower
3747	-1650	39.23	18	5.07E+03	-7.73E+03	1.24E+06	Sicilia Tower
3877	1650	-39.23	18	4.79E+03	-6.63E+03	1.10E+06	Calabria Tower
3980	1650	39.23	18	-4.74E+03	-7.55E+03	1.20E+06	Calabria Tower



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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	3.68E+05	-1.32E+05	6.83E+04	Sicilia Tower
3747	-1650	39.23	18	4.05E+05	1.64E+05	-4.60E+04	Sicilia Tower
3877	1650	-39.23	18	3.79E+05	1.65E+05	-5.19E+04	Calabria Tower
3980	1650	39.23	18	4.26E+05	-1.82E+05	4.91E+04	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.45E+04
Tie-down - Calabria	1.45E+04
Splay saddle Sicilia	3.47E+05
Splay saddle Calabria	3.49E+05
Link - Sicilia tower	-8.57E+03
Link - Calabria tower	-8.65E+03

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	0.004	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	0.000	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.002	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.005	Road box girder Calabria side
2088	1858.4	0.00	61.65	-0.001	Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.002	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	6.464	Road box girder mid span
1815	0	0	74.34	6.460	Railway box girder mid span
1284	0	18.72	74.43	6.456	Road box girder mid span
540	-1650	-18.70	54.45	0.048	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.004	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	0.042	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.052	Road box girder tower Calabria side
2043	1650	0	63.41	0.009	Railway box girder tower Calabria side
1513	1650	18.70	63.73	0.047	Road box girder tower Calabria side

• **OUTPUT IBDAS**

**Load Case**

**1359**      Reference condition + LC9  
**C1**        C1 = Fixed-Fixed

**Cable Displacements**

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,031	-0,249	-0,006
0,000	-26,000	81,100	0,003	-6,106	-0,005
1650,000	-26,000	379,000	-0,022	-0,246	-0,005

**Cable Forces**

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1202,654
-2512,875	-26,000	81,464	1223,082
-1665,000	-26,000	376,141	1280,286
-1635,000	-26,000	377,065	1246,812
-15,000	-26,000	81,149	1168,806
1635,000	-26,000	377,068	1246,752
1665,000	-26,000	376,560	1266,871
1911,375	-26,000	285,745	1240,781
2470,065	-26,000	111,514	1198,099

**Special Elements**

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	14,253
1833,000	-26,000	179,846	14,179

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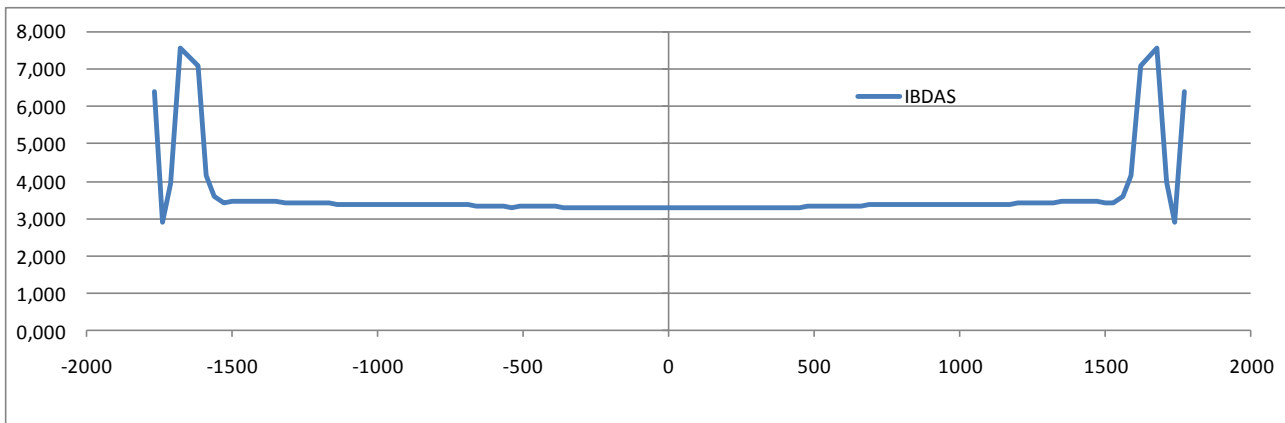
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## Deck Displacements

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	0,006
-1858,380	0,000	51,013	0,010
-1819,750	18,722	52,026	0,017
1819,750	-18,722	62,409	0,000
1858,380	0,000	61,647	-0,005
1819,750	18,722	62,409	-0,012

s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	-6,635
0,000	0,000	74,342	-6,639
0,000	18,722	74,432	-6,643
-1650,000	-18,704	54,450	-0,186
-1650,000	0,000	54,132	-0,140
-1650,000	18,704	54,450	-0,190
1650,000	-18,704	63,730	-0,189
1650,000	0,000	63,412	-0,144
1650,000	18,704	63,730	-0,193

## Hanger Forces



**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC9 (fixed-fixed)**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	U <sub>x</sub>	U <sub>y</sub>	U <sub>z</sub>	
15	-1650	-26	382.6	-0.003	-0.012	0.004	Sicilia tower - Top
70	0	-26	81.1	-0.001	-0.181	-0.020	Mid span
125	1650	-26	382.6	0.003	-0.010	0.002	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	0.006		Road box girder Sicilia side
1542	-1858.4	0	51.01	-0.002		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.010		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-0.001		Road box girder Calabria side
2088	1858.4	0	61.65	0.009		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.017		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	-0.179		Road box girder mid span
1815	0	0	74.34	-0.179		Railway box girder mid span
1284	0	18.72	74.43	-0.179		Road box girder mid span
540	-1650	-18.7	54.45	-0.141		Road box girder tower Sicilia side
1587	-1650	0	54.13	-0.135		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	-0.142		Road box girder tower Sicilia side
998	1650	-18.7	63.73	-0.140		Road box girder tower Calabria side
2043	1650	0	63.41	-0.133		Railway box girder tower Calabria side
1513	1650	18.7	63.73	-0.140		Road box girder tower Calabria side

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### Towers Forces

LC3	LC3 (IBDAS)	LC1	LC1 (IBDAS)	LC1	LC1 (IBDAS)	
Fz (MN)	Fz (MN)	Fx (MN)	Fx (MN)	Fy (MN)	Fy (MN)	
-48.78	-51.32	-5.07	2.03	-5.61	-6.11	Sicilia Tower
49.94	51.11	5.06	2.00	-8.74	-11.43	Sicilia Tower
-48.55	-51.07	4.79	-2.01	-5.68	-6.39	Calabria Tower
49.66	50.84	-4.73	-1.99	-8.51	-11.01	Calabria Tower

LC2	LC1 (IBDAS)	LC1	LC1 (IBDAS)	
Mx (MN)	Mx (MN)	My (MN)	My (MN)	
-360.31	338.44	-150.68	63.05	Sicilia Tower
-413.78	450.68	145.32	61.67	Sicilia Tower
-372.14	350.24	176.17	-78.20	Calabria Tower
-434.12	466.15	-171.20	-77.23	Calabria Tower

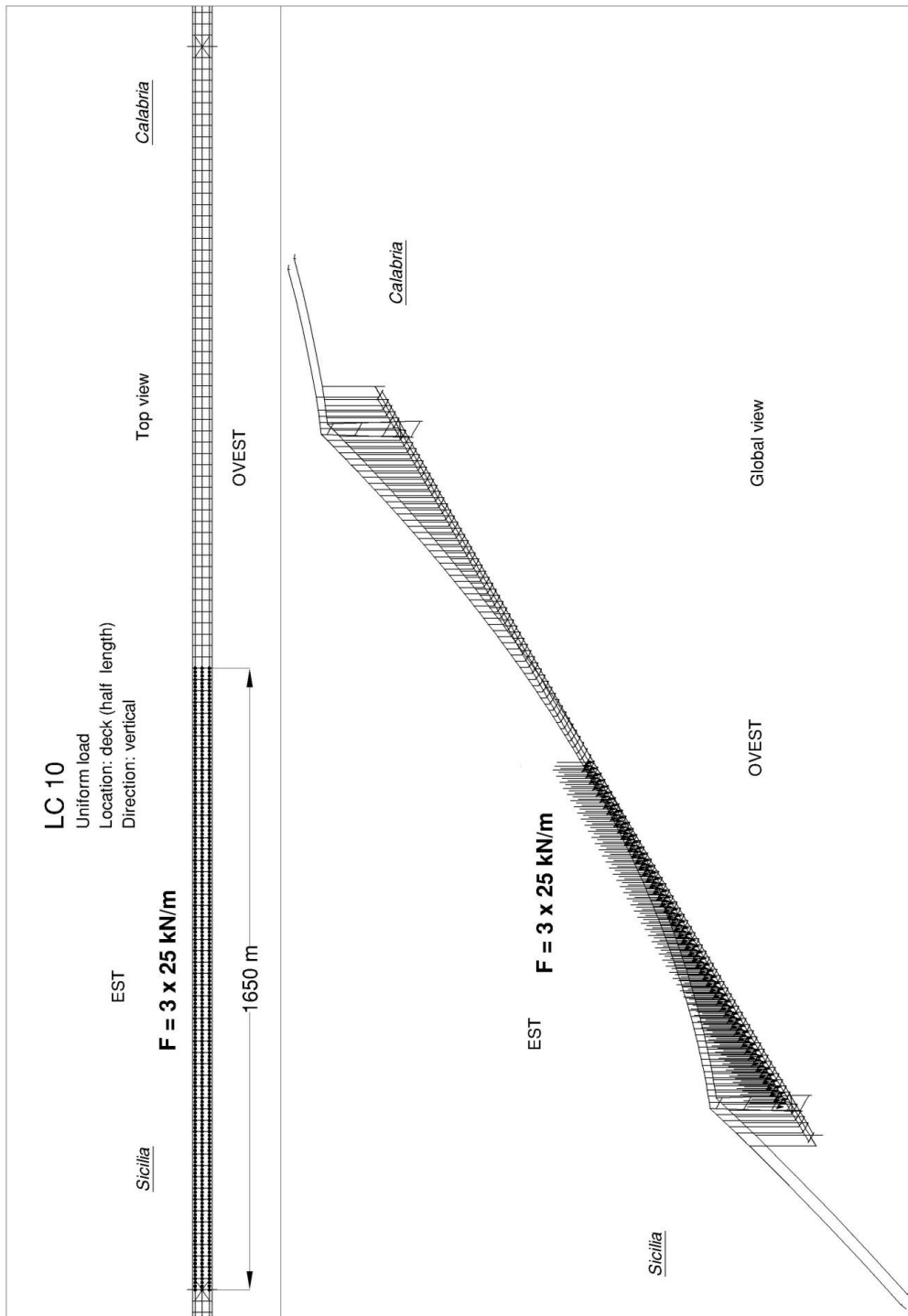
### Δ Cables Forces

Δ	Δ/RC	
-0.51	-0.04%	Sicilia splay saddle (anchorage side)
-0.51	-0.04%	Sicilia splay saddle (span side)
-0.41	-0.03%	Sicilia tower - Top (side span)
-1.00	-0.08%	Sicilia tower - Top (main span)
-0.85	-0.07%	Mid span
-1.04	-0.08%	Top Calabria tower (main span)
-0.43	-0.03%	Top Calabria tower (side span)
-0.50	-0.04%	Calabria splay saddle (span side)
-0.50	-0.04%	Calabria splay saddle (anchorage side)

### Δ Tie-down

Δ	Δ/RC	
-0.052	-0.36%	Tie-down - Sicilia
-0.045	-0.31%	Tie-down - Calabria

**6.13 LC10 – Carico uniformemente distribuito su metà impalcato (buffer free-free)**

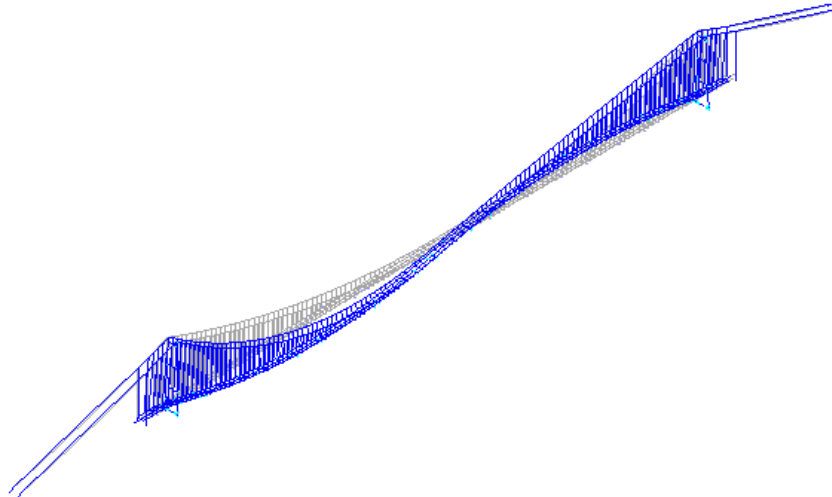


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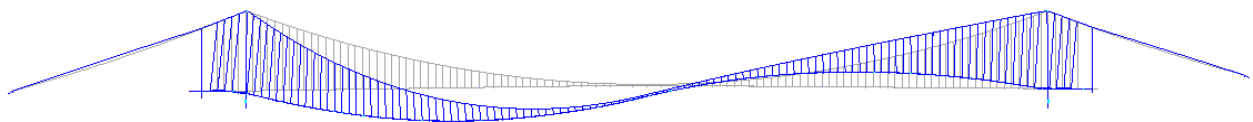
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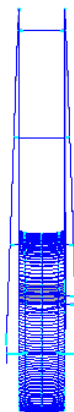
3d view



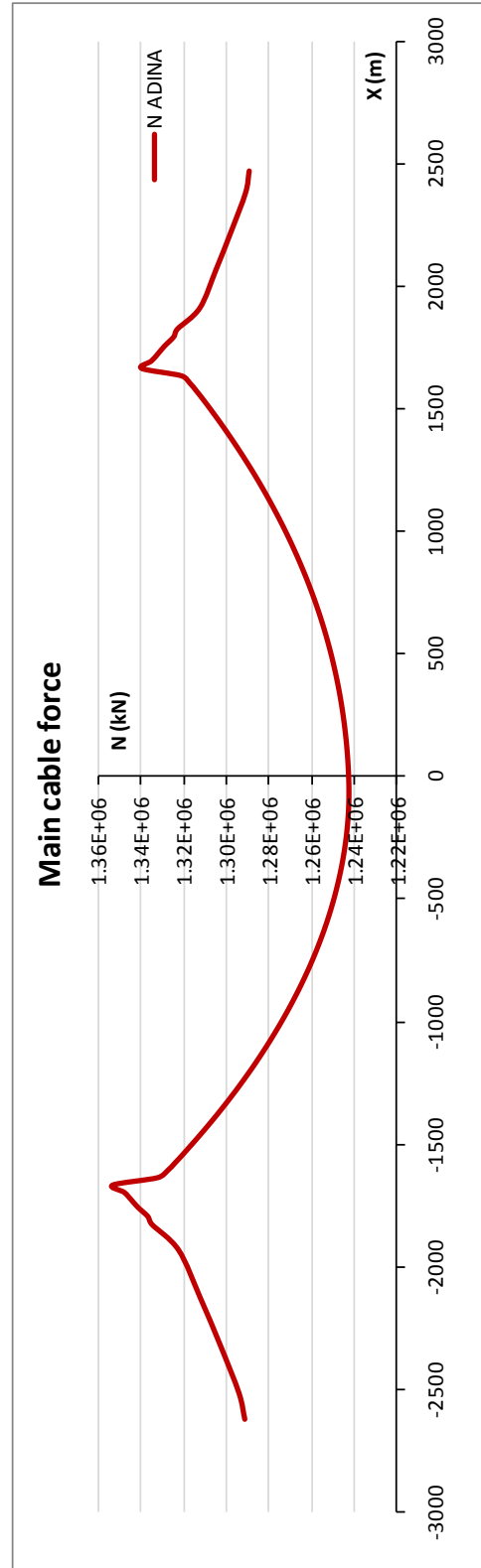
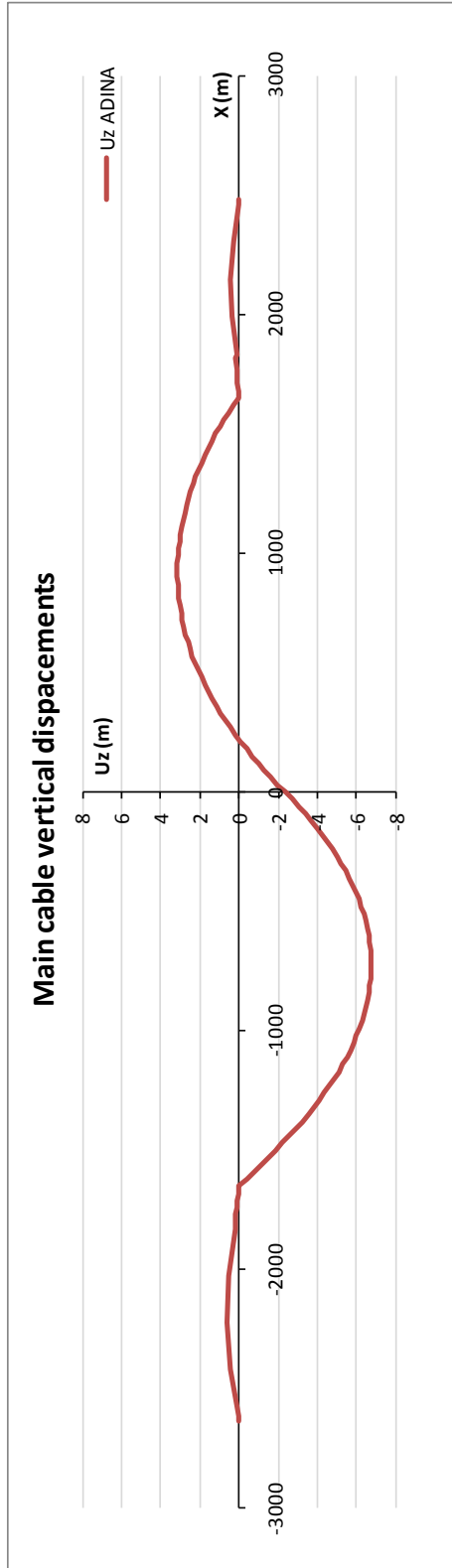
Plan view



Elevation XZ plane



Elevation YZ plane





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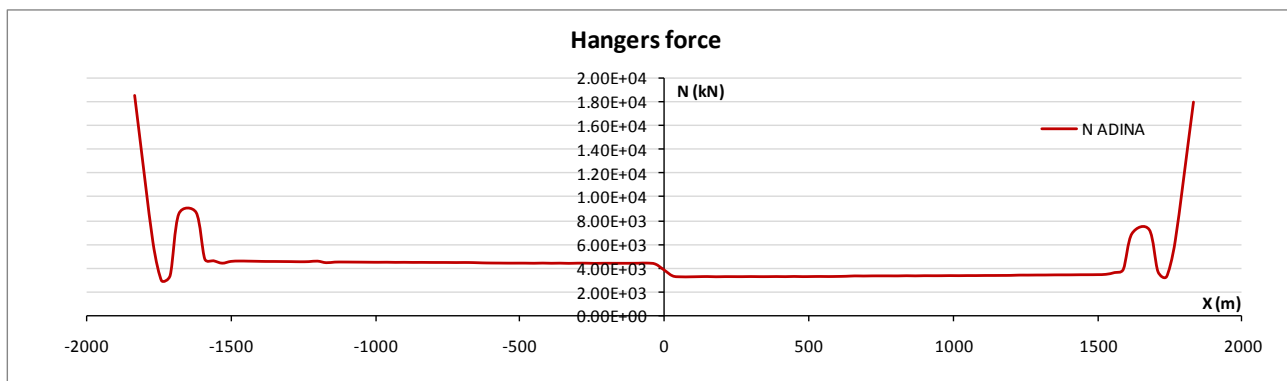
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### Cable displacements

Element	Coordinate (m)			Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26.00	382.60	0.274	0.038	-0.021	Sicilia tower - Top
70	0	-26.00	81.10	-1.170	0.007	-2.342	Mid span
125	1650	-26.00	382.60	-0.218	0.035	-0.012	Calabria tower -Top

### Cable forces

Element	Coordinate (m)			Force (kN)		
	X	Y	Z	N		
1	-2620	-26	47	1.29E+06		Sicilia splay saddle (anchorage side)
2	-2513	-26	81	1.29E+06		Sicilia splay saddle (span side)
11	-1665	-26	376	1.35E+06		Sicilia tower - Top (side span)
12	-1635	-26	377	1.33E+06		Sicilia tower - Top (main span)
66	-15	-26	81	1.24E+06		Mid span
121	1635	-26	377	1.32E+06		Top Calabria tower (main span)
122	1665	-26	377	1.34E+06		Top Calabria tower (side span)
131	2382	-26	140	1.29E+06		Calabria splay saddle (span side)
132	2470	-26	112	1.29E+06		Calabria splay saddle (anchorage side)



### Forces at the base of the tower leg

	Coordinate (m)			Force (kN)			
	X	Y	Z	F <sub>x</sub>	F <sub>y</sub>	F <sub>z</sub>	
3644	-1650	-39.23	18	-9.42E+01	-1.02E+03	1.27E+06	Sicilia Tower
3747	-1650	39.23	18	-9.40E+01	1.02E+03	1.27E+06	Sicilia Tower
3877	1650	-39.23	18	6.60E+01	-9.60E+02	1.19E+06	Calabria Tower
3980	1650	39.23	18	6.61E+01	9.65E+02	1.19E+06	Calabria Tower

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	Coordinate (m)			Moment (kNm)			
	X	Y	Z	M <sub>x</sub>	M <sub>y</sub>	M <sub>z</sub>	
3644	-1650	-39.23	18	8.91E+03	-3.22E+05	-1.85E+03	Sicilia Tower
3747	-1650	39.23	18	-9.65E+03	-3.22E+05	1.85E+03	Sicilia Tower
3877	1650	-39.23	18	7.83E+03	2.41E+05	1.38E+03	Calabria Tower
3980	1650	39.23	18	-8.50E+03	2.41E+05	-1.39E+03	Calabria Tower

### Forces in special elements

Element	N (kN)
Tie-down - Sicilia	1.85E+04
Tie-down - Calabria	1.80E+04
Splay saddle Sicilia	3.66E+05
Splay saddle Calabria	3.69E+05
Link - Sicilia tower	-1.62E+00
Link - Calabria tower	-1.09E+00

### Deck displacements

Node	Coordinate (m)			Displacement L direction	
	X	Y	Z	U <sub>x</sub> (m)	
512	-1817.8	-18.72	52.06	-1.308	Road box girder Sicilia side
1542	-1858.4	0.00	51.01	-1.308	Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-1.308	Road box girder Sicilia side
1026	1817.8	-18.72	62.43	-1.237	Road box girder Calabria side
2088	1858.4	0.00	61.65	-1.237	Railway box girder Calabria side
1541	1817.8	18.72	62.43	-1.237	Road box girder Calabria side

Node	Coordinate (m)			Displacement T direction	
	X	Y	Z	U <sub>y</sub> (m)	
769	0	-18.72	74.43	0.005	Road box girder mid span
1815	0	0	74.34	0.000	Railway box girder mid span
1284	0	18.72	74.43	-0.005	Road box girder mid span
540	-1650	-18.70	54.45	0.004	Road box girder tower Sicilia side
1587	-1650	0	54.13	0.000	Railway box girder tower Sicilia side
1055	-1650	18.70	54.45	-0.004	Road box girder tower Sicilia side
998	1650	-18.70	63.73	0.003	Road box girder tower Calabria side
2043	1650	0	63.41	0.000	Railway box girder tower Calabria side
1513	1650	18.70	63.73	-0.003	Road box girder tower Calabria side

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- **OUPUT IBDAS**

### Load Case

**1360**      Reference condition + LC10  
**C3**        C3 = Free-Free

### Cable Displacements

s[m]	y[m]	z[m]	us[m]	uy[m]	uz[m]
-1650,000	-26,000	379,000	0,314	0,034	-0,028
0,000	-26,000	81,100	-1,165	0,008	-2,513
1650,000	-26,000	379,000	-0,244	0,032	-0,017

### Cable Forces

s[m]	y[m]	z[m]	Ns[MN]
-2620,090	-26,000	46,948	1280,108
-2512,875	-26,000	81,464	1300,577
-1665,000	-26,000	376,141	1359,533
-1635,000	-26,000	377,065	1332,201
-15,000	-26,000	81,149	1242,245
1635,000	-26,000	377,068	1320,963
1665,000	-26,000	376,560	1345,111
1911,375	-26,000	285,745	1317,899
2470,065	-26,000	111,514	1274,948

### Special Elements

s[m]	y[m]	z[m]	Ns[MN]
-1833,000	-26,000	165,089	18,237
1833,000	-26,000	179,846	17,625

### Deck Displacements

s[m]	y[m]	z[m]	us[m]
-1819,750	-18,722	52,026	-1,254
-1858,380	0,000	51,013	-1,257
-1819,750	18,722	52,026	-1,258
1819,750	-18,722	62,409	-1,271

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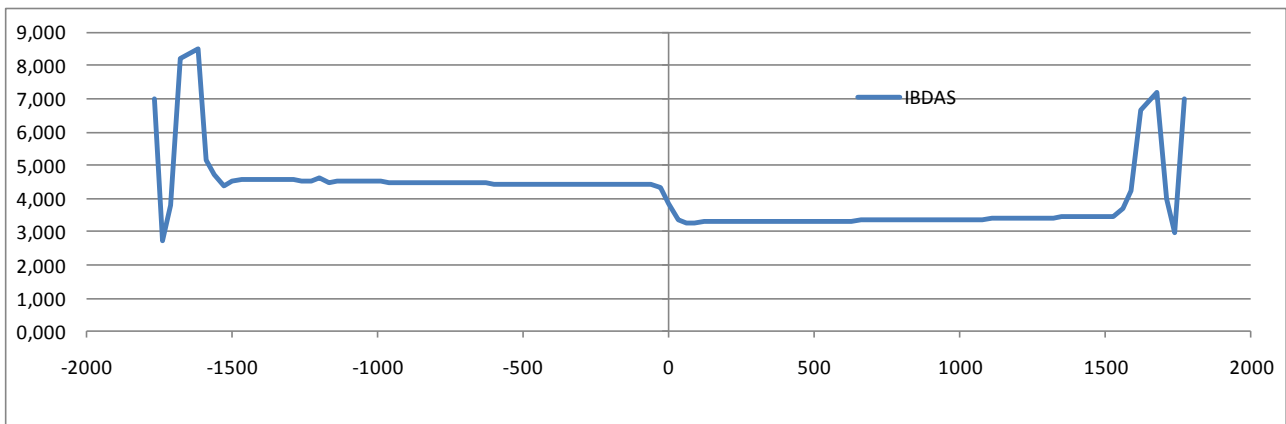
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1858,380	0,000	61,647	-1,268
1819,750	18,722	62,409	-1,267

s[m]	y[m]	z[m]	uy[m]
0,000	-18,722	74,432	0,006
0,000	0,000	74,342	0,001
0,000	18,722	74,432	-0,004
-1650,000	-18,704	54,450	0,016
-1650,000	0,000	54,132	0,016
-1650,000	18,704	54,450	0,014
1650,000	-18,704	63,730	0,017
1650,000	0,000	63,412	0,016
1650,000	18,704	63,730	0,014

### Hanger Forces



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**CONFRONTI TRA MODELLO ADINA E MODELLO IBIDAS**

**LC10**

**Δ Cable Displacements**

Element	Coordinate (m)			Δ Displacements (m)			
	X	Y	Z	Ux	Uy	Uz	
15	-1650	-26	382.6	0.004	0.006	0.000	Sicilia tower - Top
70	0	-26	81.1	0.001	0.003	-0.002	Mid span
125	1650	-26	382.6	-0.004	0.003	0.000	Calabria tower -Top

**Δ Deck Displacements L**

Node	Coordinate (m)			Δ Deck Displacements L		
	X	Y	Z	U <sub>x</sub> (m)		
512	-1817.8	-18.72	52.06	-0.046		Road box girder Sicilia side
1542	-1858.4	0	51.01	-0.043		Railway box girder Sicilia side
1027	-1817.8	18.72	52.06	-0.042		Road box girder Sicilia side
1026	1817.8	-18.72	62.43	0.037		Road box girder Calabria side
2088	1858.4	0	61.65	0.036		Railway box girder Calabria side
1541	1817.8	18.72	62.43	0.033		Road box girder Calabria side

**Δ Deck Displacements T**

Node	Coordinate (m)			Δ Deck Displacements T		
	X	Y	Z	U <sub>y</sub> (m)		
769	0	-18.72	74.43	0.003		Road box girder mid span
1815	0	0	74.34	0.001		Railway box girder mid span
1284	0	18.72	74.43	-0.001		Road box girder mid span
540	-1650	-18.7	54.45	0.017		Road box girder tower Sicilia side
1587	-1650	0	54.13	0.017		Railway box girder tower Sicilia side
1055	-1650	18.7	54.45	0.016		Road box girder tower Sicilia side
998	1650	-18.7	63.73	0.018		Road box girder tower Calabria side
2043	1650	0	63.41	0.018		Railway box girder tower Calabria side
1513	1650	18.7	63.73	0.017		Road box girder tower Calabria side

### Towers Forces

ADINA Fz (MN)	IBDAS Fz (MN)	ADINA Fx (MN)	IBDAS Fx (MN)	ADINA Fy (MN)	IBDAS Fy (MN)	
75.75	-75.61	-0.10	0.03	-0.02	-2.69	Sicilia Tower
75.75	-75.71	-0.10	0.03	0.02	2.66	Sicilia Tower
42.21	-42.12	0.07	-0.04	-0.01	-1.49	Calabria Tower
42.22	-42.20	0.07	-0.04	0.01	1.46	Calabria Tower



ADINA Mx (MN)	IBDAS Mx (MN)	ADINA My (MN)	IBDAS My (MN)	
-1.00	-6.55	-340.81	332.86	Sicilia Tower
1.01	7.19	-340.81	332.82	Sicilia Tower
-0.57	-4.21	252.15	-250.90	Calabria Tower
0.57	5.19	252.16	-250.92	Calabria Tower

### Δ Cables Forces

Δ	Δ/RC	
0.60	0.05%	Sicilia splay saddle (anchorage side)
-0.03	0.00%	Sicilia splay saddle (span side)
0.02	0.00%	Sicilia tower - Top (side span)
-0.12	-0.01%	Sicilia tower - Top (main span)
0.01	0.00%	Mid span
-0.02	0.00%	Top Calabria tower (main span)
0.00	0.00%	Top Calabria tower (side span)
-0.01	0.00%	Calabria splay saddle (span side)
0.78	0.06%	Calabria splay saddle (anchorage side)

### Δ Tie-down Forces

Δ	Δ/RC	
0.028	0.19%	Tie-down - Sicilia
0.008	0.06%	Tie-down - Calabria

		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
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## 7 Analisi modale

I risultati dell'analisi modale sono riportati rispettivamente in forma tabellare e grafica dapprima per il modello ADINA e quindi per il modello IBDAS.

Per il modello ADINA sono riportate 2 tabelle. Le tabelle sono ordinate per numero di modo, il numero totale di modi considerati è pari a 460. La prima tabella elenca: la frequenza, la massa modale percentuale distinta per le tre direzioni X, Y, Z ed il coefficiente di partecipazione modale anch'esso distinto per direzione. La seconda tabella elenca la massa modale accumulata sempre distinta per le tre direzioni.

Per il modello IBDAS è riportata una unica tabella ordinata per numero di modo, il numero totale di modi considerati è pari a 360. La tabella elenca: la frequenza, la massa modale percentuale distinta per le tre direzioni X, Y, Z e la massa modale accumulata anch'essa distinta per direzione.

I grafici vengono presentati a coppie. Ciascuna coppia riporta nell'ordine i risultati ADINA e quelli IBDAS modo per modo. Vengono confrontati i primi 20 modi del ponte. Ciascun grafico riporta la vista 3D e le tre viste secondo i piani coordinati delle deformate modali. A parte sono indicati anche il numero del modo, la frequenza e le masse modali.

### 7.1 Parametri modali ADINA

MODE	FREQUENCY (Hz)	MASS(X)	PERCENT			PARTICIPATION		
			MASS(Y)	MASS(Z)	X-MODAL	Y-MODAL	Z-MODAL	
1	<b>0.0313</b>	-	18.03	-	0	391	0	
2	<b>0.0585</b>	-	0.00	-	0	1	0	
3	<b>0.0593</b>	5.29	-	0.00	-212	0	1	
4	<b>0.0809</b>	0.02	-	5.36	-12	0	213	
5	<b>0.0833</b>	-	0.00	-	0	3	0	
6	<b>0.0849</b>	6.63	-	0.00	-237	0	-6	
7	<b>0.0865</b>	-	0.44	-	0	-61	0	
8	<b>0.0923</b>	-	-	-	0	0	0	

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9	<b>0.0998</b>	-	-	-	0	0	0
10	<b>0.1012</b>	-	0.00	-	0	5	0
11	<b>0.1018</b>	-	0.04	-	0	19	0
12	<b>0.1076</b>	0.00	-	<b>9.07</b>	1	0	277
13	<b>0.1119</b>	-	<b>4.69</b>	-	0	199	0
14	<b>0.1273</b>	0.17	-	0.00	38	0	3
15	<b>0.1327</b>	-	<b>2.29</b>	-	0	139	0
16	<b>0.1344</b>	-	0.00	-	0	6	0
17	<b>0.1420</b>	-	<b>1.36</b>	-	0	108	0
18	<b>0.1431</b>	-	-	-	0	0	0
19	<b>0.1546</b>	-	<b>3.36</b>	-	0	169	0
20	<b>0.1566</b>	-	-	-	0	0	0
21	<b>0.1604</b>	0.00	-	0.72	1	0	-78
22	<b>0.1634</b>	-	0.01	-	0	-11	0
23	<b>0.1705</b>	-	-	0.00	0	0	0
24	<b>0.1745</b>	0.00	-	<b>4.35</b>	-1	0	192
25	<b>0.1755</b>	-	0.02	-	0	14	0
26	<b>0.1766</b>	-	0.00	-	0	-1	0
27	<b>0.1809</b>	-	-	-	0	0	0
28	<b>0.1826</b>	-	0.21	-	0	42	0
29	<b>0.1908</b>	0.07	-	0.01	-24	0	11
30	<b>0.1942</b>	-	0.83	-	0	-84	0
31	<b>0.2064</b>	-	0.04	-	0	18	0
32	<b>0.2126</b>	0.01	-	<b>3.67</b>	-10	0	176
33	<b>0.2147</b>	-	0.00	-	0	-3	0
34	<b>0.2230</b>	0.00	-	0.91	-2	0	88
35	<b>0.2264</b>	-	-	0.00	0	0	0
36	<b>0.2270</b>	-	0.44	-	0	61	0
37	<b>0.2352</b>	-	0.46	-	0	-62	0
38	<b>0.2447</b>	-	0.00	-	0	2	0
39	<b>0.2535</b>	0.07	-	0.00	25	0	2
40	<b>0.2567</b>	-	0.89	-	0	87	0
41	<b>0.2622</b>	-	-	-	0	0	0
42	<b>0.2656</b>	-	0.26	-	0	47	0
43	<b>0.2827</b>	-	0.06	-	0	23	0
44	<b>0.2849</b>	0.00	-	0.33	-1	0	53
45	<b>0.2868</b>	-	0.00	-	0	0	0
46	<b>0.2968</b>	0.00	-	-	0	0	0
47	<b>0.3045</b>	-	0.00	-	0	4	0
48	<b>0.3045</b>	-	0.07	-	0	24	0



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49	<b>0.3154</b>	0.08	-	0.00	-26	0	-1
50	<b>0.3215</b>	-	0.84	-	0	-84	0
51	<b>0.3268</b>	-	0.00	-	0	6	0
52	<b>0.3442</b>	-	0.19	-	0	-40	0
53	<b>0.3444</b>	0.00	-	-	0	0	0
54	<b>0.3463</b>	0.00	-	0.22	-1	0	43
55	<b>0.3493</b>	-	0.41	-	0	59	0
56	<b>0.3507</b>	0.00	-	-	0	0	0
57	<b>0.3549</b>	0.04	-	0.07	-18	0	24
58	<b>0.3581</b>	-	0.00	-	0	-1	0
59	<b>0.3679</b>	-	0.48	-	0	63	0
60	<b>0.3687</b>	-	0.03	-	0	-15	0
61	<b>0.3761</b>	0.24	-	0.00	-45	0	-1
62	<b>0.3861</b>	-	-	-	0	0	0
63	<b>0.3929</b>	-	0.29	-	0	-50	0
64	<b>0.4064</b>	0.00	-	0.19	1	0	-41
65	<b>0.4084</b>	-	0.00	-	0	0	0
66	<b>0.4105</b>	-	-	-	0	0	0
67	<b>0.4190</b>	20.97	-	0.00	422	0	-6
68	<b>0.4255</b>	1.79	-	0.31	-123	0	-51
69	<b>0.4273</b>	0.00	-	0.00	5	0	1
70	<b>0.4323</b>	-	0.00	-	0	3	0
71	<b>0.4365</b>	0.85	-	0.00	85	0	-3
72	<b>0.4382</b>	-	0.00	-	0	1	0
73	<b>0.4510</b>	-	0.00	-	0	-2	0
74	<b>0.4596</b>	-	0.00	-	0	0	0
75	<b>0.4614</b>	0.00	-	0.00	1	0	1
76	<b>0.4646</b>	0.01	-	0.34	-9	0	54
77	<b>0.4660</b>	-	0.01	-	0	-7	0
78	<b>0.4692</b>	-	-	-	0	0	0
79	<b>0.4699</b>	-	0.23	-	0	44	0
80	<b>0.4749</b>	0.22	-	0.66	-43	0	75
81	<b>0.4758</b>	0.12	-	0.08	-32	0	26
82	<b>0.4780</b>	0.06	-	0.38	-22	0	57
83	<b>0.4890</b>	-	0.07	-	0	-24	0
84	<b>0.4935</b>	0.02	0.00	0.08	-14	0	-27
85	<b>0.4935</b>	0.00	0.00	0.01	-6	1	-11
86	<b>0.5063</b>	0.13	-	0.82	34	0	83
87	<b>0.5110</b>	0.00	-	0.00	-1	0	0
88	<b>0.5112</b>	-	0.00	-	0	1	0

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89	<b>0.5227</b>	0.00	-	0.01	-5	0	8
90	<b>0.5254</b>	0.03	-	0.00	-17	0	4
91	<b>0.5327</b>	-	0.00	-	0	-1	0
92	<b>0.5435</b>	-	0.02	-	0	-12	0
93	<b>0.5440</b>	0.00	-	0.00	0	0	0
94	<b>0.5501</b>	0.00	-	0.00	3	0	4
95	<b>0.5524</b>	-	0.11	-	0	-31	0
96	<b>0.5530</b>	-	0.01	-	0	8	0
97	<b>0.5532</b>	-	-	-	0	0	0
98	<b>0.5632</b>	-	0.00	-	0	-2	0
99	<b>0.5752</b>	-	0.00	-	0	1	0
100	<b>0.5761</b>	0.00	-	0.04	-1	0	-19
101	<b>0.5931</b>	-	0.00	-	0	3	0
102	<b>0.5954</b>	0.00	-	-	0	0	0
103	<b>0.5987</b>	0.01	-	0.00	11	0	-1
104	<b>0.6060</b>	-	0.00	-	0	-5	0
105	<b>0.6082</b>	0.01	-	0.00	-9	0	4
106	<b>0.6186</b>	-	0.00	-	0	2	0
107	<b>0.6268</b>	0.00	-	0.05	5	0	-20
108	<b>0.6284</b>	-	0.01	-	0	-10	0
109	<b>0.6306</b>	-	0.38	-	0	57	0
110	<b>0.6373</b>	-	0.05	-	0	21	0
111	<b>0.6378</b>	-	-	-	0	0	0
112	<b>0.6402</b>	-	-	-	0	0	0
113	<b>0.6412</b>	-	0.14	-	0	35	0
114	<b>0.6452</b>	-	0.00	-	0	2	0
115	<b>0.6485</b>	0.00	-	0.00	5	0	5
116	<b>0.6601</b>	-	0.00	-	0	0	0
117	<b>0.6692</b>	0.00	-	0.02	3	0	-12
118	<b>0.6735</b>	-	0.01	-	0	7	0
119	<b>0.6804</b>	-	-	-	0	0	0
120	<b>0.6894</b>	0.01	-	0.00	8	0	6
121	<b>0.6986</b>	-	0.00	-	0	-2	0
122	<b>0.7004</b>	-	0.00	-	0	2	0
123	<b>0.7079</b>	-	0.44	-	0	-61	0
124	<b>0.7103</b>	0.00	-	0.00	3	0	1
125	<b>0.7164</b>	-	0.02	-	0	-12	0
126	<b>0.7232</b>	-	-	-	0	0	0
127	<b>0.7315</b>	0.01	-	0.02	9	0	11
128	<b>0.7354</b>	-	0.06	-	0	23	0

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129	<b>0.7422</b>	-	0.01	-	0	-9	0
130	<b>0.7479</b>	0.00	-	0.03	5	0	17
131	<b>0.7530</b>	-	0.57	-	0	69	0
132	<b>0.7638</b>	0.00	-	0.01	-4	0	-7
133	<b>0.7652</b>	-	0.00	-	0	-5	0
134	<b>0.7660</b>	-	-	-	0	0	0
135	<b>0.7707</b>	-	-	-	0	0	0
136	<b>0.7775</b>	-	0.21	-	0	-42	0
137	<b>0.7837</b>	-	0.00	-	0	-4	0
138	<b>0.7859</b>	0.00	-	0.00	2	0	-5
139	<b>0.7986</b>	-	0.06	-	0	23	0
140	<b>0.8049</b>	-	0.04	-	0	-19	0
141	<b>0.8092</b>	-	-	-	0	0	0
142	<b>0.8093</b>	0.00	-	0.00	-2	0	3
143	<b>0.8255</b>	-	0.00	-	0	-2	0
144	<b>0.8276</b>	-	0.20	-	0	-41	0
145	<b>0.8329</b>	0.00	-	0.00	3	0	-2
146	<b>0.8525</b>	-	-	-	0	0	0
147	<b>0.8568</b>	0.00	-	0.00	2	0	-5
148	<b>0.8616</b>	-	0.00	-	0	3	0
149	<b>0.8668</b>	-	0.00	-	0	-5	0
150	<b>0.8730</b>	0.02	-	0.07	13	0	24
151	<b>0.8810</b>	0.01	0.00	0.00	-8	0	-6
152	<b>0.8812</b>	0.00	0.01	-	0	8	0
153	<b>0.8960</b>	-	-	-	0	0	0
154	<b>0.9025</b>	-	0.07	-	0	24	0
155	<b>0.9033</b>	0.00	-	0.00	-2	0	5
156	<b>0.9092</b>	-	0.00	-	0	0	0
157	<b>0.9259</b>	0.00	-	0.00	6	0	4
158	<b>0.9387</b>	0.00	-	-	0	0	0
159	<b>0.9419</b>	-	0.00	-	0	0	0
160	<b>0.9429</b>	-	0.05	-	0	-22	0
161	<b>0.9467</b>	-	0.08	-	0	26	0
162	<b>0.9484</b>	0.00	0.00	0.00	2	-1	-1
163	<b>0.9561</b>	0.00	-	0.00	-2	0	-2
164	<b>0.9591</b>	-	0.38	-	0	-57	0
165	<b>0.9716</b>	0.00	-	0.00	6	0	6
166	<b>0.9763</b>	-	0.05	-	0	20	0
167	<b>0.9770</b>	-	0.01	-	0	-9	0
168	<b>0.9834</b>	-	0.00	-	0	-1	0

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169	<b>0.9836</b>	-	-	-	0	0	0
170	<b>0.9949</b>	-	0.15	-	0	35	0
171	<b>0.9952</b>	0.00	0.00	0.00	-1	-1	-3
172	<b>1.0030</b>	-	0.00	-	0	4	0
173	<b>1.0128</b>	0.00	-	-	0	0	0
174	<b>1.0183</b>	0.00	-	0.00	-6	0	-6
175	<b>1.0274</b>	-	0.02	-	0	14	0
176	<b>1.0279</b>	-	0.00	-	0	0	0
177	<b>1.0297</b>	-	0.15	-	0	-36	0
178	<b>1.0381</b>	-	0.00	-	0	-2	0
179	<b>1.0427</b>	0.00	-	0.00	0	0	6
180	<b>1.0526</b>	-	0.07	-	0	-24	0
181	<b>1.0659</b>	0.00	0.00	0.00	-5	0	-4
182	<b>1.0694</b>	-	0.04	-	0	-19	0
183	<b>1.0721</b>	-	-	-	0	0	0
184	<b>1.0753</b>	-	0.25	-	0	-46	0
185	<b>1.0911</b>	-	0.01	0.00	0	-8	0
186	<b>1.0913</b>	-	0.00	0.01	0	0	-7
187	<b>1.1099</b>	0.00	-	-	-4	0	0
188	<b>1.1136</b>	-	0.50	-	0	65	0
189	<b>1.1156</b>	-	-	0.00	0	0	4
190	<b>1.1166</b>	-	-	-	0	0	0
191	<b>1.1195</b>	-	0.03	-	0	16	0
192	<b>1.1294</b>	0.01	0.00	0.00	8	1	-4
193	<b>1.1295</b>	0.00	0.06	-	0	22	0
194	<b>1.1422</b>	0.00	-	0.01	2	0	-7
195	<b>1.1614</b>	-	-	-	0	0	0
196	<b>1.1643</b>	-	0.07	-	0	24	0
197	<b>1.1664</b>	-	0.02	-	0	-14	0
198	<b>1.1672</b>	0.00	0.00	-	2	1	0
199	<b>1.1792</b>	-	0.07	-	0	-25	0
200	<b>1.1936</b>	0.01	-	0.01	-7	0	8
201	<b>1.2020</b>	0.03	-	0.06	16	0	-22
202	<b>1.2064</b>	-	-	-	0	0	0
203	<b>1.2104</b>	-	0.02	-	0	13	0
204	<b>1.2107</b>	-	0.01	-	0	8	0
205	<b>1.2185</b>	0.00	-	0.01	2	0	-11
206	<b>1.2222</b>	0.10	-	0.01	29	0	-8
207	<b>1.2336</b>	-	1.78	-	0	-123	0
208	<b>1.2374</b>	0.45	-	0.06	62	0	-23

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209	<b>1.2516</b>	-	-	-	0	0	0
210	<b>1.2527</b>	-	0.00	-	0	-5	0
211	<b>1.2532</b>	0.00	0.00	0.00	-2	0	2
212	<b>1.2583</b>	-	0.15	-	0	-36	0
213	<b>1.2620</b>	0.01	-	0.01	10	0	-10
214	<b>1.2759</b>	0.00	-	0.00	6	0	-4
215	<b>1.2857</b>	0.01	-	0.00	9	0	-5
216	<b>1.2870</b>	-	0.19	-	0	-40	0
217	<b>1.2940</b>	-	0.07	-	0	-24	0
218	<b>1.2971</b>	-	-	-	0	0	0
219	<b>1.3080</b>	-	0.11	-	0	-30	0
220	<b>1.3142</b>	0.00	0.00	0.02	3	0	12
221	<b>1.3323</b>	0.00	0.00	0.00	0	-5	0
222	<b>1.3349</b>	0.00	0.21	0.00	-1	42	-1
223	<b>1.3361</b>	0.04	0.00	0.04	19	4	19
224	<b>1.3379</b>	0.00	0.48	0.00	0	-64	0
225	<b>1.3429</b>	-	-	0.00	0	0	0
226	<b>1.3467</b>	0.01	-	0.04	8	0	18
227	<b>1.3594</b>	0.31	0.00	0.05	-52	1	20
228	<b>1.3621</b>	0.00	1.20	-	0	101	0
229	<b>1.3694</b>	-	0.61	0.00	0	72	0
230	<b>1.3774</b>	0.68	0.00	0.11	-76	1	31
231	<b>1.3824</b>	0.00	0.00	0.00	-1	2	0
232	<b>1.3851</b>	1.63	0.00	0.10	-118	0	28
233	<b>1.3889</b>	0.00	-	0.00	-1	0	0
234	<b>1.4012</b>	0.00	0.02	-	0	14	0
235	<b>1.4058</b>	0.81	0.00	0.01	83	-2	-8
236	<b>1.4081</b>	0.00	0.44	0.00	-3	-61	-1
237	<b>1.4091</b>	0.02	0.00	0.04	11	3	-18
238	<b>1.4120</b>	0.85	0.00	0.00	-85	1	4
239	<b>1.4242</b>	0.05	-	0.10	-21	0	28
240	<b>1.4244</b>	-	0.02	0.00	0	12	0
241	<b>1.4290</b>	1.55	-	0.31	115	0	-51
242	<b>1.4351</b>	0.00	0.00	0.00	1	2	-1
243	<b>1.4352</b>	0.00	0.01	0.00	1	7	0
244	<b>1.4378</b>	1.61	0.00	0.16	117	0	-37
245	<b>1.4503</b>	0.00	0.49	-	-1	-64	0
246	<b>1.4578</b>	0.00	0.10	0.00	2	-29	1
247	<b>1.4579</b>	0.21	0.00	0.09	-42	-1	-27
248	<b>1.4742</b>	0.00	0.01	0.00	-1	10	-1

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249	<b>1.4817</b>	0.00	-	0.00	2	0	4
250	<b>1.4839</b>	1.50	-	5.17	-113	0	-209
251	<b>1.4908</b>	0.00	0.03	0.00	-1	16	-2
252	<b>1.4940</b>	0.80	-	3.53	-82	0	-173
253	<b>1.5011</b>	0.00	0.00	0.00	0	-6	1
254	<b>1.5125</b>	0.94	-	4.02	89	0	185
255	<b>1.5132</b>	0.98	-	18.98	-91	0	-401
256	<b>1.5285</b>	0.00	-	0.00	1	0	-3
257	<b>1.5302</b>	0.10	0.00	0.02	28	1	12
258	<b>1.5322</b>	0.00	0.17	-	1	-38	0
259	<b>1.5352</b>	-	0.13	-	0	33	0
260	<b>1.5439</b>	-	0.00	-	0	-1	0
261	<b>1.5533</b>	11.35	-	3.12	310	0	-163
262	<b>1.5631</b>	0.43	-	0.96	-61	0	90
263	<b>1.5755</b>	0.00	-	0.00	0	0	1
264	<b>1.5780</b>	0.47	-	0.88	-63	0	86
265	<b>1.5805</b>	-	0.16	-	0	-37	0
266	<b>1.5869</b>	-	0.01	-	0	-9	0
267	<b>1.5909</b>	0.13	-	0.01	-33	0	-10
268	<b>1.5965</b>	-	0.03	-	0	17	0
269	<b>1.6052</b>	-	0.00	-	0	5	0
270	<b>1.6058</b>	0.02	-	0.02	14	0	13
271	<b>1.6213</b>	-	0.34	-	0	-54	0
272	<b>1.6219</b>	0.00	0.00	0.00	1	-2	0
273	<b>1.6253</b>	-	6.46	-	0	234	0
274	<b>1.6303</b>	-	9.52	-	0	-284	0
275	<b>1.6326</b>	-	0.06	-	0	-23	0
276	<b>1.6345</b>	0.00	0.00	0.00	1	3	1
277	<b>1.6394</b>	0.03	0.00	0.03	16	0	17
278	<b>1.6541</b>	-	0.70	-	0	-77	0
279	<b>1.6555</b>	0.15	0.00	0.03	36	0	16
280	<b>1.6681</b>	0.00	0.01	-	0	-8	0
281	<b>1.6686</b>	0.00	-	0.00	-3	0	-1
282	<b>1.6703</b>	0.20	-	0.01	41	0	9
283	<b>1.6717</b>	-	0.28	-	0	-49	0
284	<b>1.6765</b>	0.00	-	-	-1	0	0
285	<b>1.6799</b>	0.01	-	0.01	9	0	10
286	<b>1.6918</b>	-	0.06	-	0	-23	0
287	<b>1.6975</b>	-	3.03	-	0	-160	0
288	<b>1.7065</b>	-	0.04	-	0	18	0

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289	<b>1.7138</b>	-	-	0.04	0	0	-19
290	<b>1.7167</b>	-	0.68	-	0	-76	0
291	<b>1.7195</b>	-	-	-	0	0	0
292	<b>1.7281</b>	-	0.05	-	0	-20	0
293	<b>1.7305</b>	-	0.07	-	0	24	0
294	<b>1.7356</b>	0.04	-	0.04	19	0	19
295	<b>1.7442</b>	-	0.00	-	0	6	0
296	<b>1.7487</b>	0.00	-	0.05	3	0	-20
297	<b>1.7549</b>	0.14	-	0.08	34	0	-26
298	<b>1.7593</b>	-	0.01	-	0	7	0
299	<b>1.7676</b>	0.01	-	0.00	9	0	1
300	<b>1.7680</b>	5.11	-	0.09	208	0	27
301	<b>1.7722</b>	-	0.05	-	0	-20	0
302	<b>1.7737</b>	-	0.12	-	0	-32	0
303	<b>1.7745</b>	-	0.03	-	0	15	0
304	<b>1.7865</b>	0.05	-	0.02	20	0	-13
305	<b>1.7936</b>	-	0.00	-	0	2	0
306	<b>1.8051</b>	-	0.01	-	0	-9	0
307	<b>1.8129</b>	0.59	-	0.02	-71	0	13
308	<b>1.8162</b>	0.00	-	-	0	0	0
309	<b>1.8213</b>	-	0.00	-	0	5	0
310	<b>1.8238</b>	0.01	-	0.01	9	0	-10
311	<b>1.8273</b>	-	0.00	-	0	2	0
312	<b>1.8318</b>	0.76	-	0.30	80	0	-50
313	<b>1.8347</b>	-	0.02	-	0	-14	0
314	<b>1.8517</b>	-	-	0.00	0	0	-3
315	<b>1.8588</b>	0.00	0.00	-	0	5	0
316	<b>1.8603</b>	-	0.03	0.00	0	-15	0
317	<b>1.8638</b>	0.10	-	0.17	28	0	-38
318	<b>1.8651</b>	0.00	-	0.00	1	0	0
319	<b>1.8698</b>	-	0.05	-	0	20	0
320	<b>1.8748</b>	0.00	-	0.00	1	0	-1
321	<b>1.8775</b>	5.36	-	3.09	-213	0	162
322	<b>1.8957</b>	0.08	0.00	0.06	25	-1	-22
323	<b>1.8964</b>	0.00	0.10	0.00	1	30	-1
324	<b>1.9040</b>	0.00	-	0.05	1	0	20
325	<b>1.9108</b>	0.07	-	1.32	-25	0	-106
326	<b>1.9144</b>	0.00	-	0.00	-1	0	3
327	<b>1.9154</b>	-	0.00	-	0	-4	0
328	<b>1.9188</b>	-	0.00	-	0	2	0

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329	<b>1.9191</b>	-	0.12	0.00	0	-33	0
330	<b>1.9425</b>	0.06	0.00	0.26	-22	0	47
331	<b>1.9473</b>	-	0.46	0.00	0	63	1
332	<b>1.9490</b>	0.02	0.00	5.45	13	-1	215
333	<b>1.9550</b>	-	0.12	0.00	0	31	1
334	<b>1.9593</b>	0.21	-	8.38	-42	0	-267
335	<b>1.9639</b>	0.00	0.08	0.00	-1	26	-4
336	<b>1.9639</b>	0.00	0.01	0.01	-2	-9	-11
337	<b>1.9682</b>	-	0.06	-	0	-22	0
338	<b>1.9778</b>	0.02	-	0.04	-14	0	-18
339	<b>1.9918</b>	0.02	0.00	0.09	12	0	28
340	<b>1.9929</b>	0.00	0.00	0.00	-1	3	-2
341	<b>1.9976</b>	0.12	-	0.10	-32	0	30
342	<b>2.0095</b>	-	0.07	0.00	0	-24	0
343	<b>2.0137</b>	0.00	0.01	0.04	2	-8	19
344	<b>2.0139</b>	-	3.31	0.00	0	-168	-1
345	<b>2.0179</b>	0.00	0.04	0.00	-1	-19	-4
346	<b>2.0180</b>	0.19	0.00	9.52	-40	0	-284
347	<b>2.0288</b>	-	2.22	0.00	0	-137	0
348	<b>2.0384</b>	0.00	0.00	0.01	-5	-4	-9
349	<b>2.0412</b>	-	2.81	0.00	0	154	0
350	<b>2.0559</b>	0.01	0.00	0.00	9	-2	0
351	<b>2.0593</b>	-	4.29	-	0	-191	0
352	<b>2.0619</b>	-	0.12	0.00	0	-31	0
353	<b>2.0636</b>	0.00	0.01	0.00	-1	10	-1
354	<b>2.0658</b>	-	5.77	-	0	-221	0
355	<b>2.0694</b>	-	3.11	-	0	162	0
356	<b>2.0757</b>	0.03	-	0.69	16	0	77
357	<b>2.0860</b>	0.00	0.00	0.02	2	-6	-13
358	<b>2.0877</b>	0.00	0.44	0.00	0	61	-1
359	<b>2.1087</b>	-	0.08	-	0	27	0
360	<b>2.1133</b>	0.00	0.00	0.00	4	-2	2
361	<b>2.1189</b>	-	0.03	-	0	-16	0
362	<b>2.1314</b>	0.02	0.04	0.00	12	17	1
363	<b>2.1319</b>	0.65	0.00	0.00	74	-3	3
364	<b>2.1362</b>	4.64	-	-	198	0	0
365	<b>2.1375</b>	11.14	-	0.02	-307	0	12
366	<b>2.1525</b>	0.00	0.00	0.00	2	-3	0
367	<b>2.1541</b>	1.49	-	0.02	112	0	13
368	<b>2.1607</b>	0.01	0.01	0.00	-7	-7	0



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369	<b>2.1644</b>	0.00	0.10	-	1	-29	0
370	<b>2.1698</b>	-	0.00	-	0	3	0
371	<b>2.1722</b>	-	0.01	-	0	8	0
372	<b>2.1841</b>	0.00	-	0.00	-2	0	-1
373	<b>2.1925</b>	0.00	0.00	0.00	3	2	-4
374	<b>2.2000</b>	0.00	0.00	0.00	1	-3	0
375	<b>2.2051</b>	0.00	0.00	0.00	-3	4	0
376	<b>2.2125</b>	0.03	0.00	0.00	-15	0	4
377	<b>2.2169</b>	-	0.01	-	0	-8	0
378	<b>2.2211</b>	-	-	-	0	0	0
379	<b>2.2223</b>	-	0.01	-	0	11	0
380	<b>2.2278</b>	0.00	0.00	0.00	-2	3	5
381	<b>2.2286</b>	0.01	0.00	0.09	7	1	-27
382	<b>2.2347</b>	-	0.09	0.00	0	28	1
383	<b>2.2365</b>	0.00	0.00	0.02	4	0	-12
384	<b>2.2603</b>	-	0.01	-	0	9	0
385	<b>2.2699</b>	-	0.06	-	0	22	0
386	<b>2.2727</b>	-	0.00	-	0	-6	0
387	<b>2.2742</b>	-	0.00	0.00	0	0	0
388	<b>2.2811</b>	-	0.01	0.00	0	7	0
389	<b>2.2838</b>	0.00	0.00	0.00	-2	0	5
390	<b>2.2897</b>	0.01	-	0.02	7	0	-12
391	<b>2.2937</b>	0.00	0.00	0.01	-4	0	10
392	<b>2.2949</b>	-	0.01	-	0	10	0
393	<b>2.3055</b>	0.01	-	0.00	9	0	0
394	<b>2.3181</b>	-	0.58	-	0	70	0
395	<b>2.3248</b>	-	0.00	-	0	6	0
396	<b>2.3251</b>	-	0.00	-	0	0	0
397	<b>2.3302</b>	-	0.98	-	0	-91	0
398	<b>2.3354</b>	0.01	0.00	0.31	-10	-1	51
399	<b>2.3407</b>	0.00	0.00	0.12	-5	2	32
400	<b>2.3424</b>	0.00	0.12	0.00	0	-32	2
401	<b>2.3687</b>	0.00	0.00	0.05	-1	0	-21
402	<b>2.3710</b>	-	0.03	-	0	-17	0
403	<b>2.3732</b>	-	0.05	0.00	0	-21	0
404	<b>2.3771</b>	-	0.00	0.00	0	2	1
405	<b>2.3776</b>	-	0.01	-	0	7	0
406	<b>2.3821</b>	0.00	-	0.00	-2	0	-2
407	<b>2.3896</b>	-	0.00	0.00	0	-5	0
408	<b>2.3938</b>	-	-	0.00	0	0	2

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409	<b>2.4196</b>	-	0.02	-	0	11	0
410	<b>2.4296</b>	-	0.00	-	0	-2	0
411	<b>2.4297</b>	-	0.00	-	0	6	0
412	<b>2.4314</b>	-	0.00	-	0	-6	0
413	<b>2.4384</b>	0.00	-	-	-2	0	0
414	<b>2.4463</b>	0.00	0.00	0.01	-1	0	-7
415	<b>2.4541</b>	0.00	-	0.02	-3	0	-11
416	<b>2.4587</b>	-	0.05	-	0	-20	0
417	<b>2.4759</b>	-	0.02	-	0	-12	0
418	<b>2.4826</b>	-	0.00	0.00	0	-3	0
419	<b>2.4828</b>	-	0.02	-	0	-14	0
420	<b>2.5000</b>	0.00	0.00	0.00	0	-1	-2
421	<b>2.5002</b>	-	0.09	0.00	0	27	0
422	<b>2.5110</b>	-	1.63	0.00	0	117	0
423	<b>2.5112</b>	0.00	0.00	0.00	4	5	3
424	<b>2.5180</b>	-	1.28	-	0	104	0
425	<b>2.5216</b>	0.00	0.00	0.01	-2	0	7
426	<b>2.5301</b>	-	0.08	-	0	-26	0
427	<b>2.5356</b>	-	0.00	-	0	2	0
428	<b>2.5380</b>	-	0.35	-	0	55	0
429	<b>2.5490</b>	-	0.00	-	0	-2	0
430	<b>2.5564</b>	0.00	-	0.00	-2	0	0
431	<b>2.5644</b>	-	0.05	-	0	-21	0
432	<b>2.5765</b>	0.00	-	0.01	-3	0	8
433	<b>2.5781</b>	-	0.00	0.00	0	-1	1
434	<b>2.5799</b>	-	0.00	-	0	-1	0
435	<b>2.5843</b>	-	0.06	-	0	23	0
436	<b>2.5858</b>	0.00	0.00	0.01	2	0	11
437	<b>2.5919</b>	-	0.00	0.00	0	3	1
438	<b>2.5926</b>	-	0.02	-	0	-12	0
439	<b>2.6004</b>	-	0.26	0.00	0	-47	0
440	<b>2.6121</b>	0.00	-	-	0	0	0
441	<b>2.6183</b>	0.00	0.00	0.00	0	-5	1
442	<b>2.6209</b>	-	0.00	0.00	0	5	1
443	<b>2.6216</b>	0.00	0.03	0.00	0	-15	-1
444	<b>2.6303</b>	-	0.41	-	0	59	0
445	<b>2.6354</b>	0.00	-	0.00	-6	0	3
446	<b>2.6379</b>	-	-	-	0	0	0
447	<b>2.6436</b>	0.00	-	0.00	0	0	2
448	<b>2.6470</b>	-	-	-	0	0	0

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449	<b>2.6470</b>	-	0.00	-	0	-1	0
450	<b>2.6561</b>	-	0.02	-	0	-12	0
451	<b>2.6666</b>	0.01	-	0.01	-8	0	7
452	<b>2.6779</b>	0.02	-	0.07	-14	0	25
453	<b>2.6876</b>	-	0.00	-	0	-6	0
454	<b>2.6983</b>	-	0.00	-	0	-6	0
455	<b>2.6989</b>	0.00	-	0.00	2	0	-1
456	<b>2.7001</b>	-	0.00	-	0	-2	0
457	<b>2.7037</b>	0.06	-	0.03	-23	0	16
458	<b>2.7049</b>	0.33	-	0.28	-53	0	49
459	<b>2.7098</b>	-	0.01	0.00	0	11	0
460	<b>2.7186</b>	0.16	-	0.07	37	0	-24

Legend:

If value > 10

If value ≤ 10 and > 5

If value ≤ 5 and ≥ 1

MODE	FREQUENCY (Hz)	ACCUMULATE PERCENT		
		MASS(X)	MASS(Y)	MASS(Z)
1	0.0313	0.00	18.03	0.00
2	0.0585	0.00	18.03	0.00
3	0.0593	5.29	18.03	0.00
4	0.0809	5.31	18.03	5.36
5	0.0833	5.31	18.04	5.36
6	0.0849	11.94	18.04	5.37
7	0.0865	11.94	18.47	5.37
8	0.0923	11.94	18.47	5.37
9	0.0998	11.94	18.47	5.37
10	0.1012	11.94	18.48	5.37
11	0.1018	11.94	18.52	5.37
12	0.1076	11.94	18.52	14.43
13	0.1119	11.94	23.21	14.43
14	0.1273	12.11	23.21	14.44
15	0.1327	12.11	25.50	14.44
16	0.1344	12.11	25.50	14.44
17	0.1420	12.11	26.86	14.44
18	0.1431	12.11	26.86	14.44

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19	0.1546	12.11	30.22	14.44
20	0.1566	12.11	30.22	14.44
21	0.1604	12.11	30.22	15.15
22	0.1634	12.11	30.24	15.15
23	0.1705	12.11	30.24	15.15
24	0.1745	12.11	30.24	19.50
25	0.1755	12.11	30.26	19.50
26	0.1766	12.11	30.26	19.50
27	0.1809	12.11	30.26	19.50
28	0.1826	12.11	30.47	19.50
29	0.1908	12.18	30.47	19.51
30	0.1942	12.18	31.30	19.51
31	0.2064	12.18	31.34	19.51
32	0.2126	12.19	31.34	23.18
33	0.2147	12.19	31.34	23.18
34	0.2230	12.19	31.34	24.09
35	0.2264	12.19	31.34	24.09
36	0.2270	12.19	31.78	24.09
37	0.2352	12.19	32.24	24.09
38	0.2447	12.19	32.24	24.09
39	0.2535	12.27	32.24	24.09
40	0.2567	12.27	33.12	24.09
41	0.2622	12.27	33.12	24.09
42	0.2656	12.27	33.38	24.09
43	0.2827	12.27	33.44	24.09
44	0.2849	12.27	33.44	24.42
45	0.2868	12.27	33.44	24.42
46	0.2968	12.27	33.44	24.42
47	0.3045	12.27	33.44	24.42
48	0.3045	12.27	33.51	24.42
49	0.3154	12.35	33.51	24.42
50	0.3215	12.35	34.35	24.42
51	0.3268	12.35	34.36	24.42
52	0.3442	12.35	34.54	24.42
53	0.3444	12.35	34.54	24.42
54	0.3463	12.35	34.54	24.64
55	0.3493	12.35	34.96	24.64
56	0.3507	12.35	34.96	24.64
57	0.3549	12.39	34.96	24.71
58	0.3581	12.39	34.96	24.71

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59	0.3679	12.39	35.43	24.71
60	0.3687	12.39	35.46	24.71
61	0.3761	12.63	35.46	24.71
62	0.3861	12.63	35.46	24.71
63	0.3929	12.63	35.75	24.71
64	0.4064	12.63	35.75	24.91
65	0.4084	12.63	35.75	24.91
66	0.4105	12.63	35.75	24.91
67	0.4190	33.60	35.75	24.91
68	0.4255	35.38	35.75	25.22
69	0.4273	35.39	35.75	25.22
70	0.4323	35.39	35.75	25.22
71	0.4365	36.24	35.75	25.22
72	0.4382	36.24	35.75	25.22
73	0.4510	36.24	35.75	25.22
74	0.4596	36.24	35.75	25.22
75	0.4614	36.24	35.75	25.22
76	0.4646	36.25	35.75	25.56
77	0.4660	36.25	35.76	25.56
78	0.4692	36.25	35.76	25.56
79	0.4699	36.25	35.98	25.56
80	0.4749	36.46	35.98	26.22
81	0.4758	36.59	35.98	26.30
82	0.4780	36.64	35.98	26.68
83	0.4890	36.64	36.05	26.68
84	0.4935	36.67	36.05	26.77
85	0.4935	36.67	36.05	26.78
86	0.5063	36.80	36.05	27.60
87	0.5110	36.80	36.05	27.60
88	0.5112	36.80	36.05	27.60
89	0.5227	36.81	36.05	27.61
90	0.5254	36.84	36.05	27.61
91	0.5327	36.84	36.05	27.61
92	0.5435	36.84	36.07	27.61
93	0.5440	36.84	36.07	27.61
94	0.5501	36.84	36.07	27.61
95	0.5524	36.84	36.18	27.61
96	0.5530	36.84	36.19	27.61
97	0.5532	36.84	36.19	27.61
98	0.5632	36.84	36.19	27.61

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99	0.5752	36.84	36.19	27.61
100	0.5761	36.84	36.19	27.65
101	0.5931	36.84	36.19	27.65
102	0.5954	36.84	36.19	27.65
103	0.5987	36.86	36.19	27.65
104	0.6060	36.86	36.19	27.65
105	0.6082	36.87	36.19	27.66
106	0.6186	36.87	36.19	27.66
107	0.6268	36.87	36.19	27.70
108	0.6284	36.87	36.20	27.70
109	0.6306	36.87	36.59	27.70
110	0.6373	36.87	36.64	27.70
111	0.6378	36.87	36.64	27.70
112	0.6402	36.87	36.64	27.70
113	0.6412	36.87	36.78	27.70
114	0.6452	36.87	36.78	27.70
115	0.6485	36.87	36.78	27.71
116	0.6601	36.87	36.78	27.71
117	0.6692	36.87	36.78	27.73
118	0.6735	36.87	36.79	27.73
119	0.6804	36.87	36.79	27.73
120	0.6894	36.88	36.79	27.73
121	0.6986	36.88	36.79	27.73
122	0.7004	36.88	36.79	27.73
123	0.7079	36.88	37.23	27.73
124	0.7103	36.88	37.23	27.73
125	0.7164	36.88	37.25	27.73
126	0.7232	36.88	37.25	27.73
127	0.7315	36.89	37.25	27.75
128	0.7354	36.89	37.31	27.75
129	0.7422	36.89	37.32	27.75
130	0.7479	36.89	37.32	27.78
131	0.7530	36.89	37.88	27.78
132	0.7638	36.90	37.88	27.79
133	0.7652	36.90	37.89	27.79
134	0.7660	36.90	37.89	27.79
135	0.7707	36.90	37.89	27.79
136	0.7775	36.90	38.09	27.79
137	0.7837	36.90	38.10	27.79
138	0.7859	36.90	38.10	27.79

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139	0.7986	36.90	38.16	27.79
140	0.8049	36.90	38.20	27.79
141	0.8092	36.90	38.20	27.79
142	0.8093	36.90	38.20	27.79
143	0.8255	36.90	38.20	27.79
144	0.8276	36.90	38.40	27.79
145	0.8329	36.90	38.40	27.79
146	0.8525	36.90	38.40	27.79
147	0.8568	36.90	38.40	27.79
148	0.8616	36.90	38.40	27.79
149	0.8668	36.90	38.40	27.79
150	0.8730	36.92	38.40	27.86
151	0.8810	36.93	38.40	27.86
152	0.8812	36.93	38.41	27.86
153	0.8960	36.93	38.41	27.86
154	0.9025	36.93	38.47	27.86
155	0.9033	36.93	38.47	27.87
156	0.9092	36.93	38.47	27.87
157	0.9259	36.93	38.47	27.87
158	0.9387	36.93	38.47	27.87
159	0.9419	36.93	38.47	27.87
160	0.9429	36.93	38.53	27.87
161	0.9467	36.93	38.61	27.87
162	0.9484	36.93	38.61	27.87
163	0.9561	36.93	38.61	27.87
164	0.9591	36.93	38.99	27.87
165	0.9716	36.94	38.99	27.87
166	0.9763	36.94	39.03	27.87
167	0.9770	36.94	39.04	27.87
168	0.9834	36.94	39.04	27.87
169	0.9836	36.94	39.04	27.87
170	0.9949	36.94	39.19	27.87
171	0.9952	36.94	39.19	27.87
172	1.0030	36.94	39.19	27.87
173	1.0128	36.94	39.19	27.87
174	1.0183	36.94	39.19	27.88
175	1.0274	36.94	39.21	27.88
176	1.0279	36.94	39.21	27.88
177	1.0297	36.94	39.37	27.88
178	1.0381	36.94	39.37	27.88

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179	1.0427	36.94	39.37	27.88
180	1.0526	36.94	39.43	27.88
181	1.0659	36.94	39.43	27.88
182	1.0694	36.94	39.48	27.88
183	1.0721	36.94	39.48	27.88
184	1.0753	36.94	39.72	27.88
185	1.0911	36.94	39.73	27.88
186	1.0913	36.94	39.73	27.89
187	1.1099	36.95	39.73	27.89
188	1.1136	36.95	40.23	27.89
189	1.1156	36.95	40.23	27.89
190	1.1166	36.95	40.23	27.89
191	1.1195	36.95	40.26	27.89
192	1.1294	36.96	40.26	27.89
193	1.1295	36.96	40.32	27.89
194	1.1422	36.96	40.32	27.90
195	1.1614	36.96	40.32	27.90
196	1.1643	36.96	40.38	27.90
197	1.1664	36.96	40.41	27.90
198	1.1672	36.96	40.41	27.90
199	1.1792	36.96	40.48	27.90
200	1.1936	36.96	40.48	27.91
201	1.2020	36.99	40.48	27.96
202	1.2064	36.99	40.48	27.96
203	1.2104	36.99	40.50	27.96
204	1.2107	36.99	40.51	27.96
205	1.2185	36.99	40.51	27.98
206	1.2222	37.09	40.51	27.99
207	1.2336	37.09	42.29	27.99
208	1.2374	37.54	42.29	28.05
209	1.2516	37.54	42.29	28.05
210	1.2527	37.54	42.29	28.05
211	1.2532	37.54	42.29	28.05
212	1.2583	37.54	42.45	28.05
213	1.2620	37.55	42.45	28.06
214	1.2759	37.56	42.45	28.06
215	1.2857	37.57	42.45	28.07
216	1.2870	37.57	42.63	28.07
217	1.2940	37.57	42.70	28.07
218	1.2971	37.57	42.70	28.07



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219	1.3080	37.57	42.81	28.07
220	1.3142	37.57	42.81	28.08
221	1.3323	37.57	42.81	28.08
222	1.3349	37.57	43.02	28.08
223	1.3361	37.61	43.02	28.13
224	1.3379	37.61	43.50	28.13
225	1.3429	37.61	43.50	28.13
226	1.3467	37.62	43.50	28.17
227	1.3594	37.93	43.50	28.21
228	1.3621	37.93	44.70	28.21
229	1.3694	37.93	45.31	28.21
230	1.3774	38.61	45.31	28.32
231	1.3824	38.61	45.31	28.32
232	1.3851	40.24	45.31	28.42
233	1.3889	40.24	45.31	28.42
234	1.4012	40.24	45.34	28.42
235	1.4058	41.06	45.34	28.43
236	1.4081	41.06	45.78	28.43
237	1.4091	41.07	45.78	28.46
238	1.4120	41.92	45.78	28.47
239	1.4242	41.97	45.78	28.56
240	1.4244	41.97	45.80	28.56
241	1.4290	43.52	45.80	28.87
242	1.4351	43.52	45.80	28.87
243	1.4352	43.52	45.80	28.87
244	1.4378	45.13	45.80	29.02
245	1.4503	45.13	46.29	29.02
246	1.4578	45.13	46.39	29.02
247	1.4579	45.34	46.39	29.11
248	1.4742	45.34	46.40	29.11
249	1.4817	45.34	46.40	29.11
250	1.4839	46.84	46.40	34.28
251	1.4908	46.84	46.43	34.28
252	1.4940	47.64	46.43	37.81
253	1.5011	47.64	46.44	37.81
254	1.5125	48.57	46.44	41.83
255	1.5132	49.55	46.44	60.82
256	1.5285	49.55	46.44	60.82
257	1.5302	49.65	46.44	60.83
258	1.5322	49.65	46.61	60.83

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259	1.5352	49.65	46.74	60.83
260	1.5439	49.65	46.74	60.83
261	1.5533	61.00	46.74	63.95
262	1.5631	61.43	46.74	64.91
263	1.5755	61.43	46.74	64.91
264	1.5780	61.91	46.74	65.79
265	1.5805	61.91	46.90	65.79
266	1.5869	61.91	46.91	65.79
267	1.5909	62.03	46.91	65.80
268	1.5965	62.03	46.94	65.80
269	1.6052	62.03	46.95	65.80
270	1.6058	62.06	46.95	65.82
271	1.6213	62.06	47.29	65.82
272	1.6219	62.06	47.29	65.82
273	1.6253	62.06	53.75	65.82
274	1.6303	62.06	63.27	65.82
275	1.6326	62.06	63.33	65.82
276	1.6345	62.06	63.34	65.82
277	1.6394	62.09	63.34	65.85
278	1.6541	62.09	64.03	65.85
279	1.6555	62.24	64.03	65.89
280	1.6681	62.24	64.04	65.89
281	1.6686	62.24	64.04	65.89
282	1.6703	62.44	64.04	65.89
283	1.6717	62.44	64.32	65.89
284	1.6765	62.44	64.32	65.89
285	1.6799	62.45	64.32	65.91
286	1.6918	62.45	64.38	65.91
287	1.6975	62.45	67.41	65.91
288	1.7065	62.45	67.45	65.91
289	1.7138	62.45	67.45	65.95
290	1.7167	62.45	68.12	65.95
291	1.7195	62.45	68.12	65.95
292	1.7281	62.45	68.17	65.95
293	1.7305	62.45	68.24	65.95
294	1.7356	62.49	68.24	65.99
295	1.7442	62.49	68.24	65.99
296	1.7487	62.49	68.24	66.03
297	1.7549	62.63	68.24	66.11
298	1.7593	62.63	68.25	66.11

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299	1.7676	62.64	68.25	66.12
300	1.7680	67.75	68.25	66.20
301	1.7722	67.75	68.29	66.20
302	1.7737	67.75	68.42	66.20
303	1.7745	67.75	68.44	66.20
304	1.7865	67.80	68.44	66.22
305	1.7936	67.80	68.44	66.22
306	1.8051	67.80	68.45	66.22
307	1.8129	68.39	68.45	66.24
308	1.8162	68.39	68.45	66.24
309	1.8213	68.39	68.46	66.24
310	1.8238	68.40	68.46	66.26
311	1.8273	68.40	68.46	66.26
312	1.8318	69.16	68.46	66.55
313	1.8347	69.16	68.48	66.55
314	1.8517	69.16	68.48	66.56
315	1.8588	69.16	68.48	66.56
316	1.8603	69.16	68.51	66.56
317	1.8638	69.26	68.51	66.72
318	1.8651	69.26	68.51	66.72
319	1.8698	69.26	68.56	66.72
320	1.8748	69.26	68.56	66.72
321	1.8775	74.61	68.56	69.81
322	1.8957	74.69	68.56	69.87
323	1.8964	74.69	68.66	69.87
324	1.9040	74.69	68.66	69.92
325	1.9108	74.76	68.66	71.23
326	1.9144	74.76	68.66	71.23
327	1.9154	74.76	68.67	71.23
328	1.9188	74.76	68.67	71.23
329	1.9191	74.76	68.79	71.23
330	1.9425	74.82	68.79	71.49
331	1.9473	74.82	69.25	71.49
332	1.9490	74.84	69.25	76.94
333	1.9550	74.84	69.37	76.94
334	1.9593	75.05	69.37	85.33
335	1.9639	75.05	69.45	85.33
336	1.9639	75.05	69.46	85.34
337	1.9682	75.05	69.51	85.34
338	1.9778	75.08	69.51	85.38

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339	1.9918	75.09	69.51	85.48
340	1.9929	75.09	69.51	85.48
341	1.9976	75.21	69.51	85.58
342	2.0095	75.21	69.58	85.58
343	2.0137	75.21	69.59	85.63
344	2.0139	75.21	72.90	85.63
345	2.0179	75.21	72.94	85.63
346	2.0180	75.40	72.94	95.14
347	2.0288	75.40	75.16	95.14
348	2.0384	75.40	75.16	95.15
349	2.0412	75.40	77.97	95.15
350	2.0559	75.41	77.97	95.15
351	2.0593	75.41	82.26	95.15
352	2.0619	75.41	82.38	95.15
353	2.0636	75.41	82.39	95.15
354	2.0658	75.41	88.16	95.15
355	2.0694	75.41	91.27	95.15
356	2.0757	75.44	91.27	95.85
357	2.0860	75.44	91.27	95.87
358	2.0877	75.44	91.71	95.87
359	2.1087	75.44	91.80	95.87
360	2.1133	75.44	91.80	95.87
361	2.1189	75.44	91.83	95.87
362	2.1314	75.46	91.87	95.87
363	2.1319	76.11	91.87	95.87
364	2.1362	80.75	91.87	95.87
365	2.1375	91.89	91.87	95.89
366	2.1525	91.89	91.87	95.89
367	2.1541	93.38	91.87	95.91
368	2.1607	93.39	91.87	95.91
369	2.1644	93.39	91.97	95.91
370	2.1698	93.39	91.97	95.91
371	2.1722	93.39	91.98	95.91
372	2.1841	93.39	91.98	95.91
373	2.1925	93.39	91.98	95.91
374	2.2000	93.39	91.98	95.91
375	2.2051	93.39	91.98	95.91
376	2.2125	93.42	91.98	95.92
377	2.2169	93.42	91.99	95.92
378	2.2211	93.42	91.99	95.92

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379	2.2223	93.42	92.00	95.92
380	2.2278	93.42	92.01	95.92
381	2.2286	93.42	92.01	96.01
382	2.2347	93.42	92.10	96.01
383	2.2365	93.43	92.10	96.03
384	2.2603	93.43	92.11	96.03
385	2.2699	93.43	92.16	96.03
386	2.2727	93.43	92.17	96.03
387	2.2742	93.43	92.17	96.03
388	2.2811	93.43	92.17	96.03
389	2.2838	93.43	92.17	96.03
390	2.2897	93.43	92.17	96.05
391	2.2937	93.43	92.17	96.06
392	2.2949	93.43	92.18	96.06
393	2.3055	93.44	92.18	96.06
394	2.3181	93.44	92.76	96.06
395	2.3248	93.44	92.76	96.06
396	2.3251	93.44	92.76	96.06
397	2.3302	93.44	93.74	96.06
398	2.3354	93.46	93.74	96.36
399	2.3407	93.46	93.74	96.48
400	2.3424	93.46	93.86	96.48
401	2.3687	93.46	93.86	96.53
402	2.3710	93.46	93.90	96.53
403	2.3732	93.46	93.95	96.53
404	2.3771	93.46	93.95	96.53
405	2.3776	93.46	93.96	96.53
406	2.3821	93.46	93.96	96.53
407	2.3896	93.46	93.96	96.53
408	2.3938	93.46	93.96	96.53
409	2.4196	93.46	93.97	96.53
410	2.4296	93.46	93.98	96.53
411	2.4297	93.46	93.98	96.53
412	2.4314	93.46	93.98	96.53
413	2.4384	93.46	93.98	96.53
414	2.4463	93.46	93.98	96.54
415	2.4541	93.46	93.98	96.55
416	2.4587	93.46	94.03	96.55
417	2.4759	93.46	94.05	96.55
418	2.4826	93.46	94.05	96.56



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419	2.4828	93.46	94.07	96.56
420	2.5000	93.46	94.07	96.56
421	2.5002	93.46	94.16	96.56
422	2.5110	93.46	95.79	96.56
423	2.5112	93.46	95.79	96.56
424	2.5180	93.46	97.07	96.56
425	2.5216	93.46	97.07	96.56
426	2.5301	93.46	97.15	96.56
427	2.5356	93.46	97.15	96.56
428	2.5380	93.46	97.51	96.56
429	2.5490	93.46	97.51	96.56
430	2.5564	93.46	97.51	96.56
431	2.5644	93.46	97.56	96.56
432	2.5765	93.46	97.56	96.57
433	2.5781	93.46	97.56	96.57
434	2.5799	93.46	97.56	96.57
435	2.5843	93.46	97.62	96.57
436	2.5858	93.46	97.62	96.58
437	2.5919	93.46	97.62	96.58
438	2.5926	93.46	97.64	96.58
439	2.6004	93.46	97.90	96.58
440	2.6121	93.46	97.90	96.58
441	2.6183	93.46	97.90	96.58
442	2.6209	93.46	97.90	96.58
443	2.6216	93.46	97.93	96.58
444	2.6303	93.46	98.34	96.58
445	2.6354	93.47	98.34	96.59
446	2.6379	93.47	98.34	96.59
447	2.6436	93.47	98.34	96.59
448	2.6470	93.47	98.34	96.59
449	2.6470	93.47	98.34	96.59
450	2.6561	93.47	98.35	96.59
451	2.6666	93.48	98.35	96.59
452	2.6779	93.50	98.35	96.66
453	2.6876	93.50	98.36	96.66
454	2.6983	93.50	98.36	96.66
455	2.6989	93.50	98.36	96.66
456	2.7001	93.50	98.36	96.66
457	2.7037	93.56	98.36	96.69
458	2.7049	93.89	98.36	96.98

		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
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459	2.7098	93.89	98.38	96.98
460	2.7186	94.05	98.38	97.04

## 7.2 Parametri modali IBDAS

MODE	FREQUENCY (Hz)	MASS(X)	PERCENT			ACCUMULATE PERCENT		
			MASS(Y)	MASS(Z)	MASS(X)	MASS(Y)	MASS(Z)	
1	0.0309	-	15.08	-	0.00	15.08	0.00	
2	0.0569	-	-	-	0.00	15.08	0.00	
3	0.0593	4.40	-	-	4.40	15.08	0.00	
4	0.0809	0.02	-	4.40	4.42	15.08	4.40	
5	0.0835	-	0.32	-	4.42	15.40	4.40	
6	0.0846	5.41	-	0.00	9.82	15.40	4.40	
7	0.0851	-	0.00	-	9.82	15.40	4.40	
8	0.0922	-	-	-	9.82	15.40	4.40	
9	0.0996	-	-	-	9.82	15.40	4.40	
10	0.1005	-	0.03	-	9.82	15.44	4.40	
11	0.1028	-	-	-	9.82	15.44	4.40	
12	0.1076	-	-	7.40	9.82	15.44	11.80	
13	0.1114	-	4.14	-	9.82	19.58	11.80	
14	0.1273	0.15	-	0.00	9.97	19.58	11.80	
15	0.1305	-	1.71	-	9.97	21.29	11.80	
16	0.1353	-	0.00	-	9.97	21.29	11.80	
17	0.1394	-	1.08	-	9.97	22.37	11.80	
18	0.1403	-	-	-	9.97	22.37	11.80	
19	0.1521	-	2.81	-	9.97	25.18	11.80	
20	0.1564	-	-	-	9.97	25.18	11.80	
21	0.1600	-	-	0.28	9.97	25.18	12.09	
22	0.1642	-	0.00	-	9.97	25.18	12.09	
23	0.1676	-	-	0.00	9.97	25.18	12.09	
24	0.1681	-	-	3.82	9.97	25.18	15.91	
25	0.1700	-	-	-	9.97	25.18	15.91	
26	0.1727	-	0.01	-	9.97	25.19	15.91	
27	0.1803	-	0.23	-	9.97	25.42	15.91	
28	0.1805	-	-	-	9.97	25.42	15.91	
29	0.1906	0.06	-	0.01	10.03	25.42	15.92	
30	0.1915	-	0.82	-	10.03	26.25	15.92	
31	0.2048	0.01	-	2.98	10.04	26.25	18.90	
32	0.2051	-	0.01	-	10.04	26.26	18.90	
33	0.2085	-	0.02	-	10.04	26.27	18.90	



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34	<b>0.2194</b>	-	0.35	-	10.04	26.63	18.90
35	<b>0.2226</b>	-	-	0.62	10.04	26.63	19.52
36	<b>0.2257</b>	-	-	-	10.04	26.63	19.52
37	<b>0.2296</b>	-	0.49	-	10.04	27.12	19.52
38	<b>0.2448</b>	-	-	-	10.04	27.12	19.52
39	<b>0.2512</b>	-	0.37	-	10.04	27.49	19.52
40	<b>0.2529</b>	0.06	-	-	10.10	27.49	19.53
41	<b>0.2594</b>	-	0.22	-	10.10	27.71	19.53
42	<b>0.2612</b>	-	-	-	10.10	27.71	19.53
43	<b>0.2694</b>	-	-	-	10.10	27.71	19.53
44	<b>0.2760</b>	-	0.22	-	10.10	27.93	19.53
45	<b>0.2841</b>	-	-	0.27	10.10	27.93	19.80
46	<b>0.2868</b>	-	0.03	-	10.10	27.96	19.80
47	<b>0.2894</b>	-	0.45	-	10.10	28.41	19.80
48	<b>0.3031</b>	-	-	-	10.10	28.41	19.80
49	<b>0.3042</b>	0.01	-	0.01	10.11	28.41	19.81
50	<b>0.3050</b>	-	-	-	10.11	28.41	19.81
51	<b>0.3079</b>	-	0.15	-	10.11	28.56	19.81
52	<b>0.3143</b>	0.07	-	-	10.18	28.56	19.81
53	<b>0.3210</b>	-	-	-	10.18	28.56	19.81
54	<b>0.3266</b>	-	0.00	-	10.18	28.56	19.81
55	<b>0.3337</b>	-	0.28	-	10.18	28.84	19.81
56	<b>0.3395</b>	-	0.47	-	10.18	29.31	19.81
57	<b>0.3423</b>	-	-	-	10.18	29.31	19.81
58	<b>0.3449</b>	-	-	0.18	10.18	29.31	19.99
59	<b>0.3500</b>	-	0.11	-	10.18	29.43	19.99
60	<b>0.3676</b>	-	-	-	10.18	29.43	19.99
61	<b>0.3681</b>	-	-	-	10.18	29.43	19.99
62	<b>0.3742</b>	0.20	-	0.00	10.38	29.43	20.00
63	<b>0.3749</b>	0.02	-	0.06	10.41	29.43	20.05
64	<b>0.3759</b>	-	0.01	-	10.41	29.44	20.05
65	<b>0.3776</b>	-	-	-	10.41	29.44	20.05
66	<b>0.3834</b>	-	-	-	10.41	29.44	20.05
67	<b>0.3899</b>	-	0.14	-	10.41	29.58	20.05
68	<b>0.4040</b>	0.51	-	0.28	10.92	29.58	20.33
69	<b>0.4040</b>	0.27	-	0.12	11.19	29.58	20.45
70	<b>0.4044</b>	0.74	-	0.00	11.93	29.58	20.45
71	<b>0.4064</b>	-	-	-	11.93	29.58	20.45
72	<b>0.4080</b>	-	-	-	11.93	29.58	20.45
73	<b>0.4173</b>	17.24	-	0.02	29.17	29.58	20.47

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74	<b>0.4237</b>	0.00	-	-	29.17	29.58	20.47
75	<b>0.4251</b>	-	-	-	29.17	29.58	20.47
76	<b>0.4261</b>	-	0.04	-	29.17	29.62	20.47
77	<b>0.4302</b>	-	0.05	-	29.17	29.67	20.47
78	<b>0.4337</b>	0.82	-	0.00	29.99	29.67	20.48
79	<b>0.4399</b>	-	-	-	29.99	29.67	20.48
80	<b>0.4451</b>	-	0.01	-	29.99	29.68	20.48
81	<b>0.4490</b>	-	0.00	-	29.99	29.68	20.48
82	<b>0.4543</b>	-	-	-	29.99	29.68	20.48
83	<b>0.4552</b>	0.22	-	1.21	30.21	29.68	21.68
84	<b>0.4618</b>	0.12	-	0.09	30.33	29.68	21.77
85	<b>0.4643</b>	-	0.19	-	30.33	29.87	21.77
86	<b>0.4646</b>	-	-	-	30.33	29.87	21.77
87	<b>0.4675</b>	0.32	-	0.70	30.64	29.87	22.47
88	<b>0.4732</b>	0.00	-	0.01	30.64	29.87	22.48
89	<b>0.4771</b>	0.15	-	0.05	30.80	29.87	22.54
90	<b>0.4825</b>	-	0.05	-	30.80	29.92	22.54
91	<b>0.4901</b>	0.00	-	0.00	30.80	29.92	22.54
92	<b>0.4906</b>	-	-	-	30.80	29.92	22.54
93	<b>0.5045</b>	-	-	-	30.80	29.92	22.54
94	<b>0.5052</b>	-	-	-	30.80	29.92	22.54
95	<b>0.5055</b>	-	-	-	30.80	29.92	22.54
96	<b>0.5136</b>	0.01	-	0.04	30.81	29.92	22.57
97	<b>0.5182</b>	-	-	0.03	30.81	29.92	22.60
98	<b>0.5226</b>	-	-	-	30.81	29.92	22.60
99	<b>0.5229</b>	-	0.05	-	30.81	29.97	22.60
100	<b>0.5240</b>	0.07	-	-	30.88	29.97	22.60
101	<b>0.5276</b>	-	0.00	-	30.88	29.97	22.60
102	<b>0.5324</b>	-	-	-	30.88	29.97	22.60
103	<b>0.5449</b>	-	-	0.00	30.88	29.97	22.60
104	<b>0.5453</b>	-	0.11	-	30.88	30.08	22.60
105	<b>0.5459</b>	-	-	-	30.88	30.08	22.60
106	<b>0.5558</b>	-	-	-	30.88	30.08	22.60
107	<b>0.5690</b>	-	0.00	-	30.88	30.08	22.60
108	<b>0.5703</b>	-	-	0.05	30.88	30.08	22.65
109	<b>0.5748</b>	-	0.00	-	30.88	30.08	22.65
110	<b>0.5845</b>	-	-	-	30.88	30.08	22.65
111	<b>0.5865</b>	-	-	-	30.88	30.08	22.65
112	<b>0.5945</b>	0.00	-	0.00	30.88	30.08	22.65
113	<b>0.6100</b>	-	0.00	-	30.88	30.08	22.65

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114	<b>0.6154</b>	-	-	-	30.88	30.08	22.65
115	<b>0.6166</b>	-	-	0.05	30.88	30.08	22.69
116	<b>0.6226</b>	-	0.18	-	30.88	30.26	22.69
117	<b>0.6271</b>	-	-	-	30.88	30.26	22.69
118	<b>0.6330</b>	-	0.21	-	30.88	30.48	22.69
119	<b>0.6366</b>	0.01	-	-	30.89	30.48	22.69
120	<b>0.6505</b>	-	-	-	30.89	30.48	22.69
121	<b>0.6556</b>	-	-	0.01	30.89	30.48	22.70
122	<b>0.6578</b>	-	0.00	-	30.89	30.48	22.70
123	<b>0.6676</b>	-	-	-	30.89	30.48	22.70
124	<b>0.6745</b>	0.01	-	0.00	30.90	30.48	22.71
125	<b>0.6854</b>	-	0.64	-	30.90	31.11	22.71
126	<b>0.6858</b>	-	0.05	-	30.90	31.16	22.71
127	<b>0.6905</b>	-	0.02	-	30.90	31.18	22.71
128	<b>0.6950</b>	-	-	0.00	30.90	31.18	22.71
129	<b>0.6994</b>	-	-	-	30.90	31.18	22.71
130	<b>0.7080</b>	-	-	-	30.90	31.18	22.71
131	<b>0.7161</b>	0.00	0.01	-	30.90	31.19	22.71
132	<b>0.7164</b>	0.01	0.00	0.00	30.91	31.19	22.71
133	<b>0.7253</b>	-	0.43	-	30.91	31.61	22.71
134	<b>0.7308</b>	-	0.00	-	30.91	31.61	22.71
135	<b>0.7377</b>	-	-	0.01	30.91	31.61	22.72
136	<b>0.7482</b>	-	-	-	30.91	31.61	22.72
137	<b>0.7569</b>	-	0.00	-	30.91	31.62	22.72
138	<b>0.7583</b>	0.01	-	-	30.91	31.62	22.72
139	<b>0.7689</b>	-	0.01	-	30.91	31.62	22.72
140	<b>0.7784</b>	-	-	0.01	30.91	31.62	22.73
141	<b>0.7883</b>	-	-	-	30.91	31.62	22.73
142	<b>0.7924</b>	-	0.13	-	30.91	31.75	22.73
143	<b>0.7932</b>	-	0.01	-	30.91	31.76	22.73
144	<b>0.7987</b>	0.00	-	0.00	30.92	31.76	22.73
145	<b>0.8075</b>	-	0.00	-	30.92	31.76	22.73
146	<b>0.8097</b>	-	-	-	30.92	31.76	22.73
147	<b>0.8191</b>	0.00	-	0.01	30.92	31.76	22.74
148	<b>0.8247</b>	-	0.01	-	30.92	31.77	22.74
149	<b>0.8284</b>	-	-	-	30.92	31.77	22.74
150	<b>0.8288</b>	-	0.01	-	30.92	31.78	22.74
151	<b>0.8394</b>	0.00	-	0.00	30.92	31.78	22.74
152	<b>0.8433</b>	-	-	-	30.92	31.78	22.74
153	<b>0.8493</b>	-	-	-	30.92	31.78	22.74

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154	<b>0.8533</b>	0.03	-	0.04	30.95	31.78	22.78
155	<b>0.8573</b>	-	0.11	-	30.95	31.89	22.78
156	<b>0.8621</b>	0.00	-	0.01	30.95	31.89	22.78
157	<b>0.8674</b>	-	-	-	30.95	31.89	22.78
158	<b>0.8684</b>	-	-	-	30.95	31.89	22.78
159	<b>0.8772</b>	-	0.06	-	30.95	31.95	22.78
160	<b>0.8806</b>	1.25	-	-	32.20	31.95	22.78
161	<b>0.8817</b>	0.03	0.00	-	32.23	31.95	22.78
162	<b>0.8819</b>	0.22	-	0.00	32.45	31.95	22.78
163	<b>0.8913</b>	-	0.24	-	32.45	32.19	22.78
164	<b>0.8928</b>	-	0.04	-	32.45	32.23	22.78
165	<b>0.9052</b>	0.00	-	0.00	32.45	32.23	22.78
166	<b>0.9080</b>	-	-	-	32.45	32.23	22.78
167	<b>0.9179</b>	-	0.00	-	32.45	32.23	22.78
168	<b>0.9270</b>	0.00	-	-	32.46	32.23	22.78
169	<b>0.9278</b>	-	0.01	-	32.46	32.24	22.78
170	<b>0.9475</b>	-	0.30	-	32.46	32.53	22.78
171	<b>0.9476</b>	-	0.01	-	32.46	32.54	22.78
172	<b>0.9514</b>	-	-	0.00	32.46	32.54	22.79
173	<b>0.9537</b>	-	0.00	-	32.46	32.54	22.79
174	<b>0.9565</b>	-	-	-	32.46	32.54	22.79
175	<b>0.9577</b>	-	0.01	-	32.46	32.55	22.79
176	<b>0.9678</b>	-	-	-	32.46	32.55	22.79
177	<b>0.9755</b>	-	-	-	32.46	32.55	22.79
178	<b>0.9869</b>	-	-	-	32.46	32.55	22.79
179	<b>0.9910</b>	-	0.00	-	32.46	32.55	22.79
180	<b>1.0000</b>	-	-	0.00	32.46	32.55	22.79
181	<b>1.0074</b>	-	0.00	-	32.46	32.55	22.79
182	<b>1.0207</b>	-	0.01	-	32.46	32.56	22.79
183	<b>1.0255</b>	-	-	-	32.46	32.56	22.79
184	<b>1.0260</b>	-	-	-	32.46	32.56	22.79
185	<b>1.0297</b>	-	0.08	-	32.46	32.64	22.79
186	<b>1.0468</b>	-	-	-	32.46	32.64	22.79
187	<b>1.0515</b>	-	-	0.00	32.46	32.64	22.79
188	<b>1.0650</b>	-	-	-	32.46	32.64	22.79
189	<b>1.0672</b>	-	0.42	-	32.46	33.06	22.79
190	<b>1.0685</b>	-	0.01	-	32.46	33.07	22.79
191	<b>1.0774</b>	-	-	-	32.46	33.07	22.79
192	<b>1.0851</b>	-	0.00	-	32.46	33.08	22.79
193	<b>1.0967</b>	0.00	-	-	32.46	33.08	22.79

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194	<b>1.1024</b>	-	0.46	-	32.46	33.53	22.79
195	<b>1.1038</b>	-	-	-	32.46	33.53	22.79
196	<b>1.1039</b>	-	0.00	0.00	32.46	33.53	22.79
197	<b>1.1083</b>	-	0.04	-	32.46	33.57	22.79
198	<b>1.1147</b>	0.00	-	0.00	32.46	33.57	22.80
199	<b>1.1219</b>	-	0.04	-	32.46	33.61	22.80
200	<b>1.1334</b>	-	-	-	32.46	33.61	22.80
201	<b>1.1424</b>	-	-	-	32.46	33.61	22.80
202	<b>1.1426</b>	-	0.17	-	32.46	33.78	22.80
203	<b>1.1505</b>	-	0.17	-	32.46	33.95	22.80
204	<b>1.1606</b>	-	0.00	-	32.46	33.95	22.80
205	<b>1.1608</b>	0.00	-	0.01	32.46	33.95	22.80
206	<b>1.1807</b>	-	-	-	32.46	33.95	22.80
207	<b>1.1816</b>	-	0.38	-	32.46	34.33	22.80
208	<b>1.1827</b>	0.02	-	0.04	32.49	34.33	22.84
209	<b>1.1913</b>	-	1.15	-	32.49	35.48	22.84
210	<b>1.1920</b>	0.03	0.01	0.04	32.52	35.49	22.88
211	<b>1.1986</b>	-	0.21	-	32.52	35.70	22.88
212	<b>1.2016</b>	0.07	-	-	32.58	35.70	22.88
213	<b>1.2139</b>	0.18	-	0.05	32.76	35.70	22.93
214	<b>1.2188</b>	-	-	-	32.76	35.70	22.93
215	<b>1.2205</b>	-	-	-	32.76	35.70	22.93
216	<b>1.2240</b>	-	-	0.00	32.76	35.70	22.93
217	<b>1.2334</b>	-	0.09	-	32.76	35.78	22.93
218	<b>1.2479</b>	0.00	-	0.01	32.76	35.78	22.94
219	<b>1.2513</b>	-	0.24	-	32.76	36.02	22.94
220	<b>1.2531</b>	0.00	-	0.00	32.76	36.02	22.94
221	<b>1.2567</b>	-	-	-	32.76	36.02	22.94
222	<b>1.2573</b>	-	0.05	-	32.76	36.07	22.94
223	<b>1.2656</b>	0.00	-	0.00	32.77	36.07	22.94
224	<b>1.2663</b>	-	0.07	-	32.77	36.14	22.94
225	<b>1.2814</b>	-	-	0.01	32.77	36.14	22.95
226	<b>1.2901</b>	-	0.26	-	32.77	36.40	22.95
227	<b>1.2935</b>	-	0.09	-	32.77	36.49	22.95
228	<b>1.2938</b>	-	-	-	32.77	36.49	22.95
229	<b>1.2943</b>	-	-	-	32.77	36.49	22.95
230	<b>1.3066</b>	-	-	0.02	32.77	36.49	22.98
231	<b>1.3117</b>	-	1.37	-	32.77	37.87	22.98
232	<b>1.3178</b>	-	0.06	-	32.77	37.93	22.98
233	<b>1.3187</b>	0.01	-	0.05	32.78	37.93	23.02

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234	<b>1.3232</b>	0.62	-	0.02	33.40	37.93	23.04
235	<b>1.3252</b>	-	0.10	-	33.40	38.02	23.04
236	<b>1.3316</b>	-	-	-	33.40	38.02	23.04
237	<b>1.3318</b>	-	0.01	-	33.40	38.03	23.04
238	<b>1.3324</b>	0.07	-	0.02	33.47	38.03	23.06
239	<b>1.3417</b>	-	0.03	-	33.47	38.06	23.06
240	<b>1.3463</b>	0.54	0.00	0.02	34.01	38.06	23.09
241	<b>1.3482</b>	0.00	1.08	-	34.01	39.13	23.09
242	<b>1.3514</b>	0.18	-	0.02	34.19	39.13	23.10
243	<b>1.3686</b>	-	-	-	34.19	39.13	23.10
244	<b>1.3698</b>	-	0.00	-	34.19	39.14	23.10
245	<b>1.3742</b>	-	0.00	-	34.19	39.14	23.10
246	<b>1.3770</b>	0.07	-	0.03	34.26	39.14	23.13
247	<b>1.3876</b>	0.33	-	-	34.59	39.14	23.13
248	<b>1.4023</b>	-	0.00	-	34.59	39.14	23.13
249	<b>1.4025</b>	0.15	-	0.01	34.74	39.14	23.13
250	<b>1.4041</b>	0.51	-	0.19	35.25	39.14	23.32
251	<b>1.4052</b>	-	-	-	35.25	39.14	23.32
252	<b>1.4061</b>	0.00	0.08	-	35.26	39.22	23.32
253	<b>1.4094</b>	-	0.03	-	35.26	39.25	23.32
254	<b>1.4144</b>	4.65	-	0.32	39.90	39.25	23.64
255	<b>1.4276</b>	0.00	-	0.00	39.90	39.25	23.64
256	<b>1.4287</b>	0.42	-	0.02	40.32	39.25	23.66
257	<b>1.4366</b>	-	0.00	-	40.32	39.26	23.66
258	<b>1.4384</b>	-	0.13	-	40.32	39.39	23.66
259	<b>1.4417</b>	-	-	-	40.32	39.39	23.66
260	<b>1.4435</b>	-	0.01	-	40.32	39.39	23.66
261	<b>1.4437</b>	0.09	-	0.65	40.42	39.39	24.31
262	<b>1.4491</b>	0.00	-	0.00	40.42	39.39	24.32
263	<b>1.4552</b>	0.61	-	1.46	41.03	39.39	25.78
264	<b>1.4593</b>	0.00	0.35	0.00	41.03	39.75	25.78
265	<b>1.4654</b>	-	0.46	-	41.03	40.20	25.78
266	<b>1.4676</b>	0.90	-	-	41.93	40.20	25.78
267	<b>1.4677</b>	-	-	-	41.93	40.20	25.78
268	<b>1.4701</b>	-	0.02	-	41.93	40.22	25.78
269	<b>1.4727</b>	0.01	-	0.02	41.94	40.22	25.80
270	<b>1.4787</b>	-	-	0.00	41.94	40.22	25.80
271	<b>1.4801</b>	-	0.16	-	41.94	40.38	25.80
272	<b>1.4863</b>	0.03	-	0.00	41.97	40.38	25.80
273	<b>1.4878</b>	0.04	-	2.17	42.01	40.38	27.97

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274	<b>1.4908</b>	2.52	-	20.69	44.53	40.38	48.65
275	<b>1.4968</b>	-	0.21	-	44.53	40.59	48.65
276	<b>1.5033</b>	-	-	-	44.53	40.59	48.65
277	<b>1.5098</b>	-	0.38	0.00	44.53	40.98	48.66
278	<b>1.5127</b>	0.99	-	0.48	45.52	40.98	49.13
279	<b>1.5144</b>	-	-	-	45.52	40.98	49.13
280	<b>1.5200</b>	-	0.09	-	45.52	41.07	49.13
281	<b>1.5247</b>	2.82	-	0.69	48.34	41.07	49.82
282	<b>1.5332</b>	-	0.01	-	48.34	41.08	49.82
283	<b>1.5375</b>	3.70	-	3.14	52.04	41.08	52.97
284	<b>1.5434</b>	2.54	-	1.07	54.59	41.08	54.04
285	<b>1.5499</b>	-	-	-	54.59	41.08	54.04
286	<b>1.5503</b>	-	-	-	54.59	41.08	54.04
287	<b>1.5516</b>	-	-	-	54.59	41.08	54.04
288	<b>1.5537</b>	-	0.25	-	54.59	41.33	54.04
289	<b>1.5549</b>	0.31	-	0.01	54.89	41.33	54.05
290	<b>1.5551</b>	-	0.00	-	54.89	41.33	54.05
291	<b>1.5695</b>	-	-	-	54.89	41.33	54.05
292	<b>1.5788</b>	0.00	-	0.16	54.90	41.33	54.21
293	<b>1.5839</b>	-	0.06	-	54.90	41.39	54.21
294	<b>1.5852</b>	-	-	-	54.90	41.39	54.21
295	<b>1.5860</b>	-	0.04	-	54.90	41.43	54.21
296	<b>1.5874</b>	-	0.35	-	54.90	41.78	54.21
297	<b>1.5920</b>	-	0.01	-	54.90	41.79	54.21
298	<b>1.5967</b>	-	0.06	-	54.90	41.85	54.21
299	<b>1.5985</b>	0.23	-	0.03	55.12	41.85	54.25
300	<b>1.6089</b>	-	0.17	-	55.12	42.02	54.25
301	<b>1.6094</b>	0.11	-	0.01	55.23	42.02	54.26
302	<b>1.6164</b>	0.06	-	0.00	55.29	42.02	54.26
303	<b>1.6184</b>	-	1.51	-	55.29	43.53	54.26
304	<b>1.6201</b>	-	-	-	55.29	43.53	54.26
305	<b>1.6213</b>	-	2.13	-	55.29	45.66	54.26
306	<b>1.6216</b>	0.00	-	0.21	55.29	45.66	54.46
307	<b>1.6327</b>	-	10.37	-	55.29	56.02	54.46
308	<b>1.6411</b>	0.00	-	0.13	55.30	56.02	54.60
309	<b>1.6453</b>	-	0.01	-	55.30	56.03	54.60
310	<b>1.6547</b>	-	-	-	55.30	56.03	54.60
311	<b>1.6587</b>	-	0.36	-	55.30	56.39	54.60
312	<b>1.6643</b>	-	-	0.03	55.30	56.39	54.63
313	<b>1.6695</b>	0.00	0.00	0.01	55.30	56.39	54.63

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314	<b>1.6698</b>	-	<b>1.45</b>	-	55.30	57.84	54.63
315	<b>1.6711</b>	-	0.00	-	55.30	57.84	54.63
316	<b>1.6728</b>	-	0.00	-	55.30	57.84	54.63
317	<b>1.6770</b>	-	0.08	-	55.30	57.92	54.63
318	<b>1.6818</b>	0.00	-	0.05	55.30	57.92	54.68
319	<b>1.6890</b>	-	-	-	55.30	57.92	54.68
320	<b>1.6924</b>	-	0.04	-	55.30	57.96	54.68
321	<b>1.7044</b>	-	0.09	-	55.30	58.05	54.68
322	<b>1.7066</b>	0.00	-	0.10	55.30	58.05	54.78
323	<b>1.7110</b>	-	0.01	-	55.30	58.06	54.78
324	<b>1.7200</b>	-	0.01	-	55.30	58.06	54.78
325	<b>1.7229</b>	-	-	-	55.30	58.06	54.78
326	<b>1.7259</b>	-	0.06	-	55.30	58.12	54.78
327	<b>1.7291</b>	-	-	0.00	55.30	58.12	54.78
328	<b>1.7355</b>	-	0.01	-	55.30	58.13	54.78
329	<b>1.7397</b>	<b>1.06</b>	-	0.06	56.36	58.13	54.84
330	<b>1.7407</b>	0.05	-	0.02	56.42	58.13	54.86
331	<b>1.7445</b>	-	0.00	-	56.42	58.14	54.86
332	<b>1.7468</b>	-	0.29	-	56.42	58.42	54.86
333	<b>1.7564</b>	-	-	-	56.42	58.42	54.86
334	<b>1.7593</b>	-	0.01	-	56.42	58.43	54.86
335	<b>1.7617</b>	0.90	-	0.16	57.31	58.43	55.02
336	<b>1.7627</b>	<b>1.26</b>	-	0.03	58.57	58.43	55.05
337	<b>1.7743</b>	-	0.00	-	58.57	58.43	55.05
338	<b>1.7812</b>	0.00	-	0.35	58.57	58.43	55.40
339	<b>1.7896</b>	-	-	-	58.57	58.43	55.40
340	<b>1.7923</b>	-	-	-	58.57	58.43	55.40
341	<b>1.7924</b>	-	0.03	-	58.57	58.46	55.40
342	<b>1.7988</b>	-	-	0.20	58.57	58.46	55.60
343	<b>1.8000</b>	0.04	-	0.04	58.61	58.46	55.64
344	<b>1.8004</b>	0.17	-	0.06	58.78	58.46	55.69
345	<b>1.8010</b>	-	0.02	-	58.78	58.48	55.69
346	<b>1.8081</b>	-	0.07	-	58.78	58.55	55.69
347	<b>1.8108</b>	-	0.04	-	58.78	58.59	55.69
348	<b>1.8144</b>	-	-	-	58.78	58.59	55.69
349	<b>1.8162</b>	0.00	-	0.41	58.78	58.59	56.10
350	<b>1.8224</b>	0.00	0.06	-	58.78	58.65	56.10
351	<b>1.8226</b>	-	0.11	-	58.78	58.76	56.10
352	<b>1.8253</b>	-	0.01	-	58.78	58.77	56.10
353	<b>1.8278</b>	0.09	-	0.21	58.87	58.77	56.31



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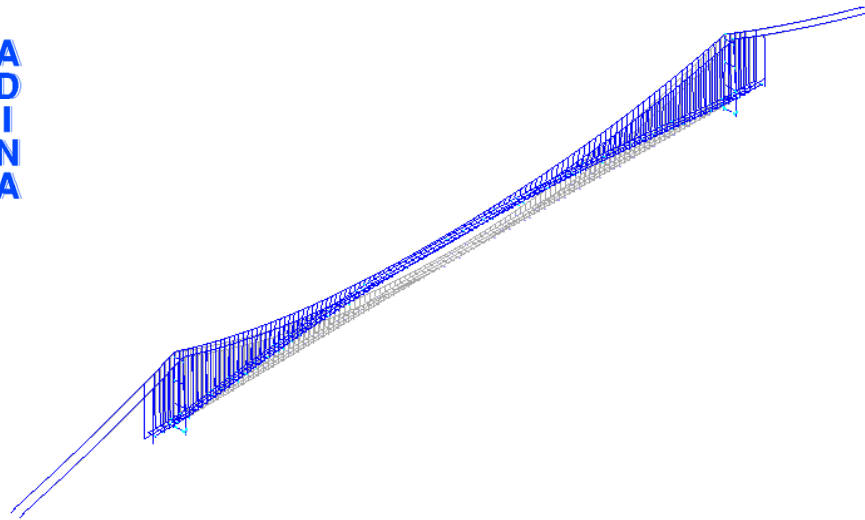
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354	<b>1.8331</b>	0.34	-	0.06	59.21	58.77	56.37
355	<b>1.8337</b>	-	-	-	59.21	58.77	56.37
356	<b>1.8454</b>	5.04	-	2.01	64.25	58.77	58.38
357	<b>1.8483</b>	0.01	0.02	0.00	64.26	58.79	58.38
358	<b>1.8547</b>	-	0.05	-	64.26	58.84	58.38
359	<b>1.8549</b>	-	-	-	64.26	58.84	58.38
360	<b>1.8575</b>	-	0.02	-	64.26	58.86	58.38



A  
D  
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A



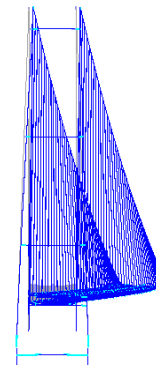
3D view



Plane view

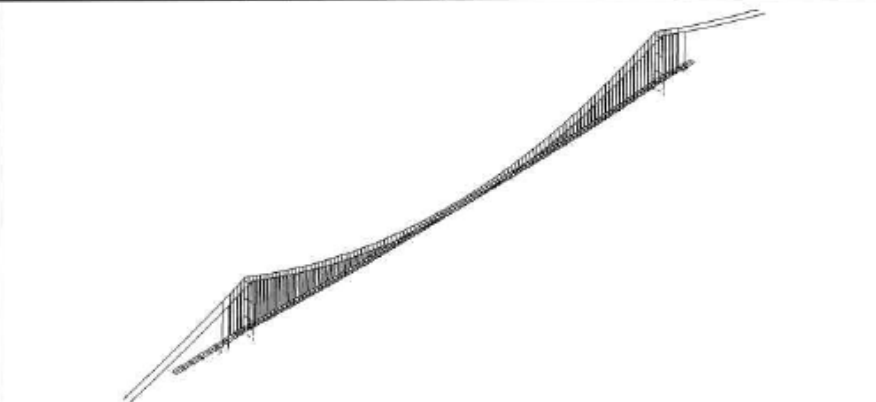


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
1	0.0313	-	18.03	-	0	391	0



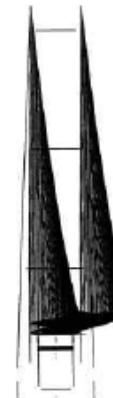
isometric view



front view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
1	0.0309	-	15.08	-

top view

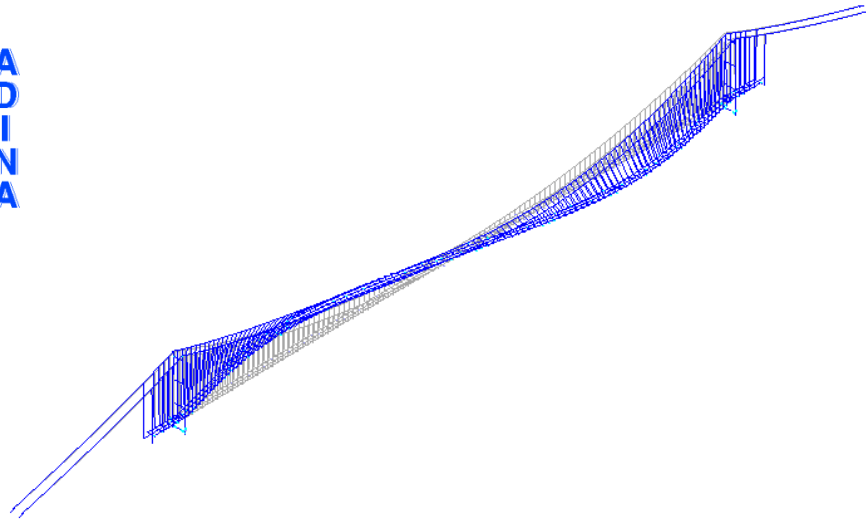


left view

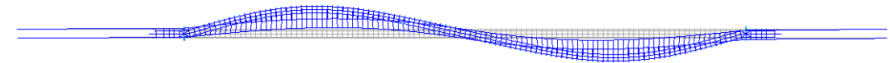
eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 1 (0.03089 Hz) (isometric/top/front/left view)



A  
D  
I  
N  
A



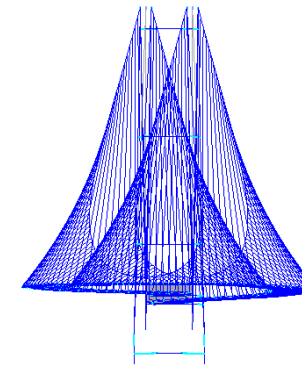
3D view



Plane view

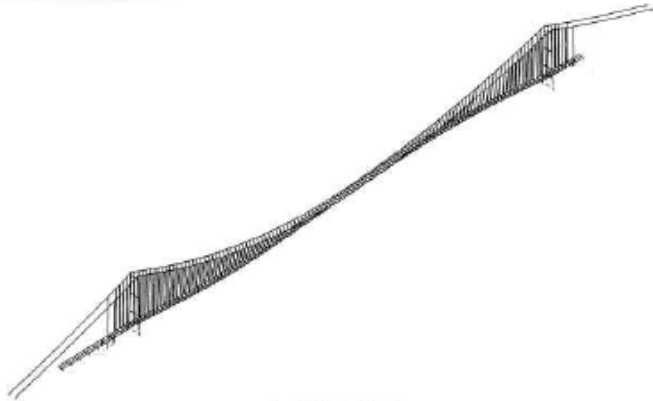


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
2	0.0585	-	0.00	-	0	1	0



isometric view



front view

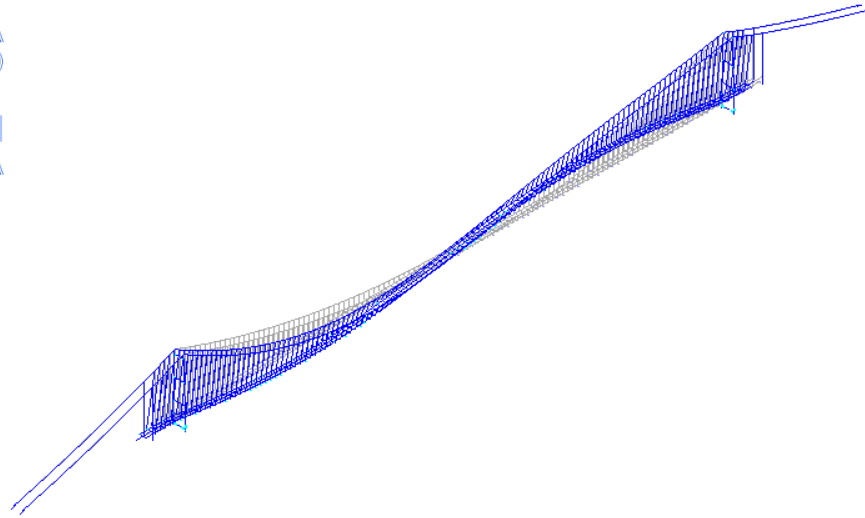


top view

left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
2	0.0569	-	-	-

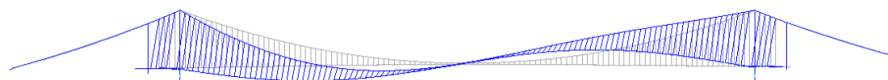
eigan13<'g6c1'4<global (phase1000 at time= 100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 2 (0.05695 Hz) (isometric/top/front/left view)



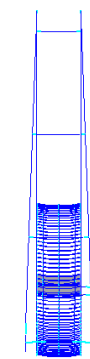
3D view



Plane view

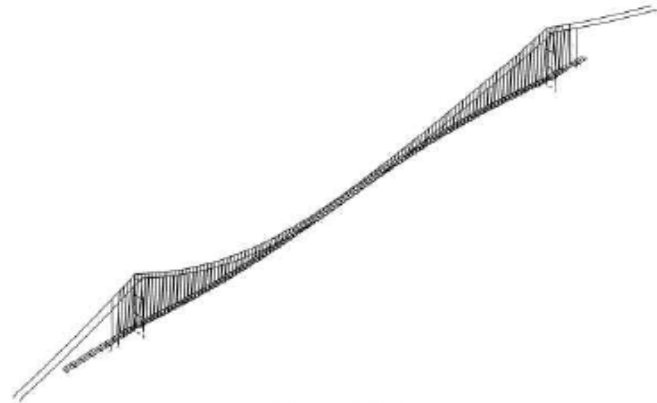


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
3	0.0593	5.29	-	0.00	-212	0	1



isometric view



front view

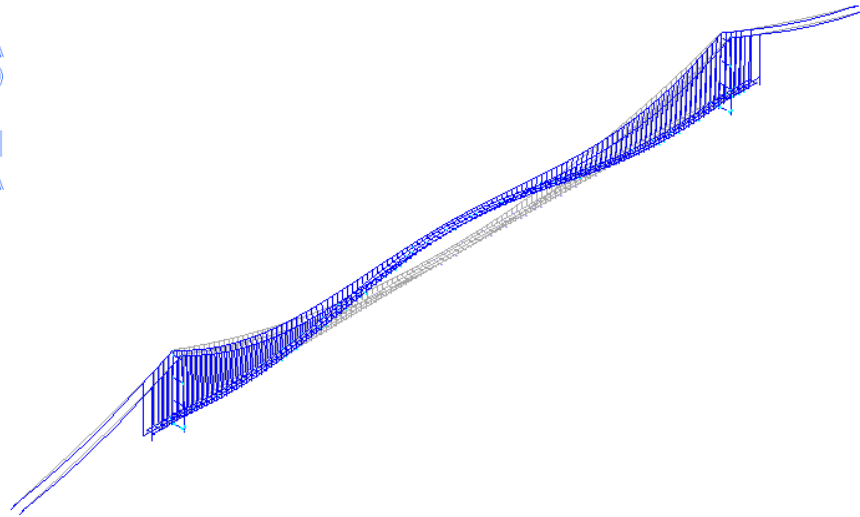
top view



left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
3	0.0593	4.40	-	-

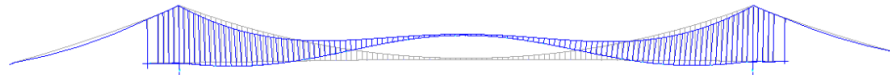
eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 3 (0.05932 Hz) (isometric/top/front/left view)



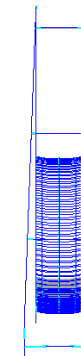
3D view



Plane view



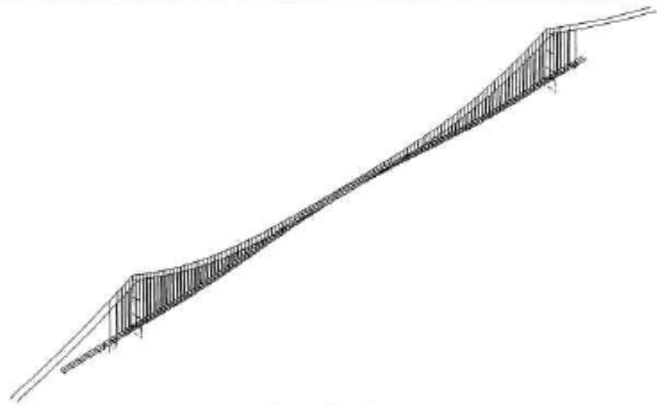
Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
<b>4</b>	<b>0.0809</b>	0.02	-	5.36	-12	0	213



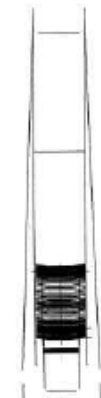


isometric view



front view

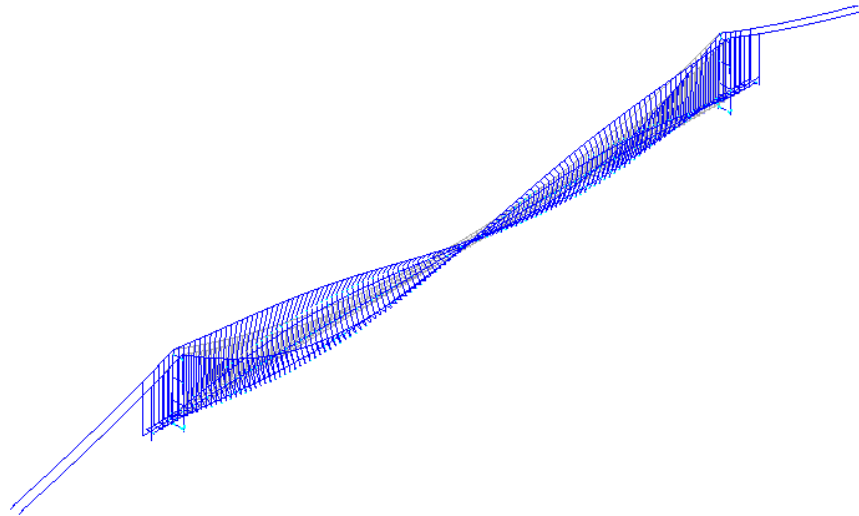
top view



left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
4	0.0809	0.02	-	4.40

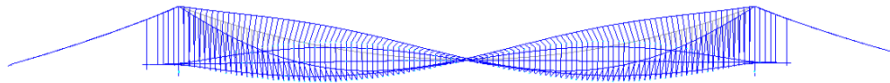
eigant3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 4 (0.08090 Hz) (isometric/top/front/left view)



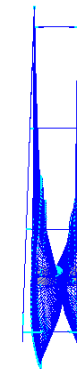
3D view



Plane view

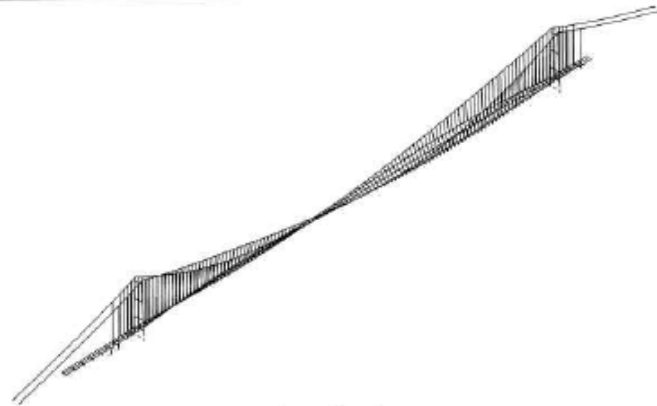


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
5	0.0833	-	0.00	-	0	3	0



isometric view



front view

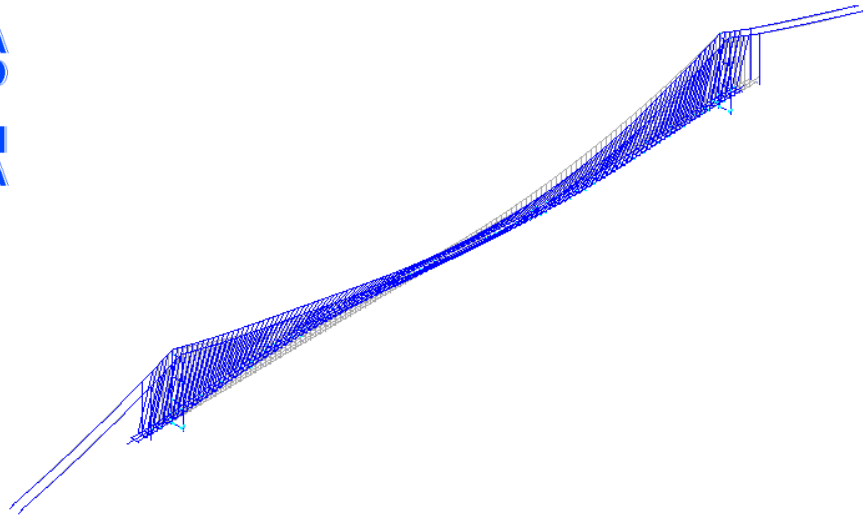
top view



left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
7	0.0851	-	0.00	-

eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 7 (0.08507 Hz) (isometric/top/front/left view)



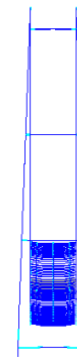
3D view



Plane view



Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
6	0.0849	6.63	-	0.00	-237	0	-6

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
6	0.0846	5.41	-	0.00



isometric view



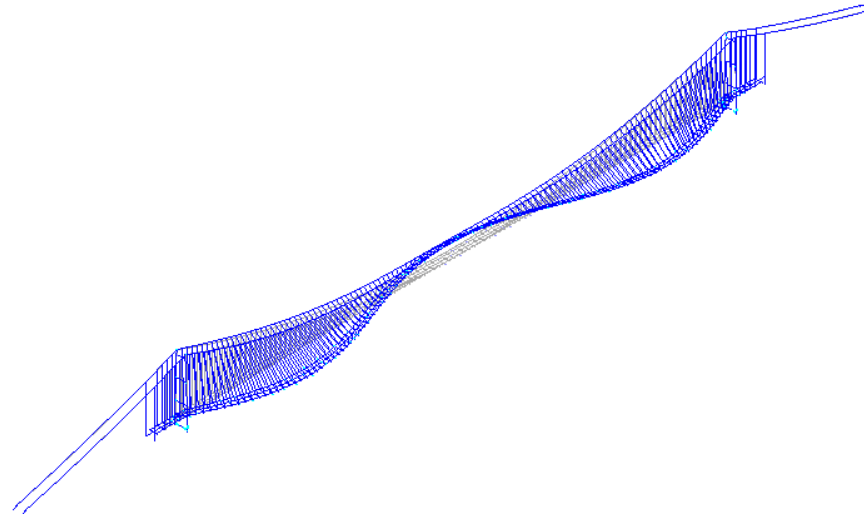
front view

top view

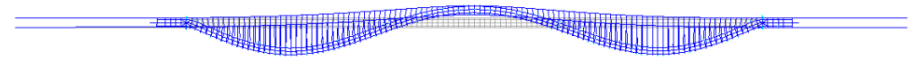


left view

eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 6 (0.08462 Hz) (isometric/top/front/left view)



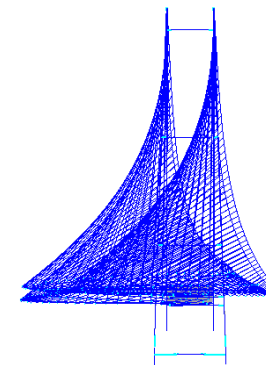
*3D view*



*Plane view*

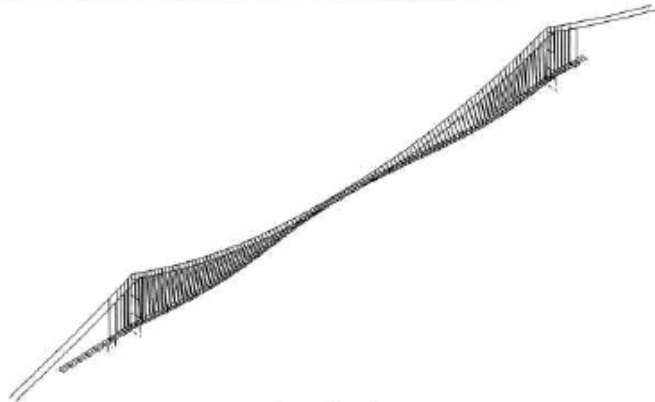


*Elevation XZ plane*



*Elevation YZ plane*

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
<b>7</b>	<b>0.0865</b>	-	0.44	-	0	-61	0



isometric view



front view

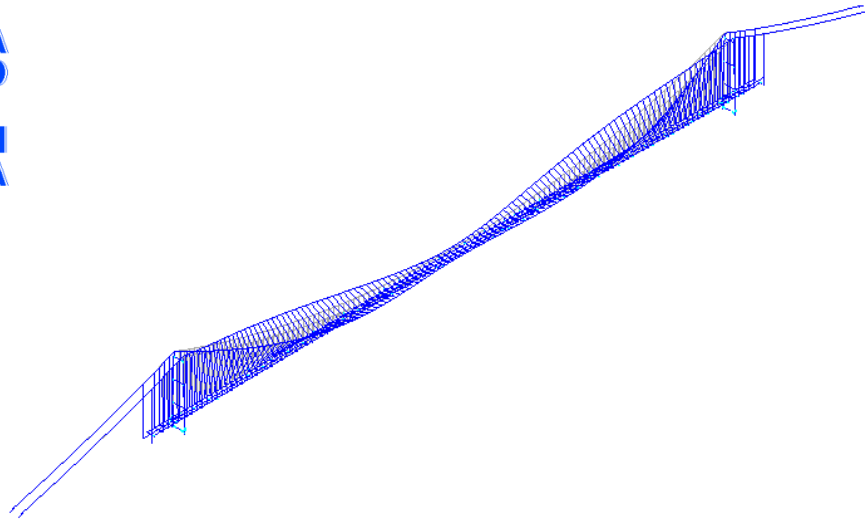
top view



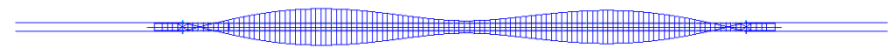
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
5	0.0835	-	0.32	-

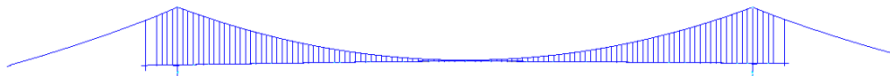
eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 5 (0.08352 Hz) (isometric/top/front/left view)



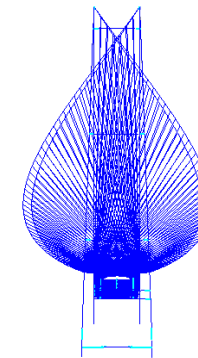
3D view



Plane view



Elevation XZ plane

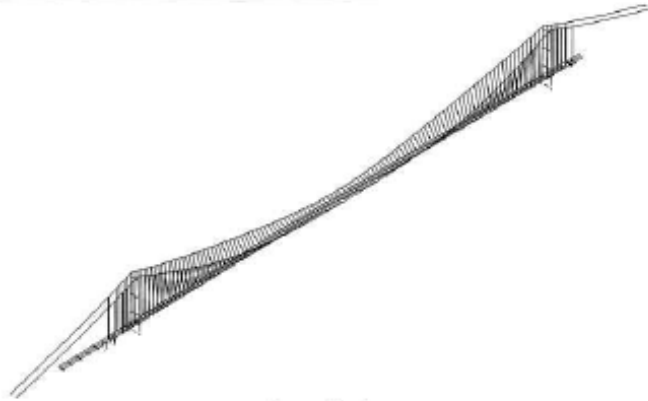


Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
8	0.0923	-	-	-	0	0	0



MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
8	0.0922	-	-	-



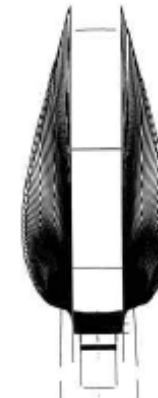
isometric view



front view

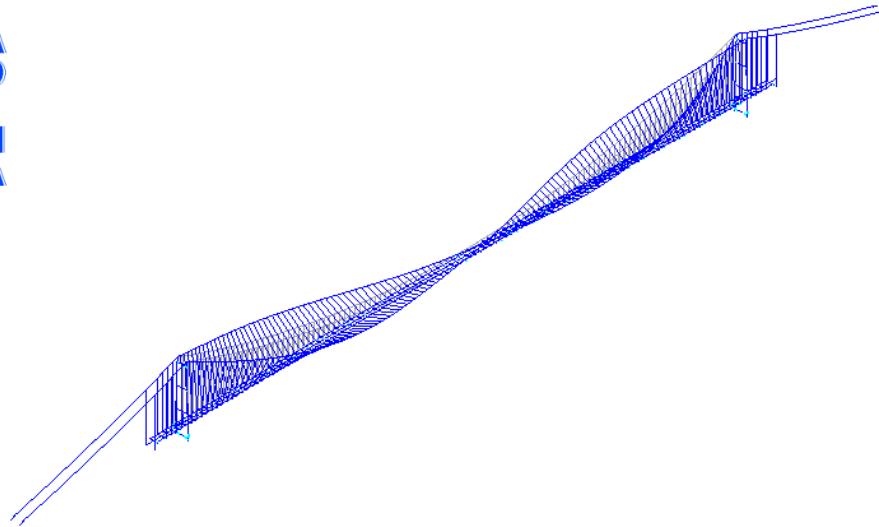


top view

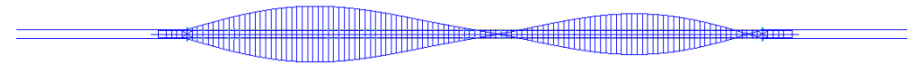


left view

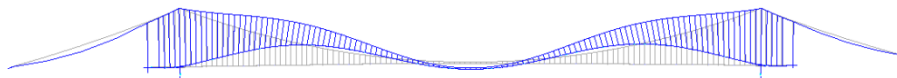
eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 8 (0.09216 Hz) (isometric/top/front/left view)



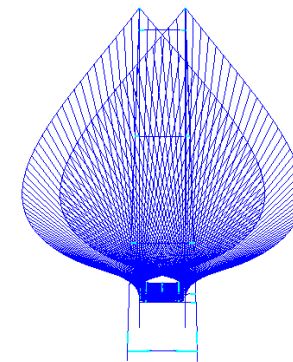
3D view



Plane view

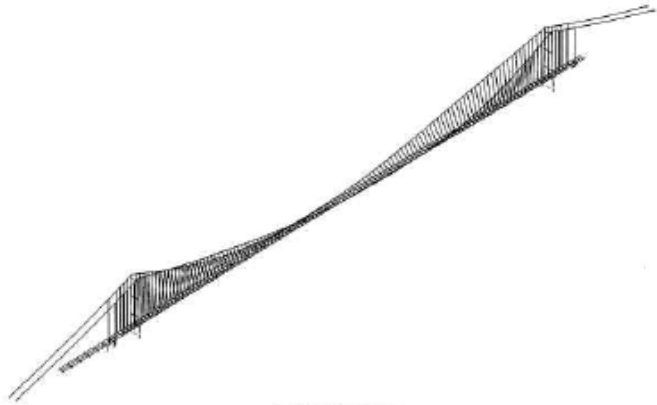


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
9	0.0998	-	-	-	0	0	0



isometric view



front view

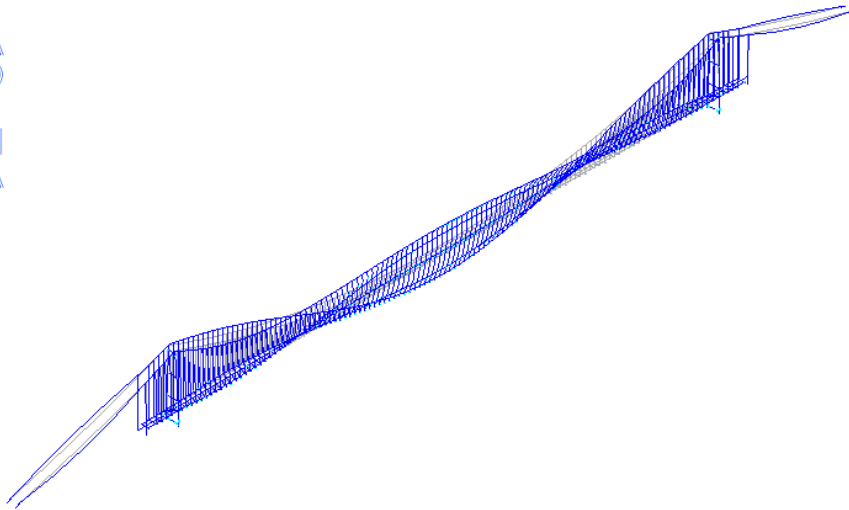
top view



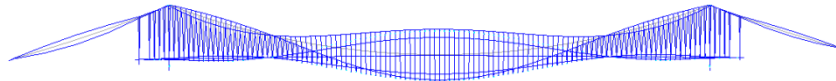
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
9	0.0996	-	-	-

eigani3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 9 (0.09965 Hz) (isometric/top/front/left view)

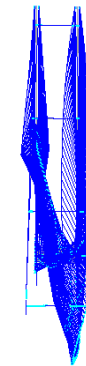


3D view



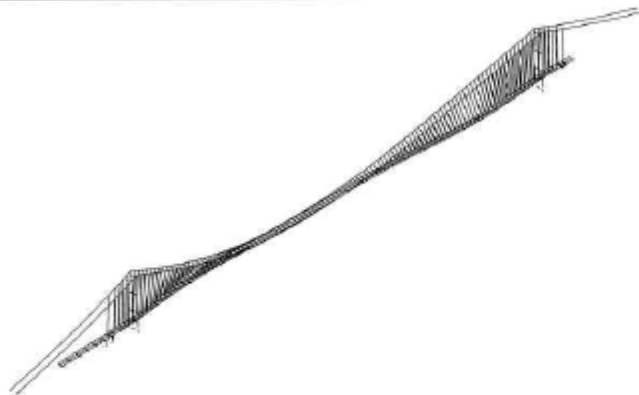
Elevation XZ plane

Plane view



Elevation YZ plane

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
10	0.1012	-	0.00	-	0	5	0



isometric view



front view

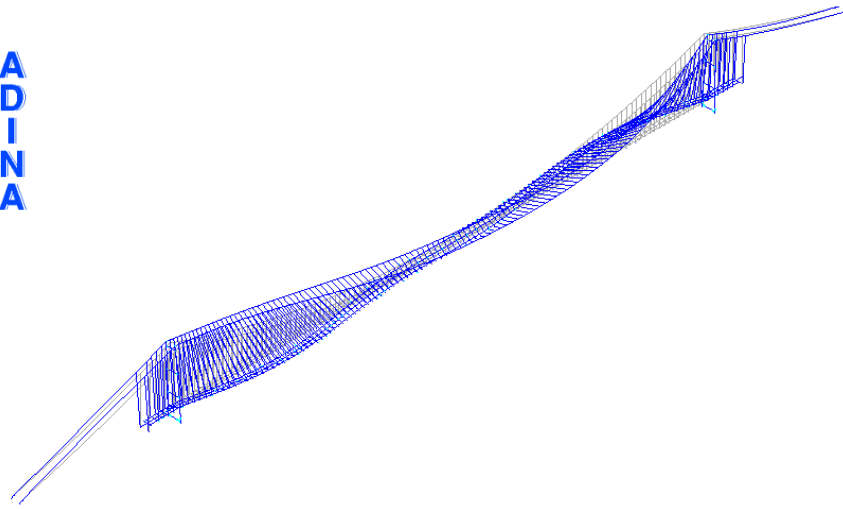
top view



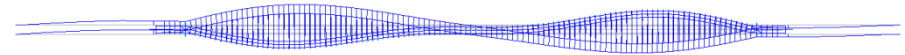
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
10	0.1005	-	0.03	-

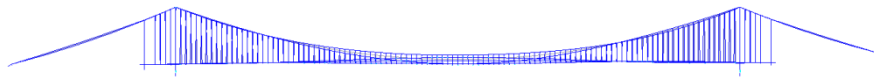
eigani3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 10 (0.10048 Hz) (isometric/top/front/left view)



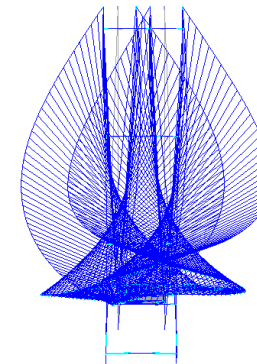
3D view



Plane view

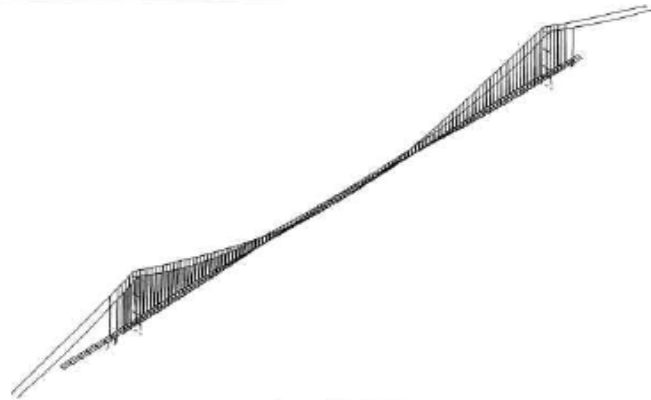


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
<b>11</b>	<b>0.1018</b>	-	0.04	-	0	19	0



isometric view



front view

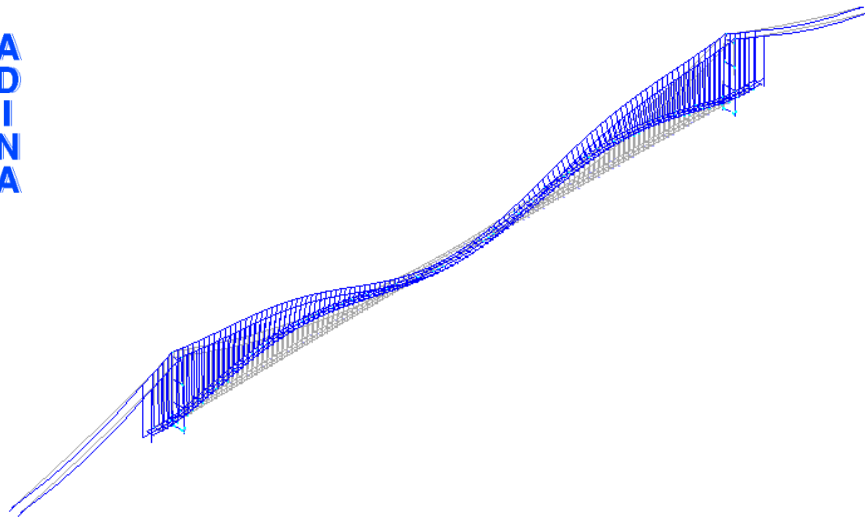
top view



left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
<b>11</b>	<b>0.1028</b>	-	-	-

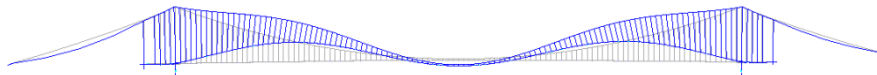
eigani3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 11 (0.10279 Hz) (isometric/top/front/left view)



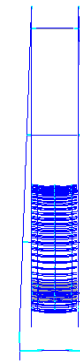
3D view



Plane view



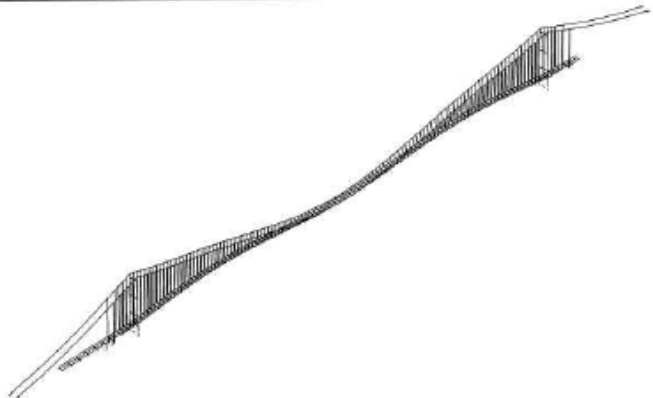
Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
12	0.1076	0.00	-	9.07	1	0	277





isometric view



front view

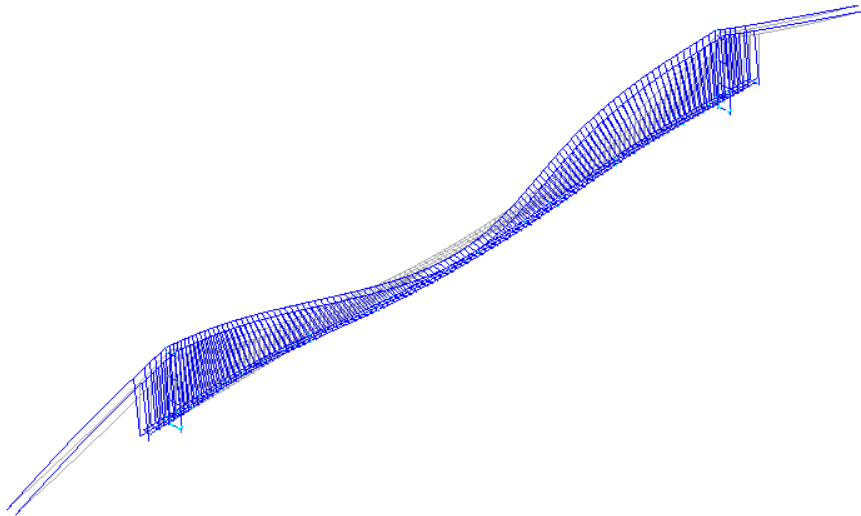
top view



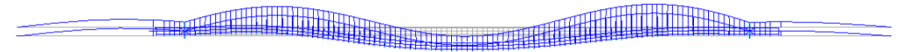
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
12	0.1076	-	-	7.40

eigani3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 12 (0.10757 Hz) (isometric/top/front/left view)



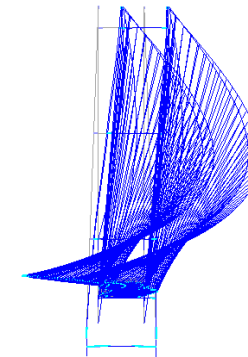
3D view



Plane view

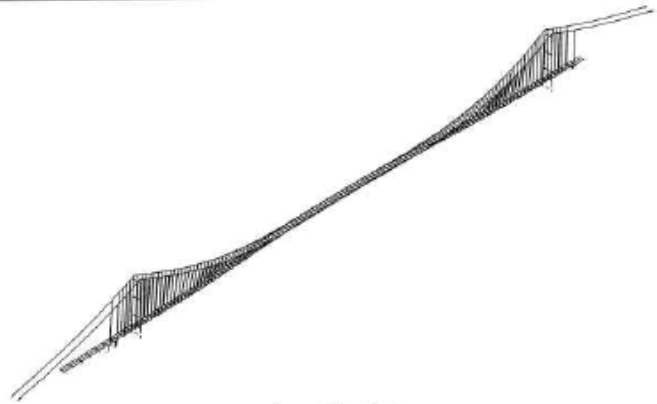


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
<b>13</b>	<b>0.1119</b>	-	4.69	-	0	199	0



isometric view



front view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
13	0.1114	-	4.14	-

top view

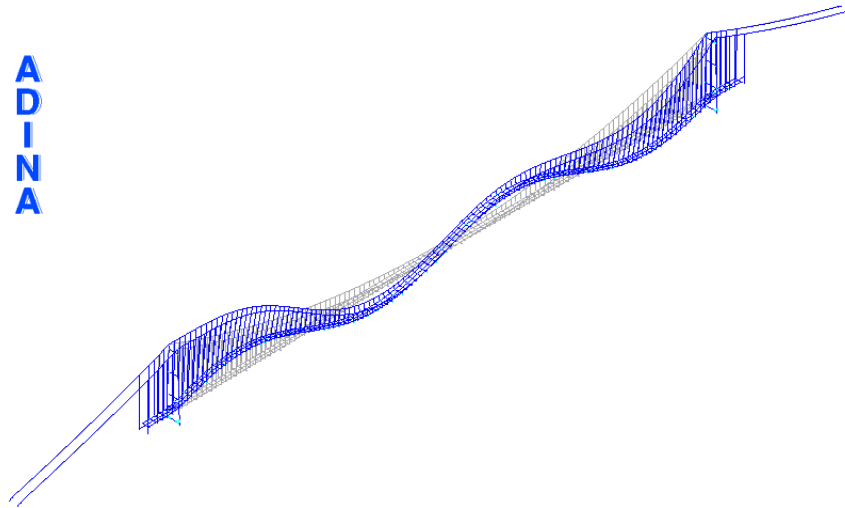


left view

eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 13 (0.11142 Hz) (isometric/top/front/left view)



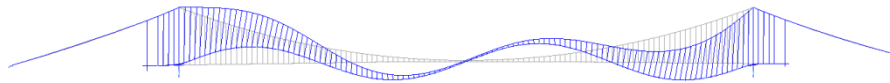
A  
D  
I  
N  
A



3D view



Plane view

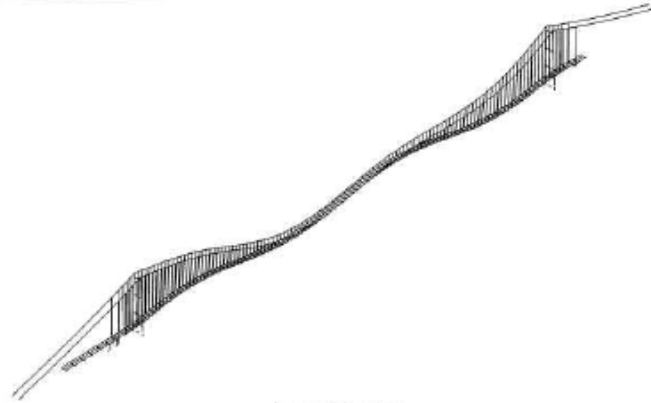


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
14	0.1273	0.17	-	0.00	38	0	3



isometric view



front view

top view



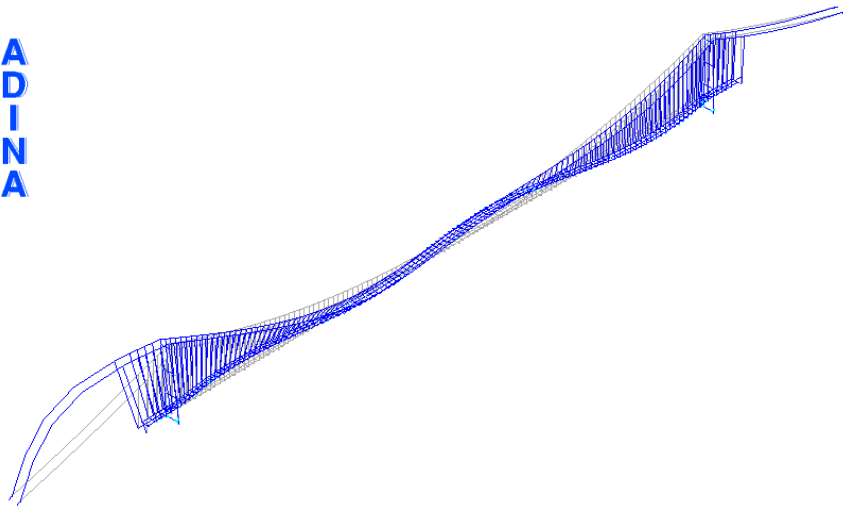
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
14	0.1273	0.15	-	0.00

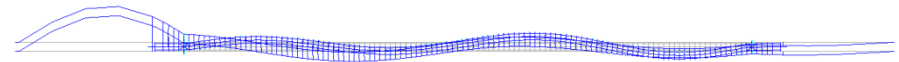
eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 14 (0.12728 Hz) (isometric/top/front/left view)



A  
D  
I  
N  
A



3D view



Plane view

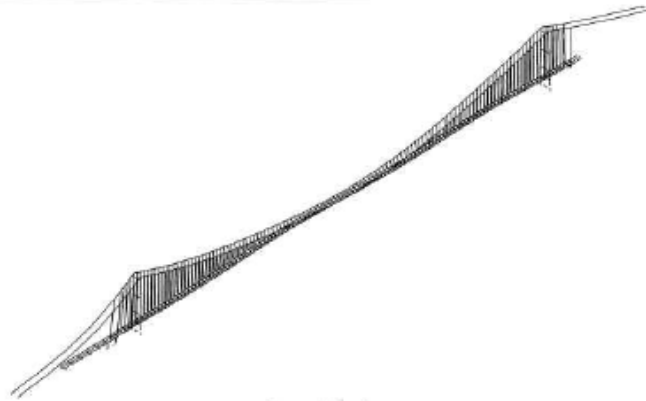


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
15	0.1327	-	2.29	-	0	139	0



isometric view



front view

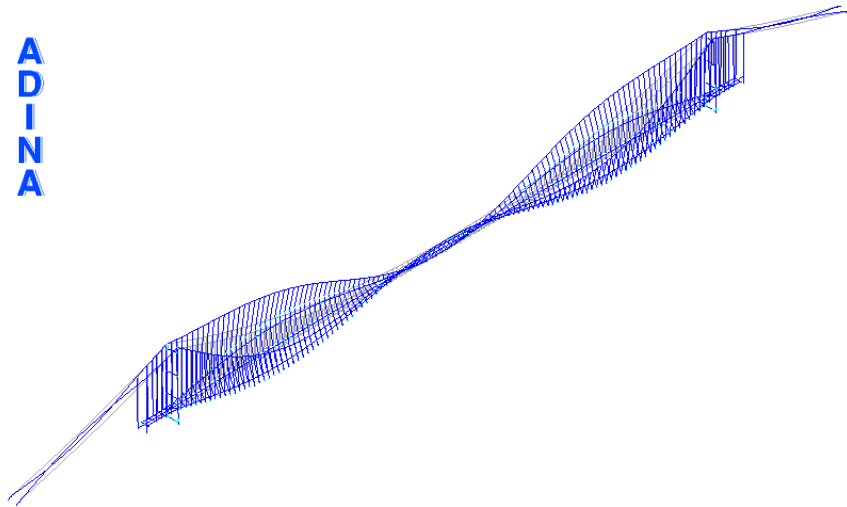
MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
15	0.1305	-	1.71	-

top view

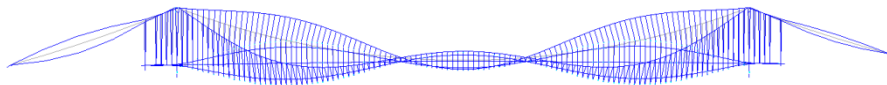


left view

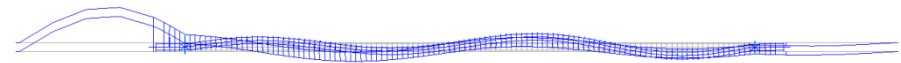
eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 15 (0.13046 Hz) (isometric/top/front/left view)



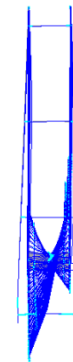
3D view



Elevation XZ plane



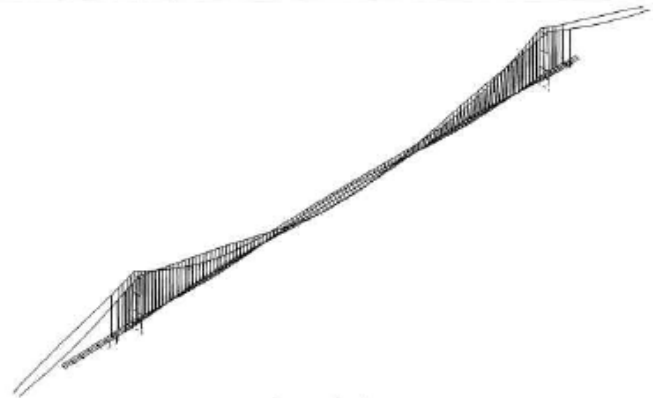
Plane view



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
16	0.1344	-	0.00	-	0	6	0





isometric view



front view

top view



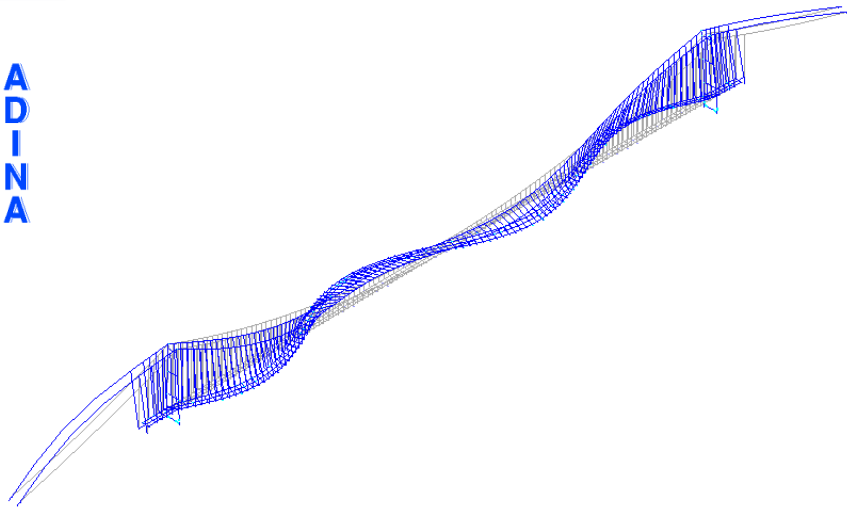
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
16	0.1353	-	0.00	-

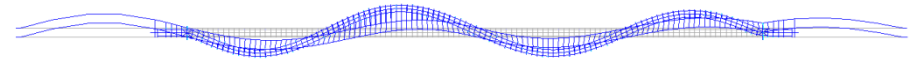
eiganl3<'g&c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 16 (0.13529 Hz) (isometric/top/front/left view)



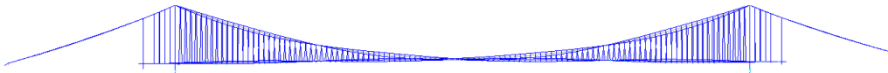
A  
D  
I  
N  
A



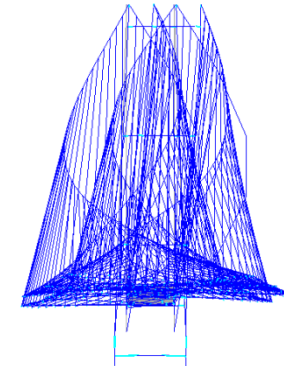
3D view



Plane view

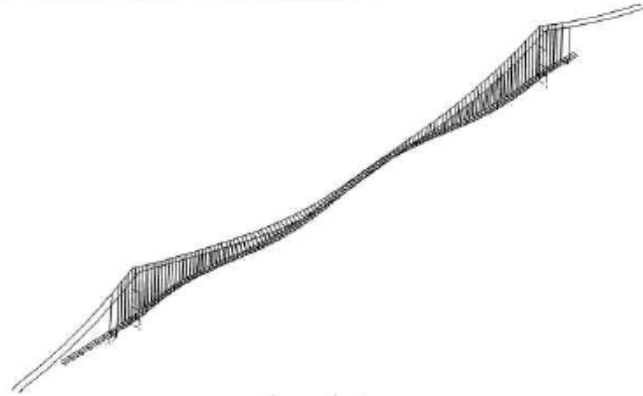


Elevation XZ plane



Elevation YZ plane

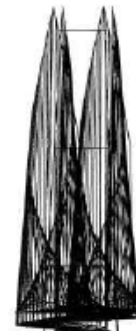
MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
17	0.1420	-	1.36	-	0	108	0



isometric view



front view



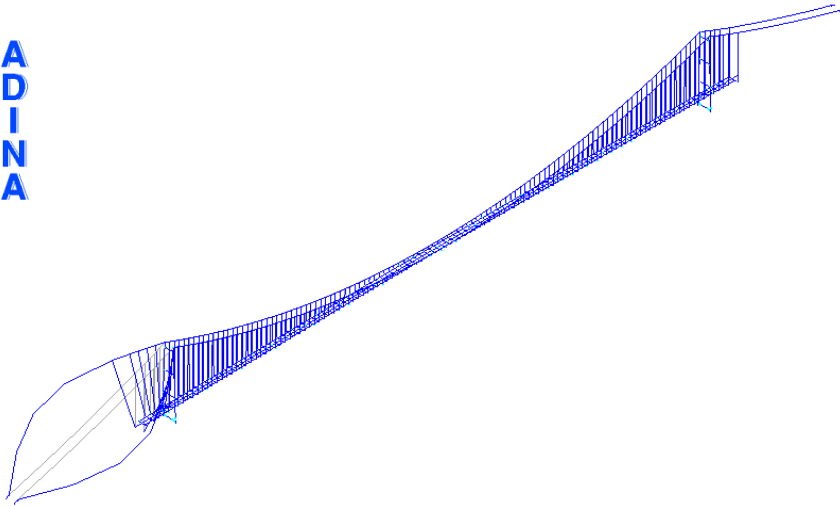
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
<b>17</b>	<b>0.1394</b>	-	1.08	-

eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 17 (0.13944 Hz) (isometric/top/front/left view)



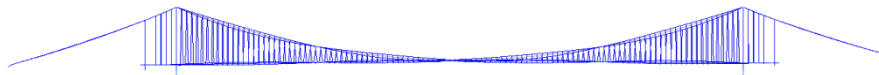
A  
D  
I  
N  
A



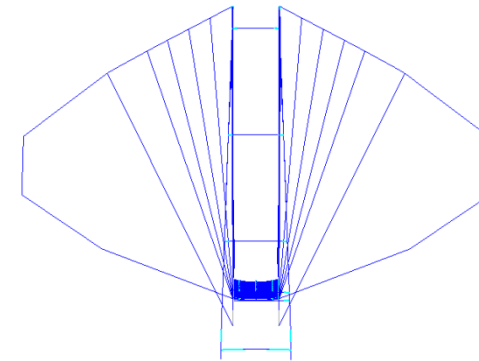
3D view



Plane view

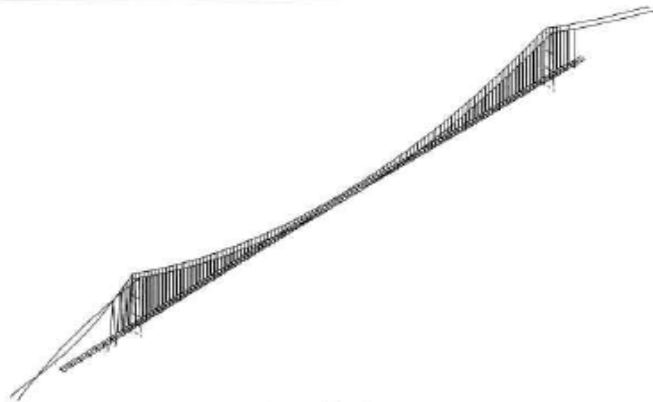


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
18	0.1431	-	-	-	0	0	0



isometric view



front view

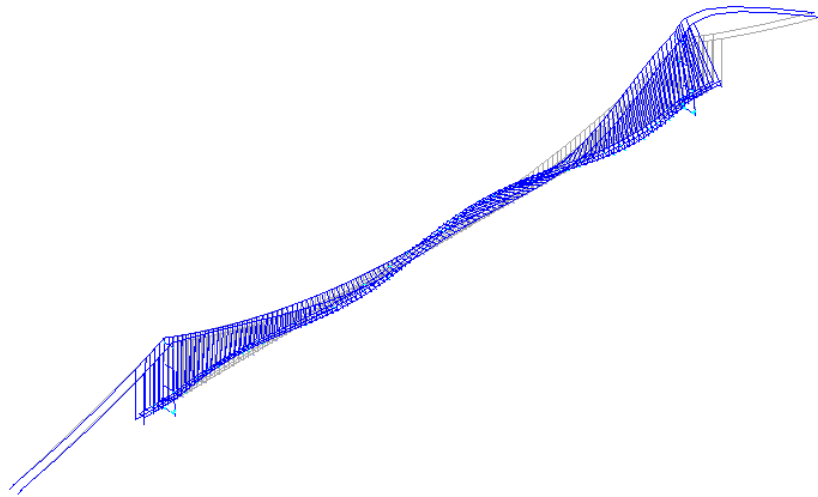
top view



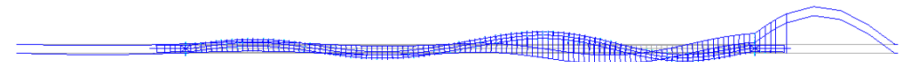
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
<b>18</b>	<b>0.1403</b>	-	-	-

eigen13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 18 (0.14033 Hz) (isometric/top/front/left view)



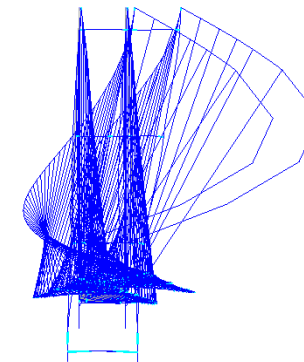
3D view



Plane view

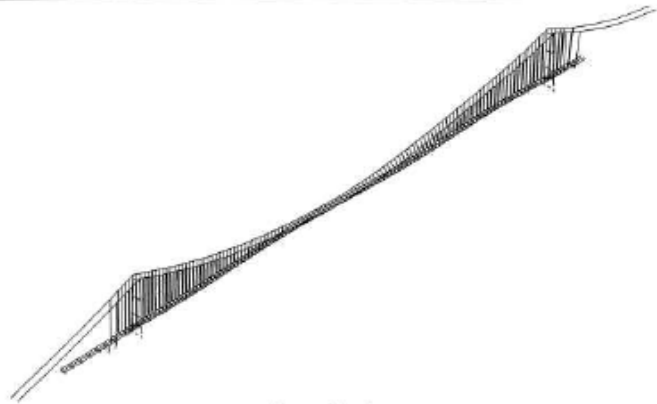


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
19	0.1546	-	3.36	-	0	169	0



isometric view



front view

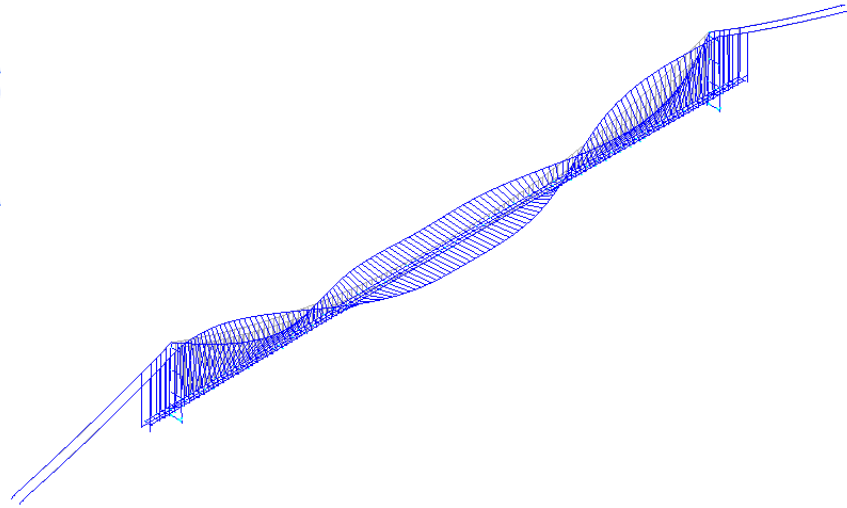
top view



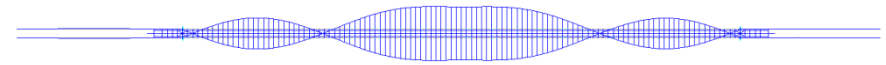
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
19	0.1521	-	2.81	-

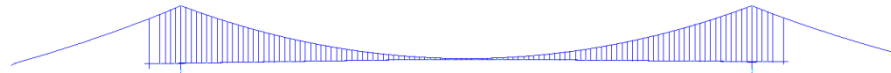
eigani3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 19 (0.15211 Hz) (isometric/top/front/left view)



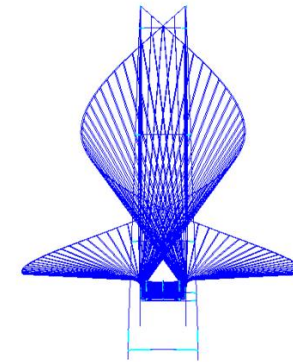
3D view



Plane view



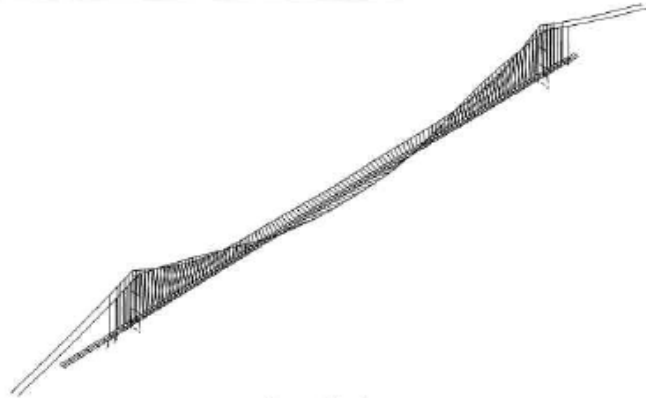
Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
20	0.1566	-	-	-	0	0	0





isometric view



front view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
20	0.1564	-	-	-

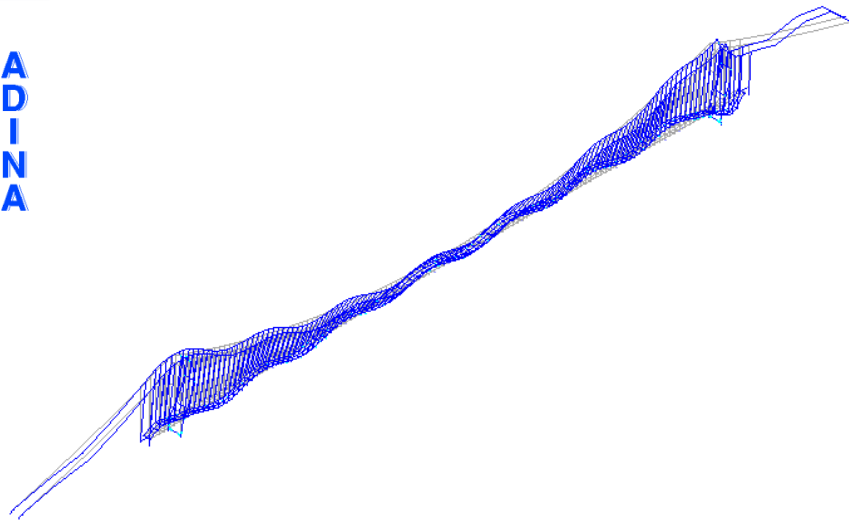


top view



left view

eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 20 (0.15636 Hz) (isometric/top/front/left view)



3D view



Plane view

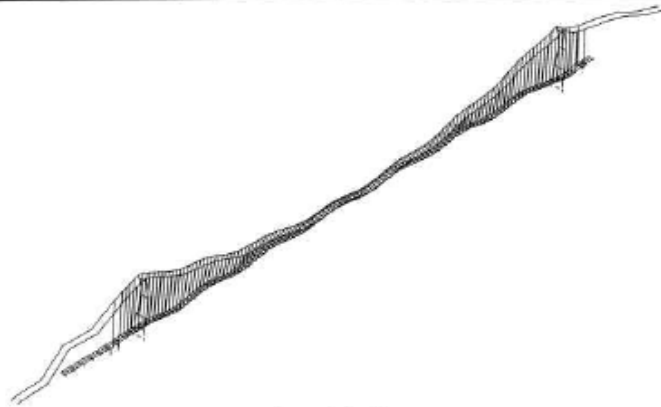


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X	Y	Z	X	Y	Z
	Hz	%	%	%			
67	0.4190	20.97	-	0.00	422	0	-6



isometric view



front view

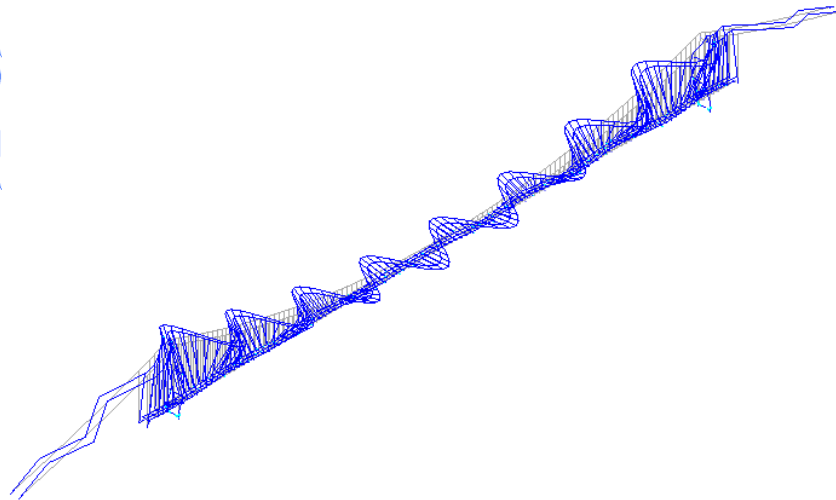
top view



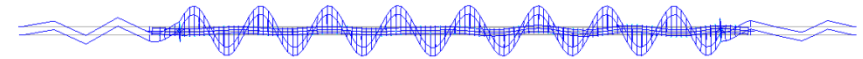
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
<b>73</b>	<b>0.4173</b>	17.24	-	0.02

eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 73 (0.41733 Hz) (isometric/top/front/left view)



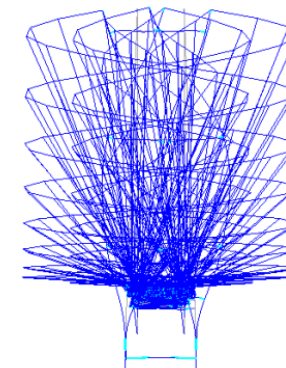
3D view



Plane view

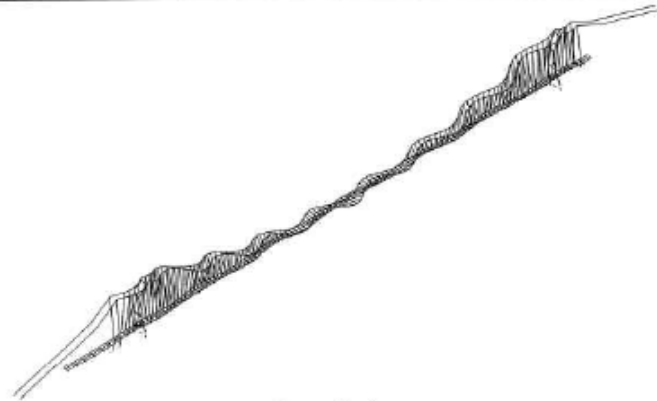


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
<b>118</b>	<b>0.6735</b>	-	0.01	-	0	7	0



isometric view



front view

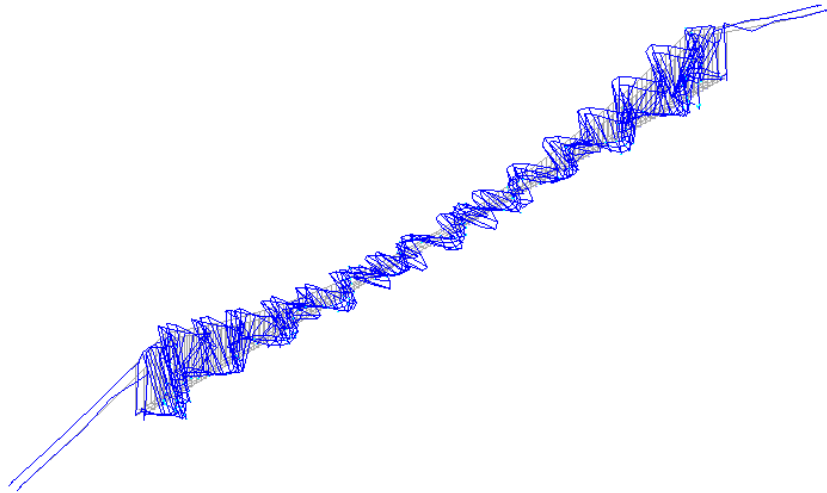
MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
125	0.6854	-	0.64	-

top view

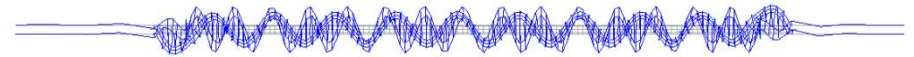


left view

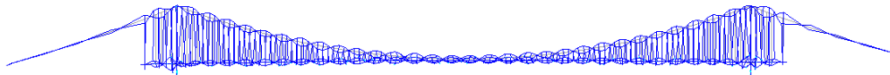
eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 125 (0.68544 Hz) (isometric/top/front/left view)



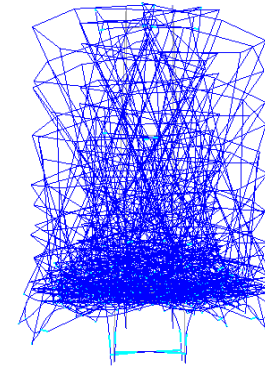
3D view



Plane view



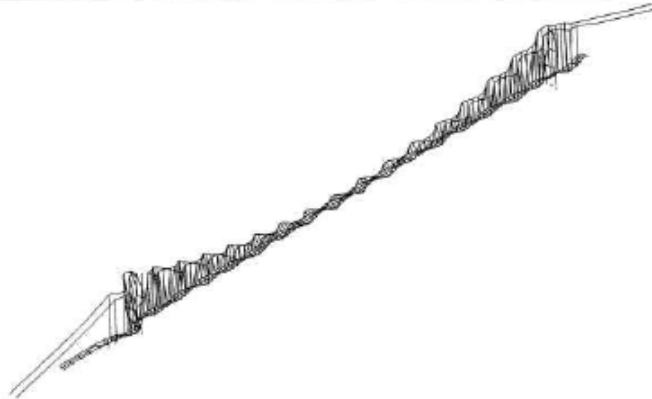
Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
219	1.3080	-	0.11	-	0	-30	0

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
<b>231</b>	<b>1.3117</b>	-	1.37	-



isometric view



front view

top view

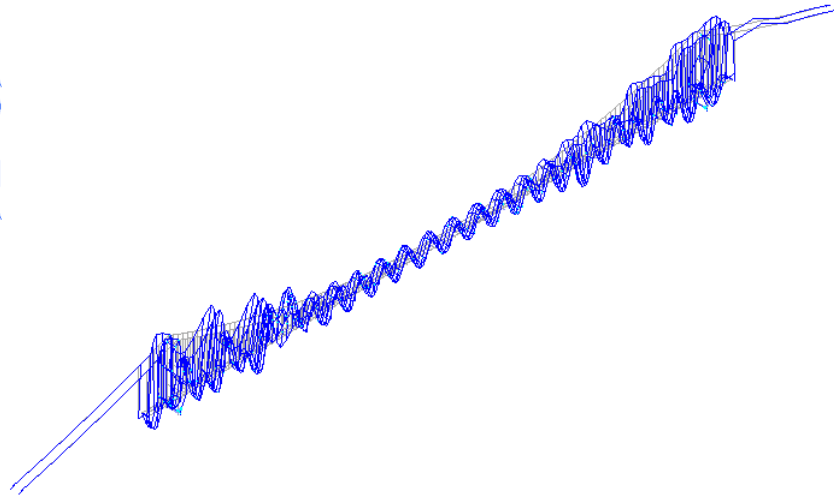


left view

eigan13<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 231 (1.31173 Hz) (isometric/top/front/left view)



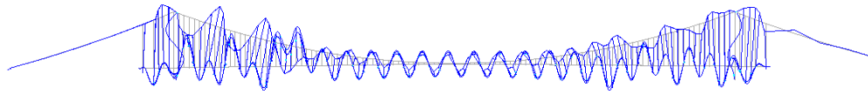
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I  
N  
A



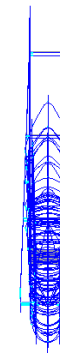
3D view



Plane view



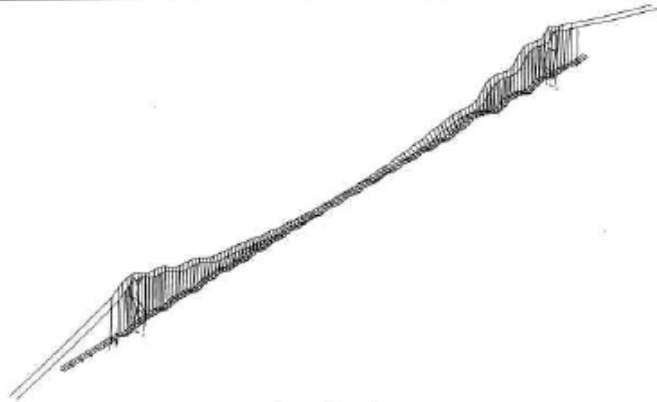
Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
241	1.4290	1.55	-	0.31	115	0	-51





isometric view



front view

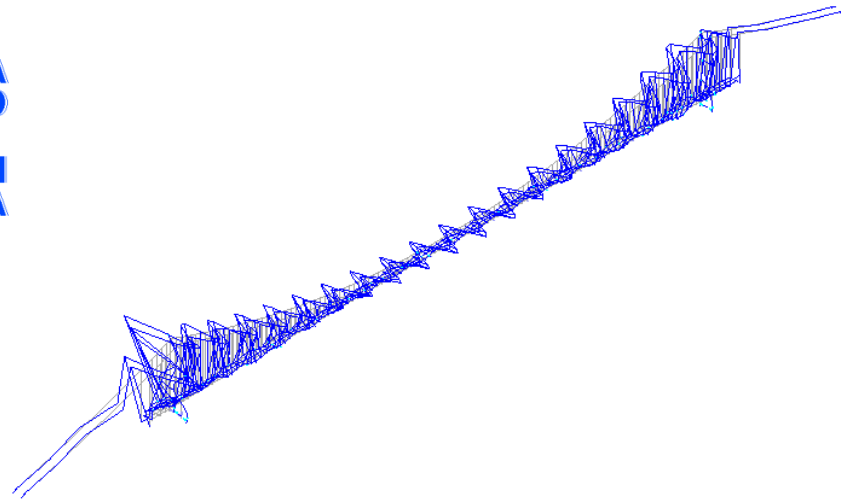
top view



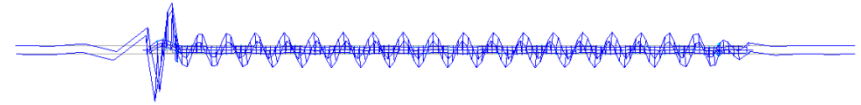
left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
254	1.4144	4.65	-	0.32

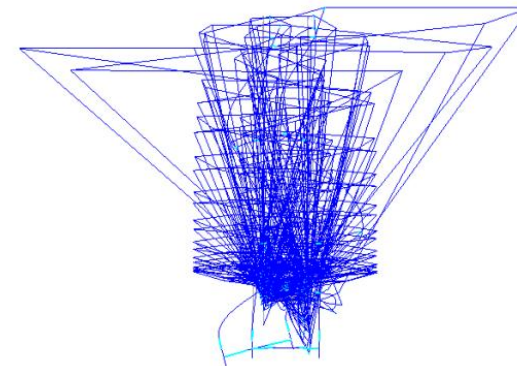
eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz); Frequency no 254 (1.41435 Hz) (isometric/top/front/left view)



3D view



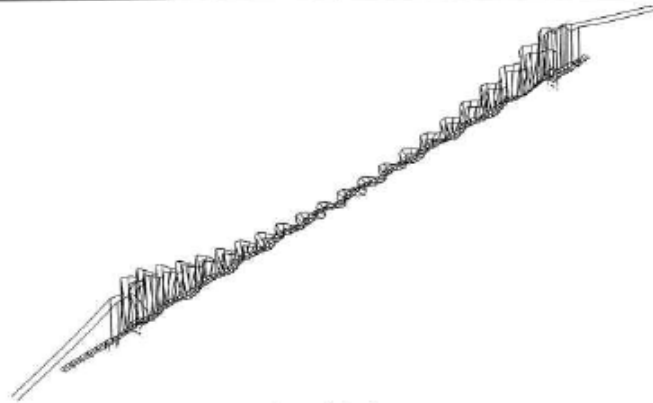
Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
274	1.6303	-	9.52	-	0	-284	0

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
<b>307</b>	<b>1.6327</b>	-	10.37	-



isometric view



front view

top view

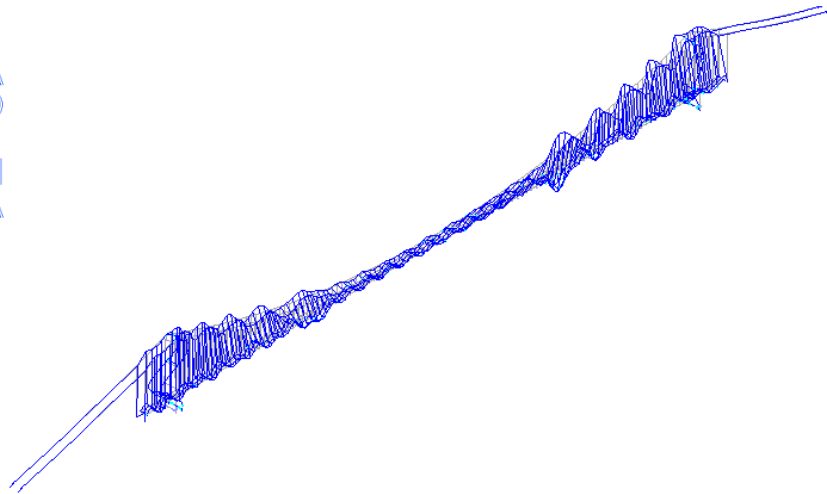


left view

eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 307 (1.63269 Hz) (isometric/top/front/left view)



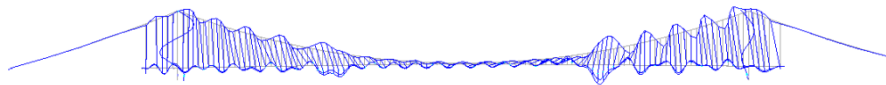
A  
D  
I  
N  
A



3D view



Plane view

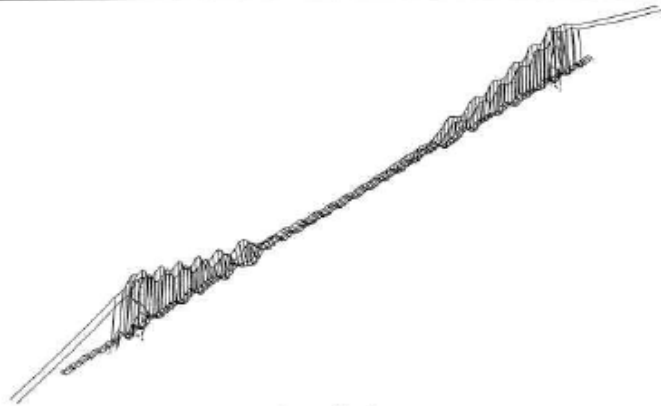


Elevation XZ plane



Elevation YZ plane

MODE	FREQUENCY Hz	MODAL MASS			MODAL PARTICIPATION FACTOR		
		X %	Y %	Z %	X	Y	Z
300	1.7680	5.11	-	0.09	208	0	27



isometric view



front view

top view





left view

MODE	FREQUENCY Hz	MODAL MASS		
		X %	Y %	Z %
356	1.8454	5.04	-	2.01

eiganl3<'g6c1'4<global (phase1000 at time=100.0days)  
Free Vibration Analysis (shift value = 0.000 Hz): Frequency no 356 (1.84536 Hz) (isometric/top/front/left view)



		<b>Ponte sullo Stretto di Messina</b> <b>PROGETTO DEFINITIVO</b>		
Validazione del modello globale agli elementi finiti	<i>Codice documento</i> PS0005	<i>Rev</i> 0	<i>Data</i> 13-04-2011	

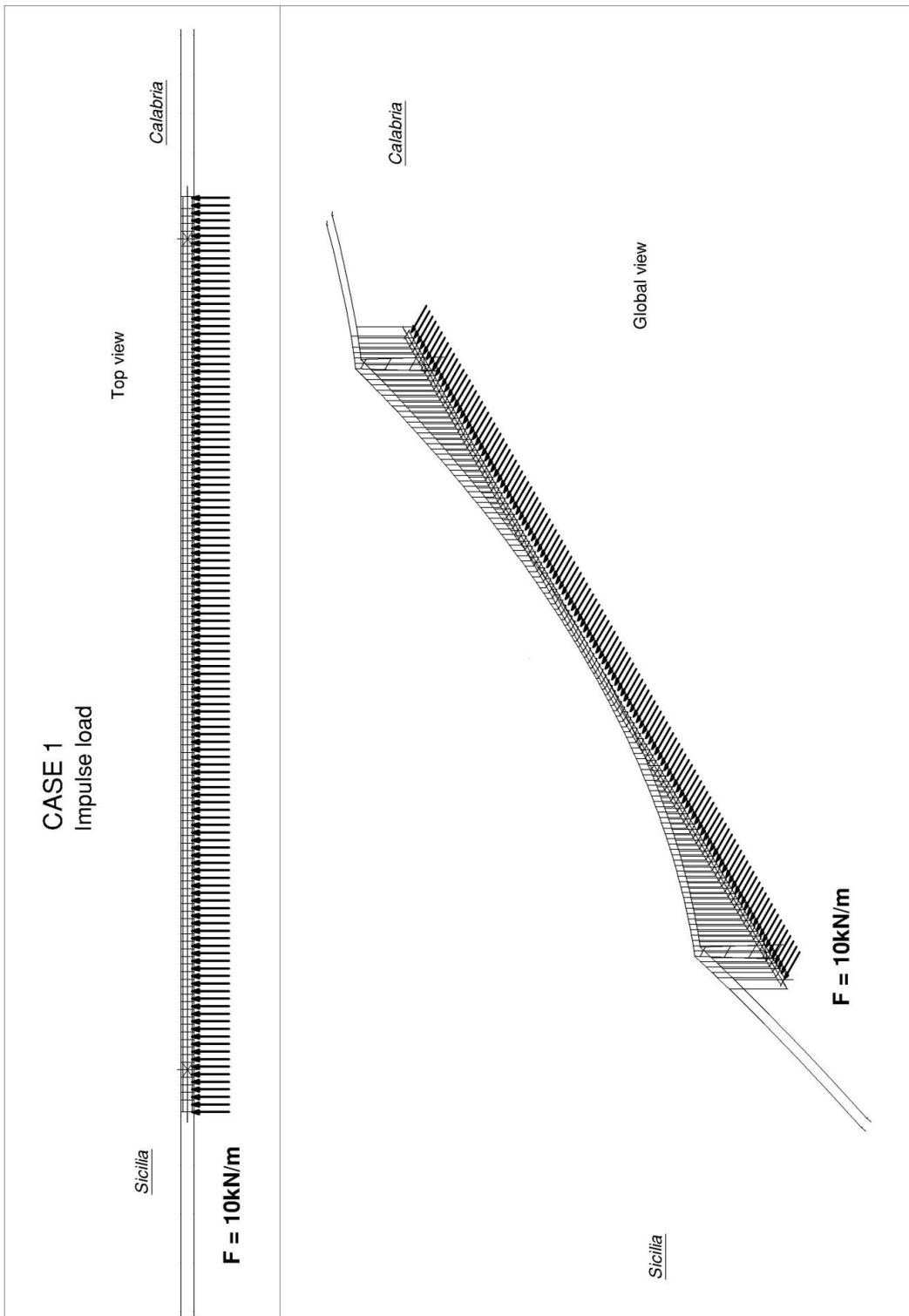
## 8 Casi di carico dinamico (impulsivo) - Risultati

I casi di carico impulsivo sono riportati nell'ordine dal Caso 1 al Caso 3. L'organizzazione dei risultati all'interno di ciascun caso è identica. Il generico caso comprende i seguenti risultati in formato di grafici time history sia per ADINA che IBDAS:

- spostamento del cavo nella sezione di mezzeria
- forze nei cavi alle torri
- spostamenti in testa alle torri
- forze nei tie down
- momenti alla base delle torri

Solo per ADINA. Spettro di Fourier dello spostamento in un punto significativo al caso di carico (spostamento trasversale del punto di mezzeria per il caso 1 e spostamento longitudinale della testa torri per il caso 3).

**8.1 Caso 1 – Carico uniforme distribuito trasversalmente sull’impalcato (buffer free-free)**





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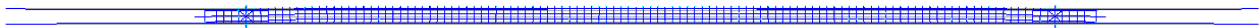
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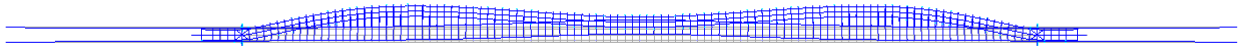
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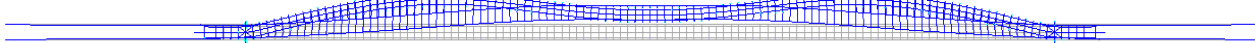
TIME 2.000



TIME 4.000



TIME 6.000



TIME 8.000



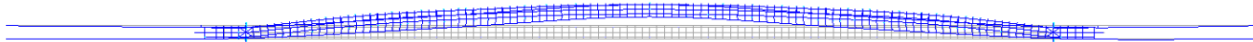
TIME 10.00



TIME 12.00



TIME 14.00



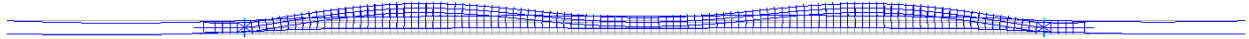
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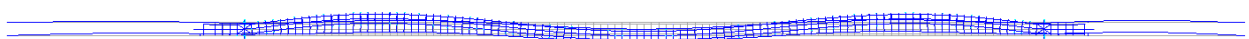
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TIME 16.00



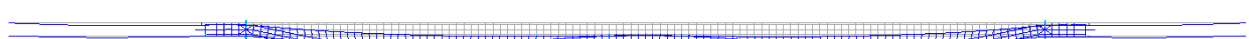
TIME 18.00



TIME 20.00



TIME 22.00



TIME 24.00



TIME 26.00



TIME 28.00



TIME 30.00



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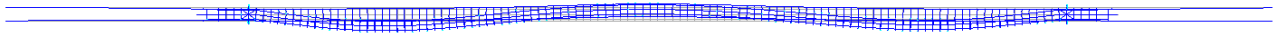
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TIME 32.00



TIME 34.00



TIME 36.00



TIME 401.00

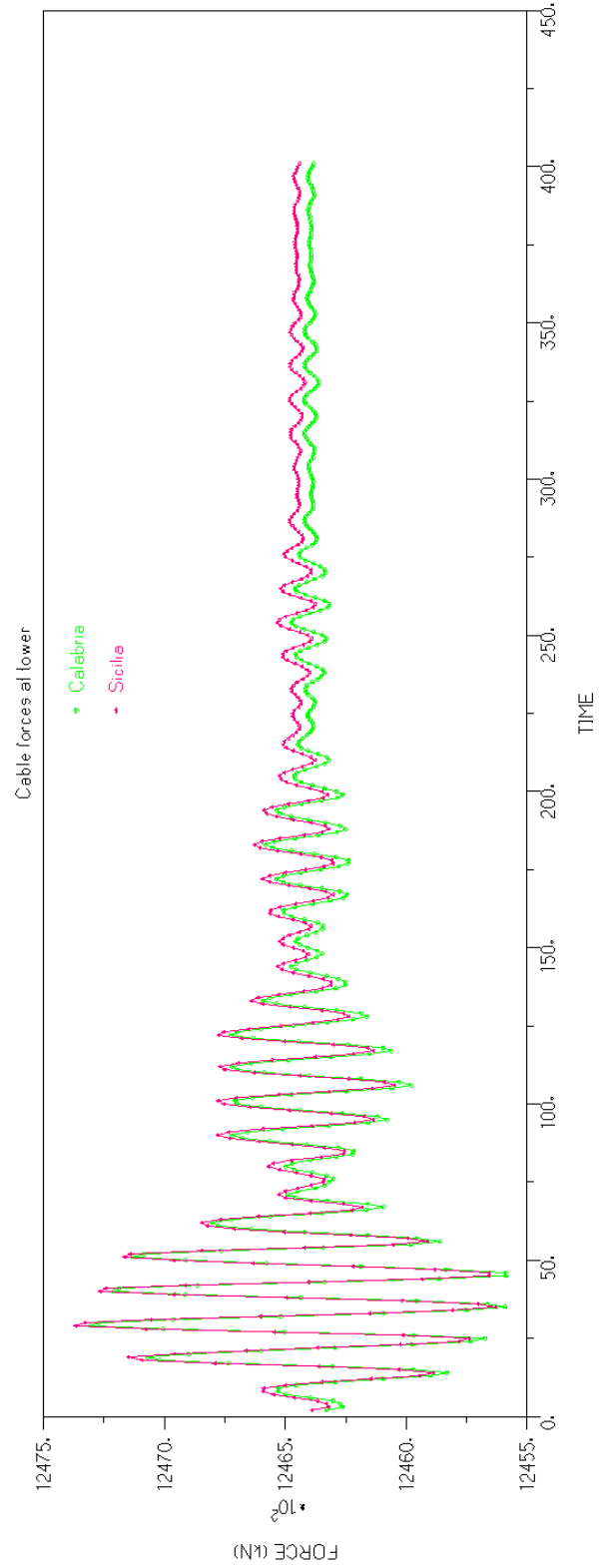
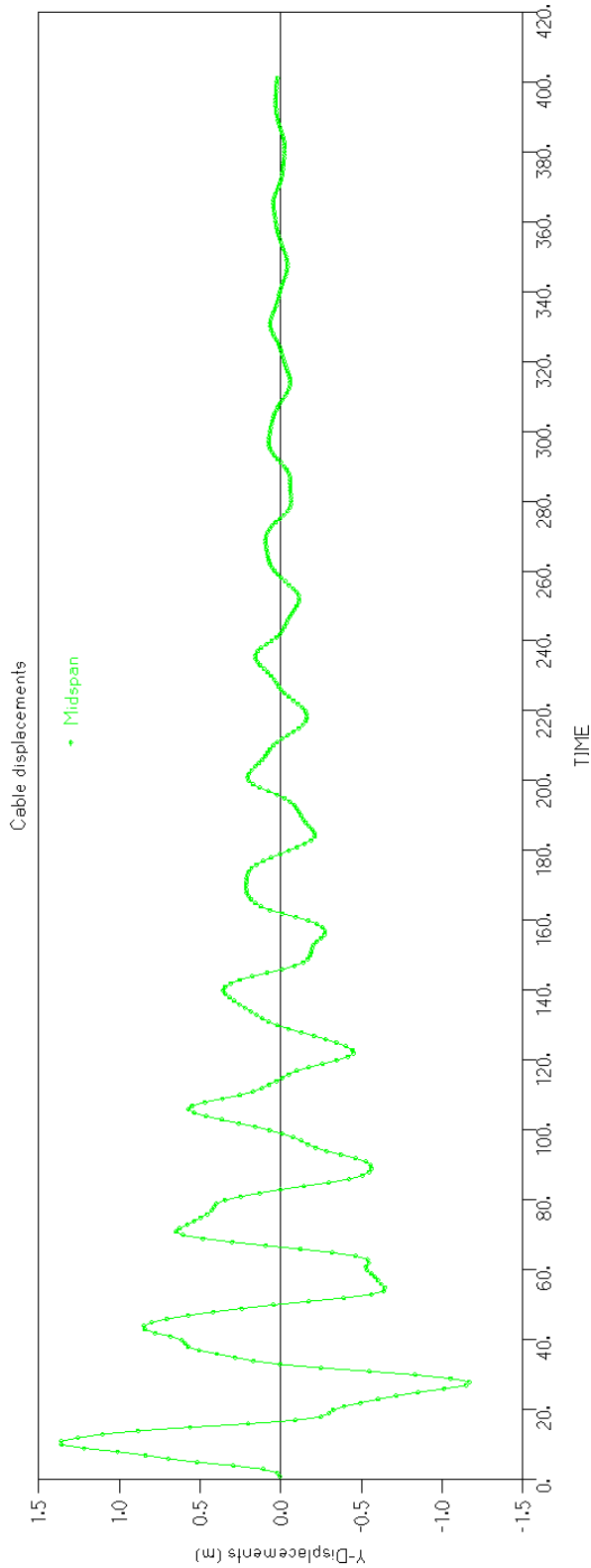


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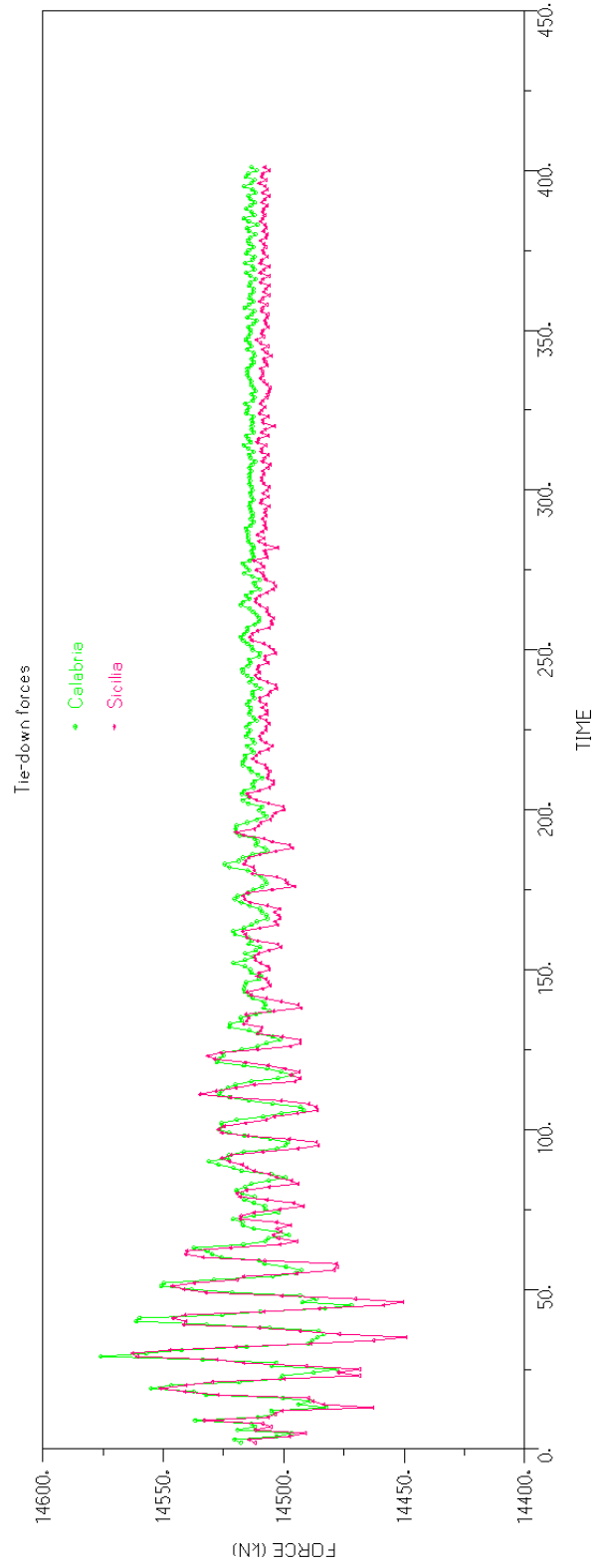
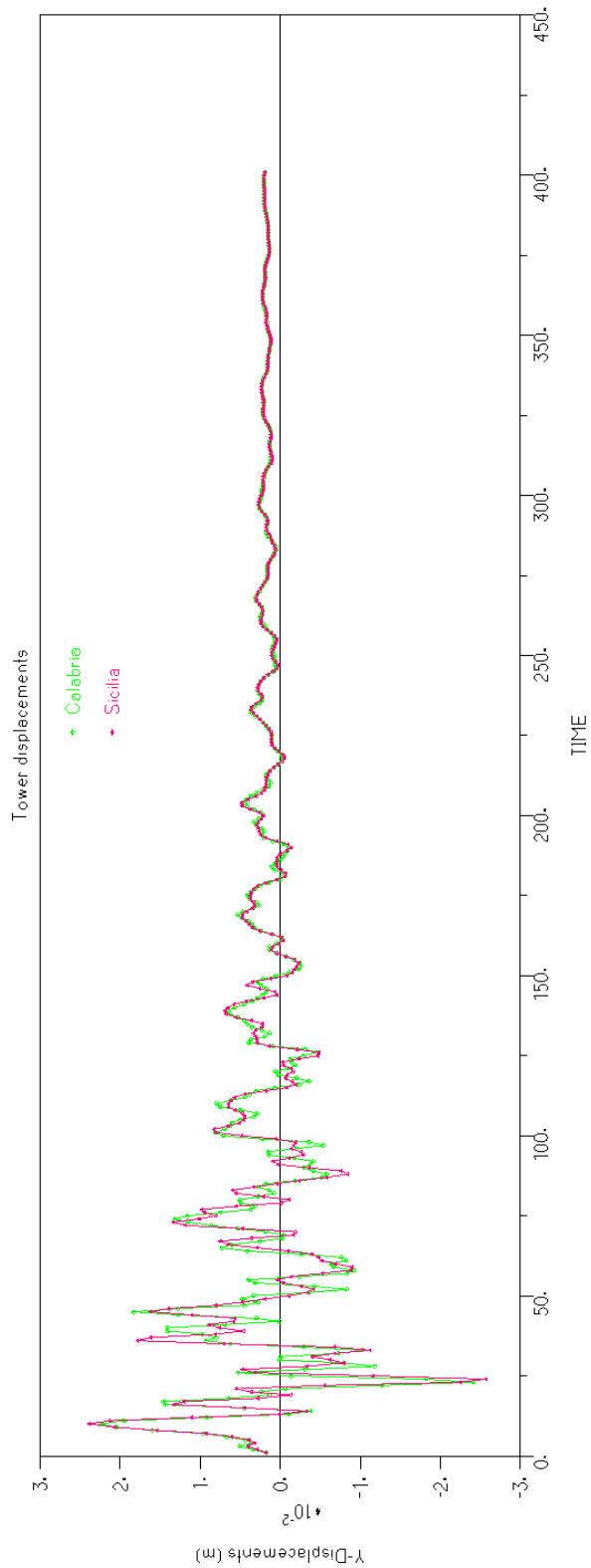


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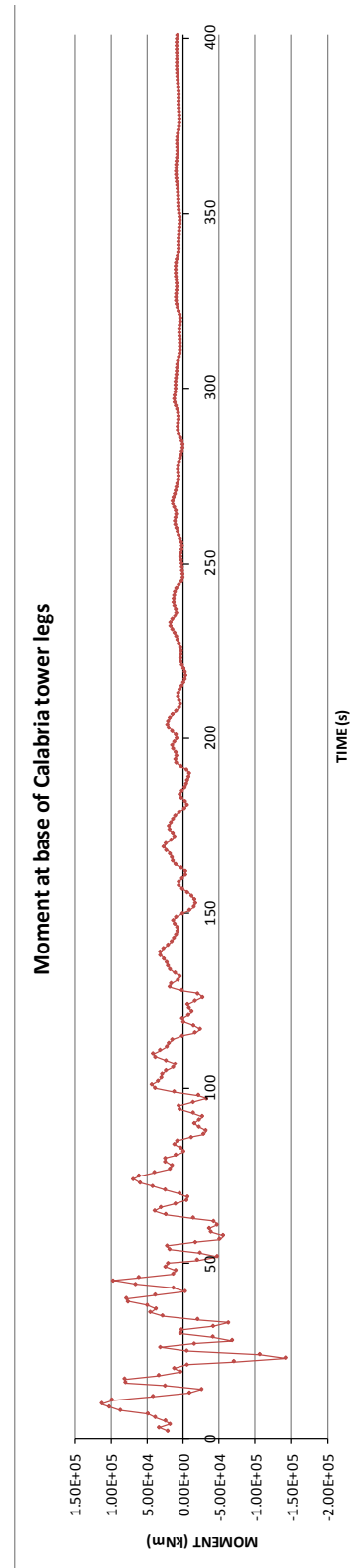
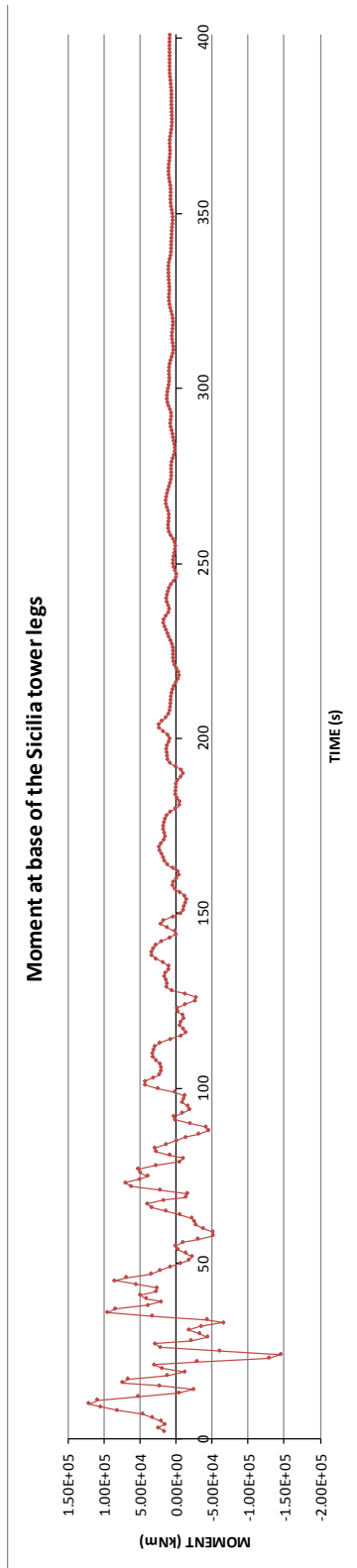


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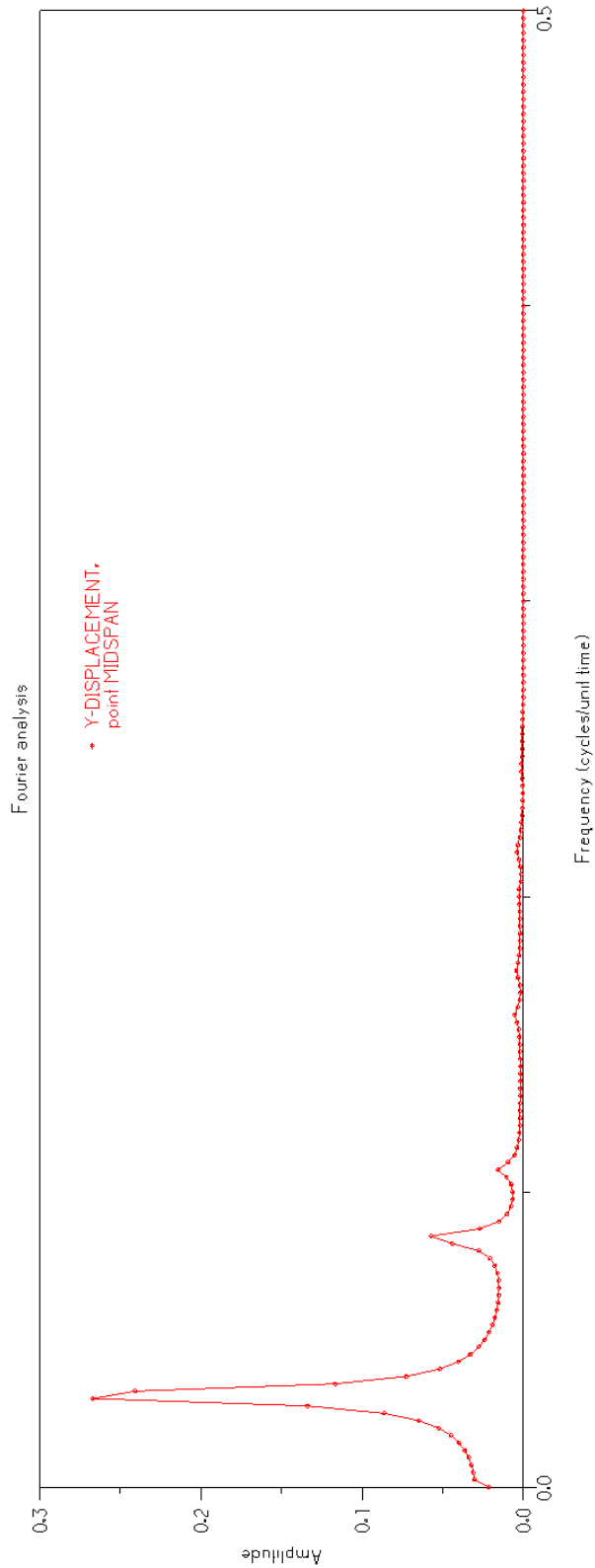


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elementi finiti

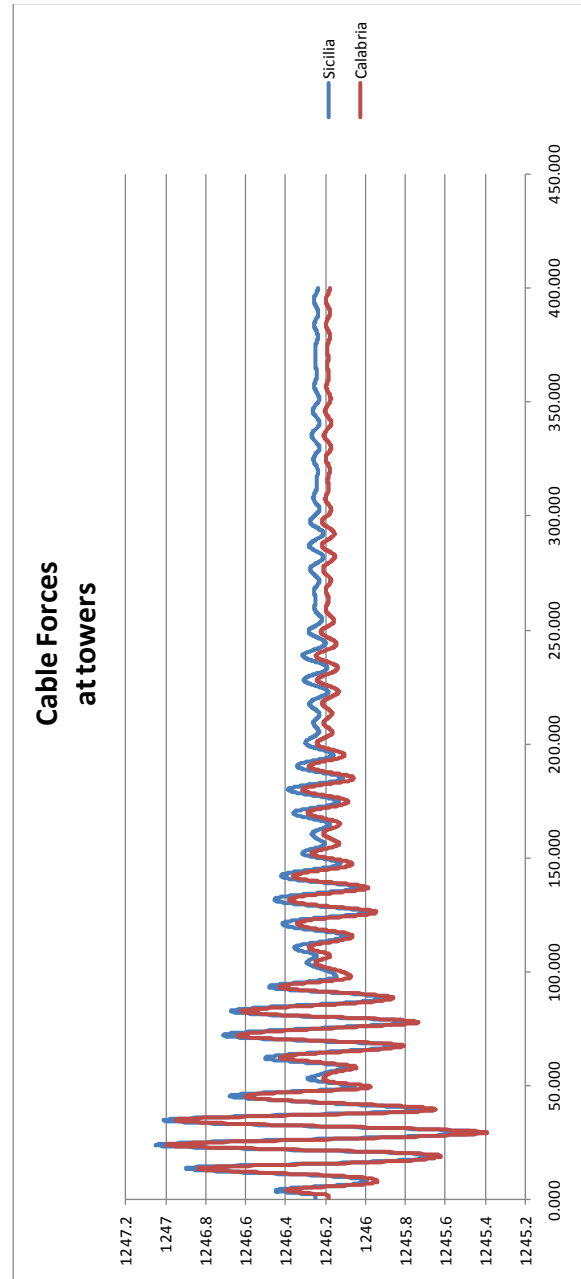
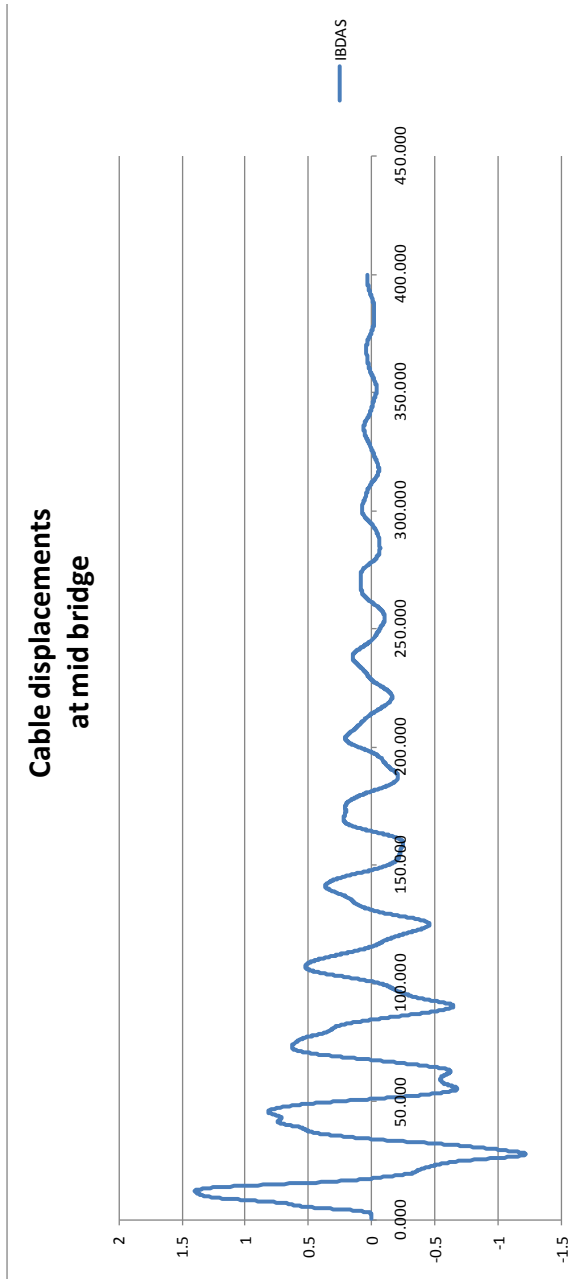
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**Case 1 – Uniform load on deck (IBDAS)**



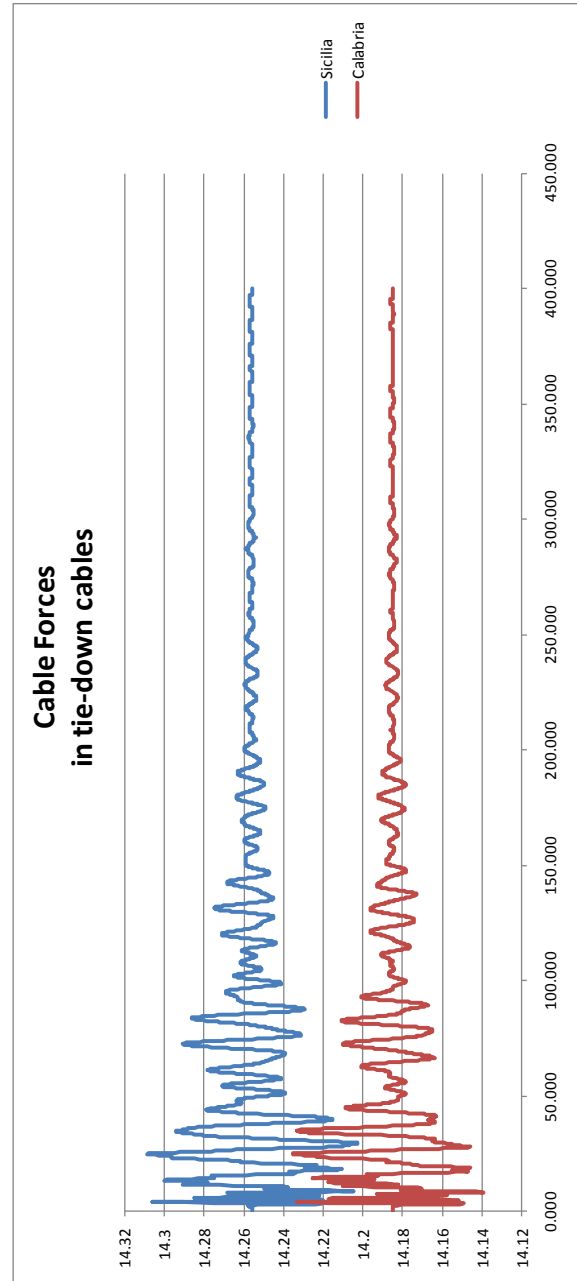
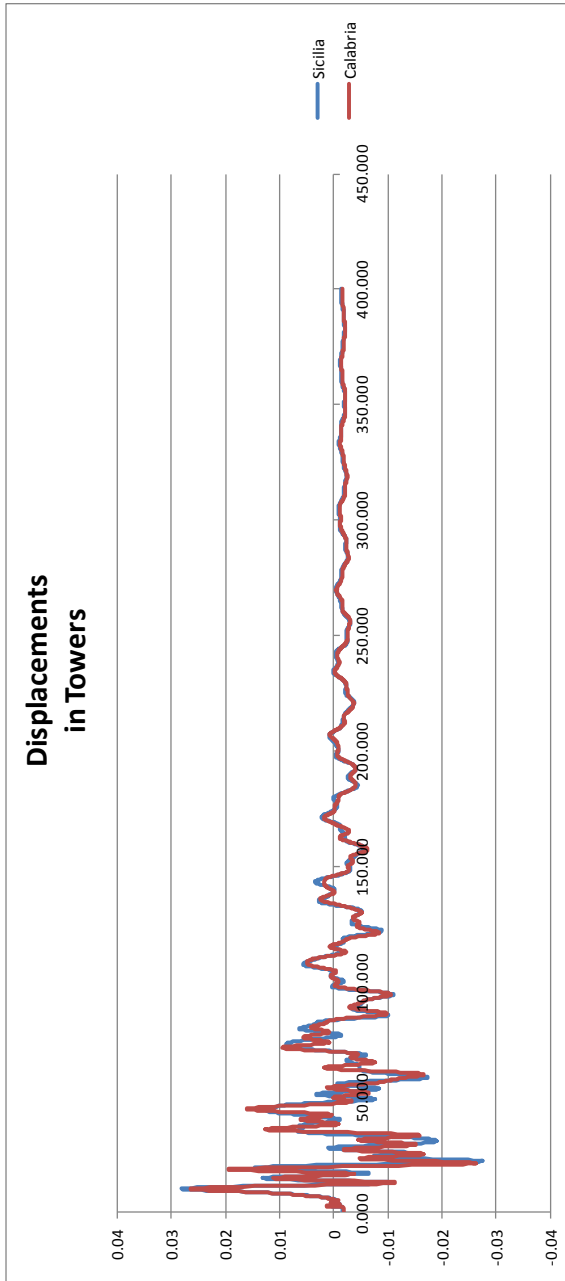


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elementi finiti

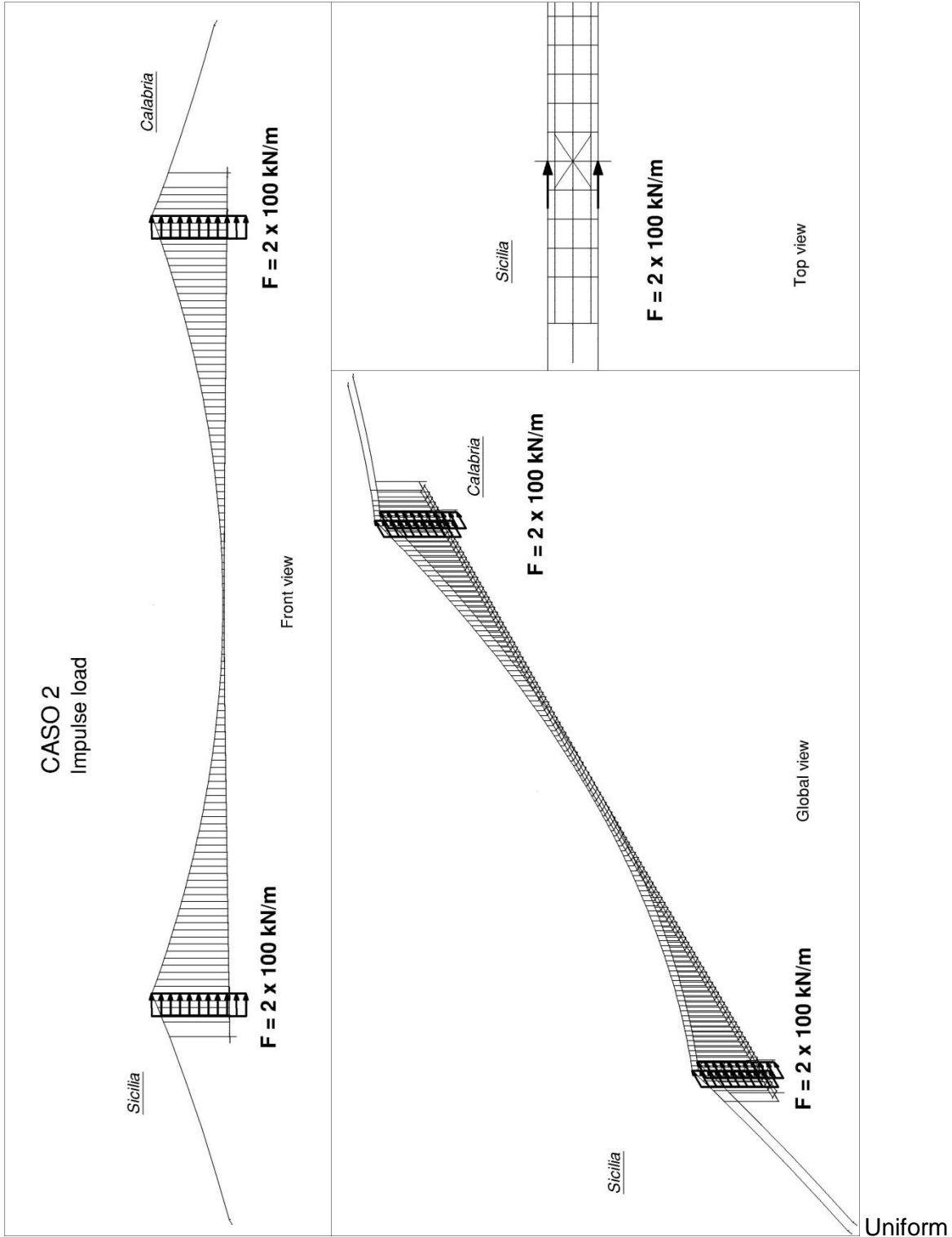
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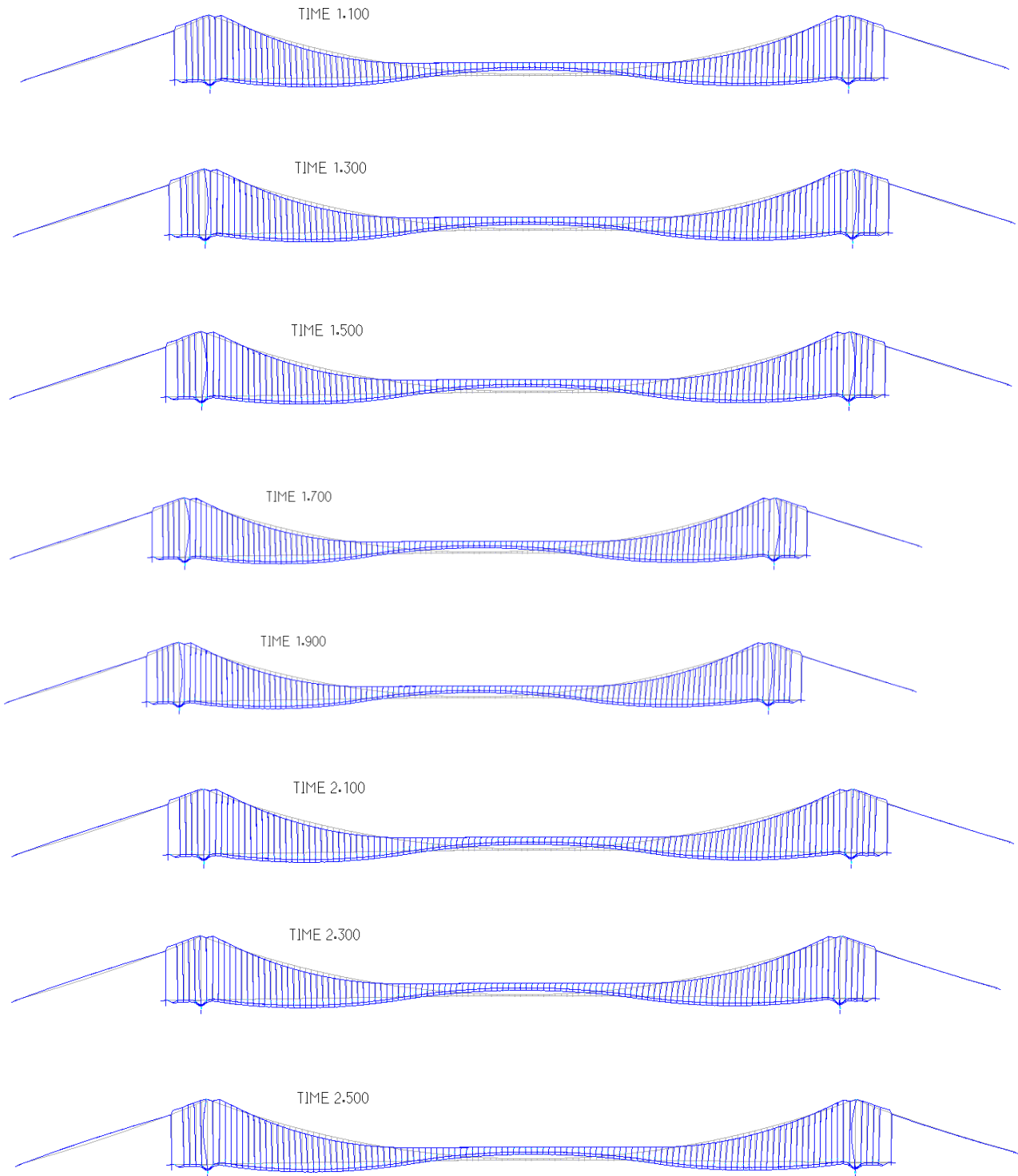
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**8.2 Case 2 – Carico uniformemente distribuito sulle torri (buffer free-free)**



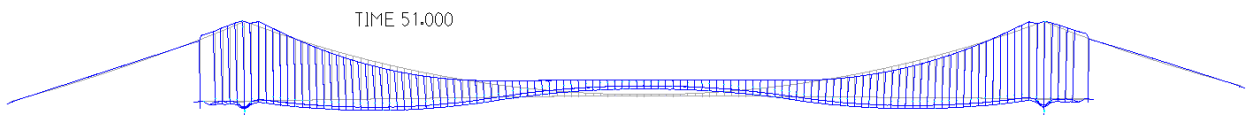
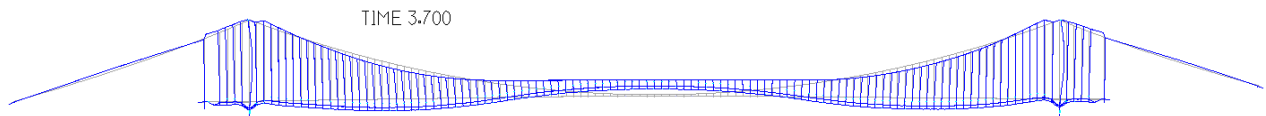
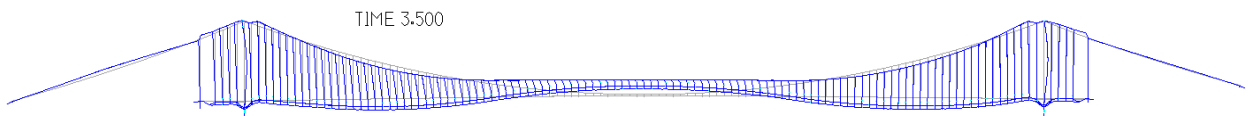
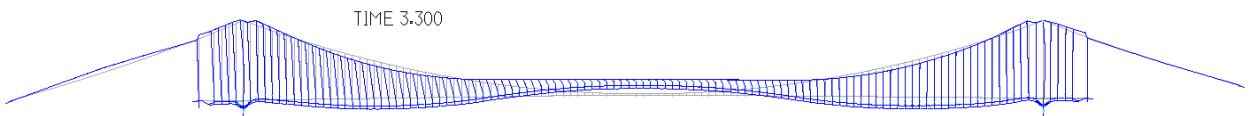
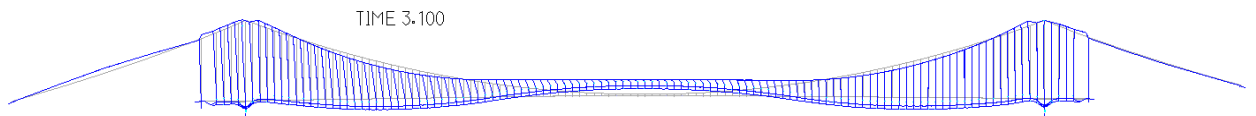
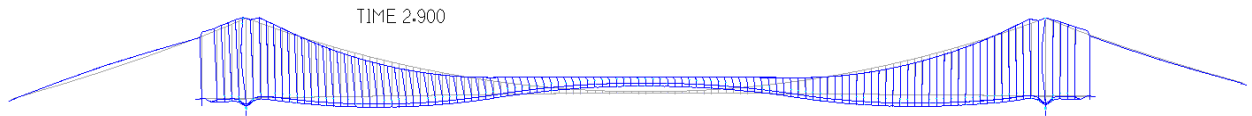
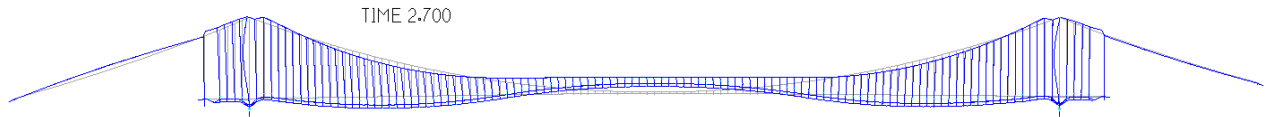
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13-04-2011**Deformation**

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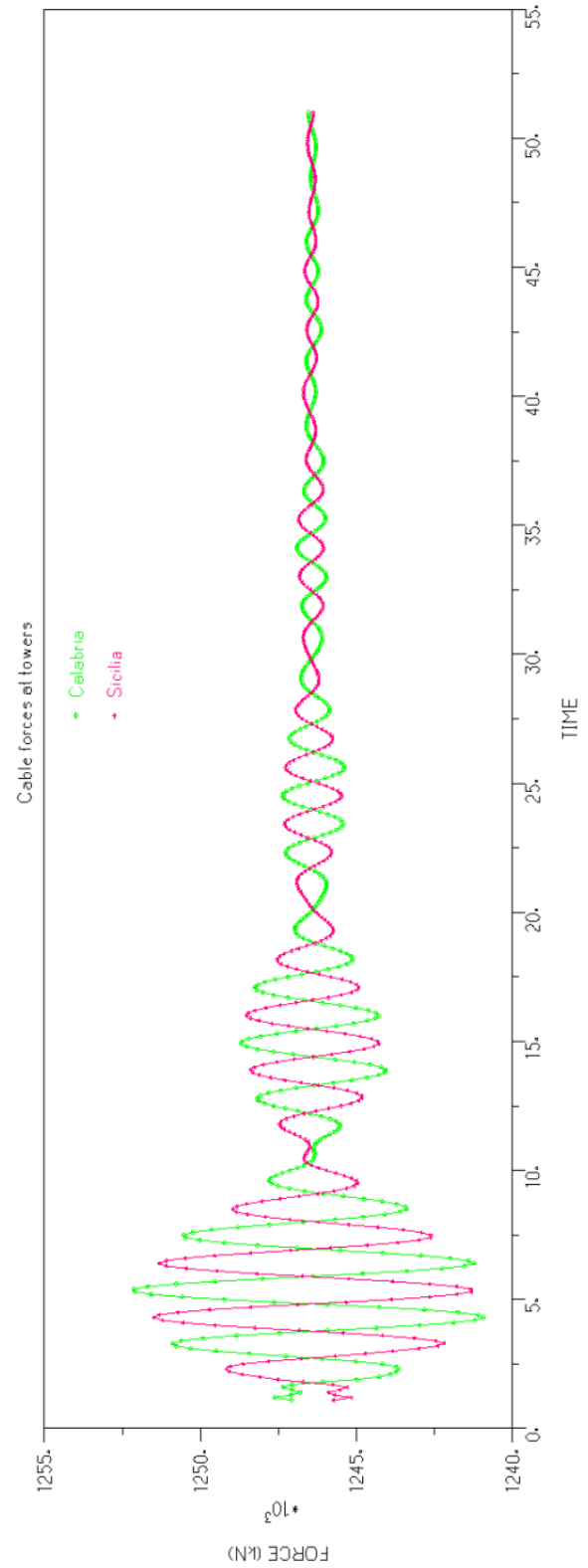
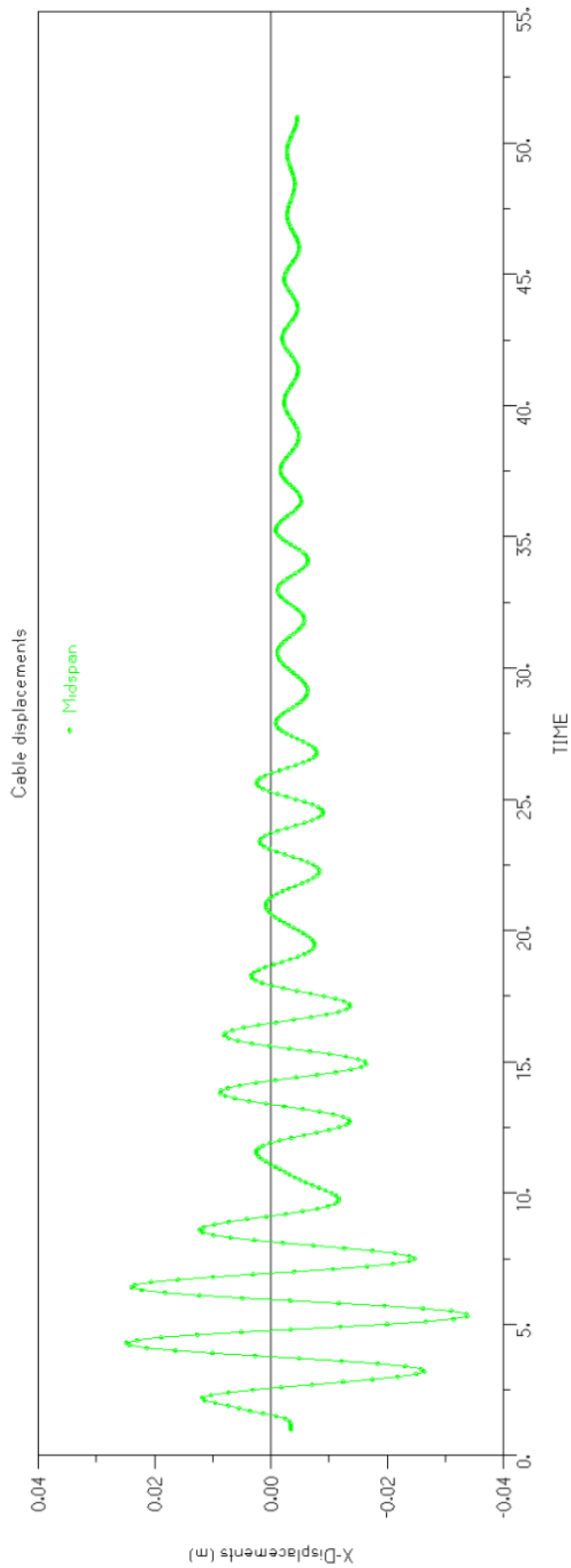


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elementi finiti

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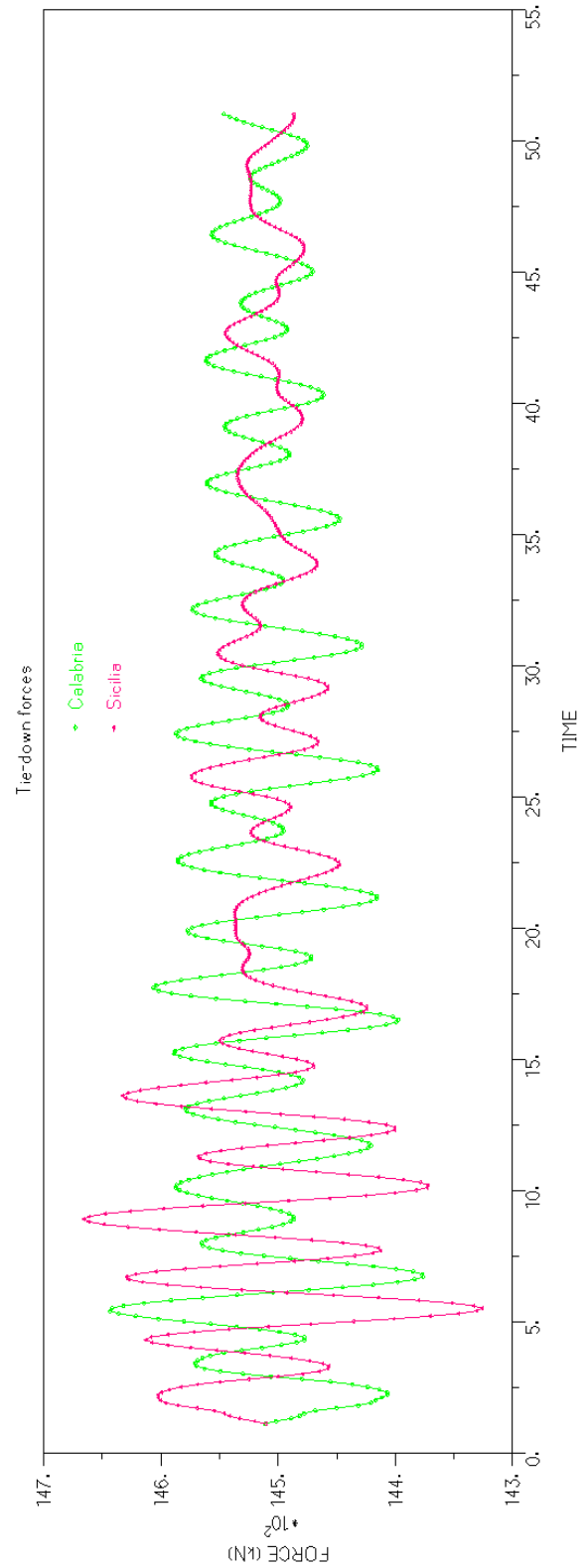
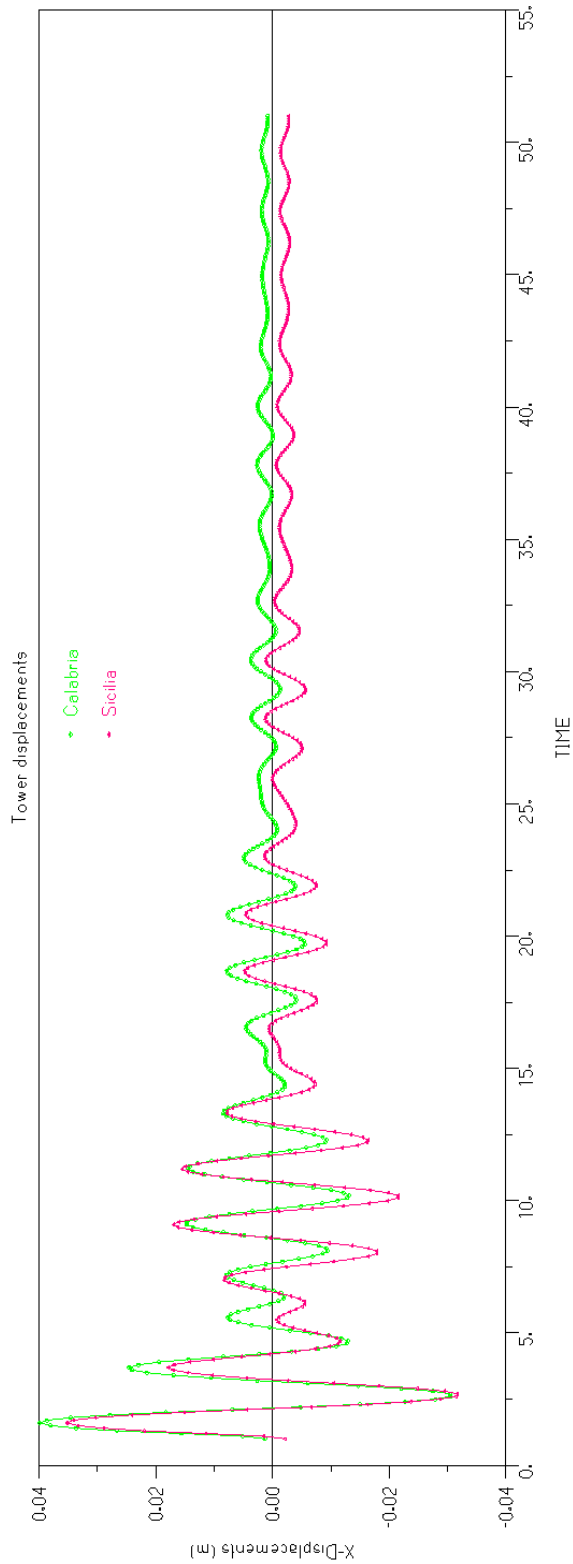


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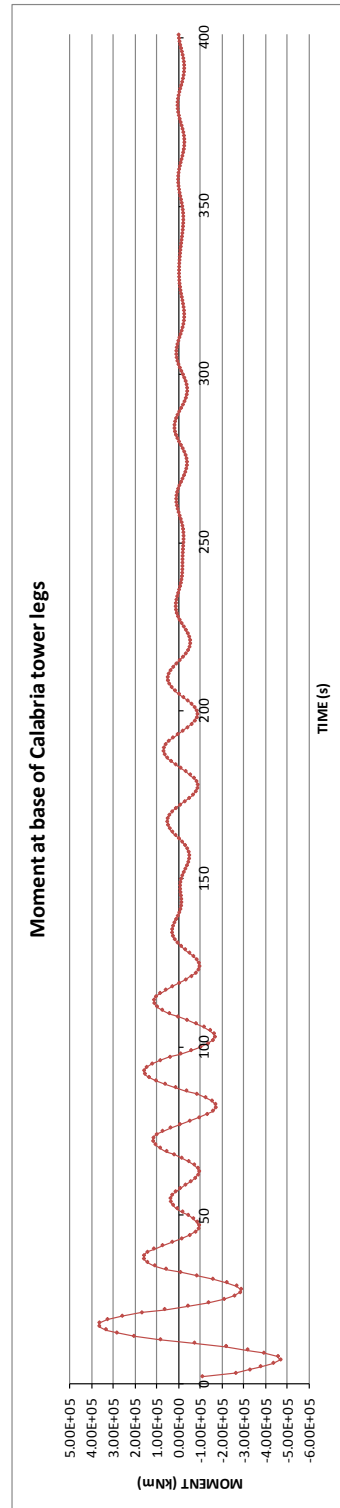
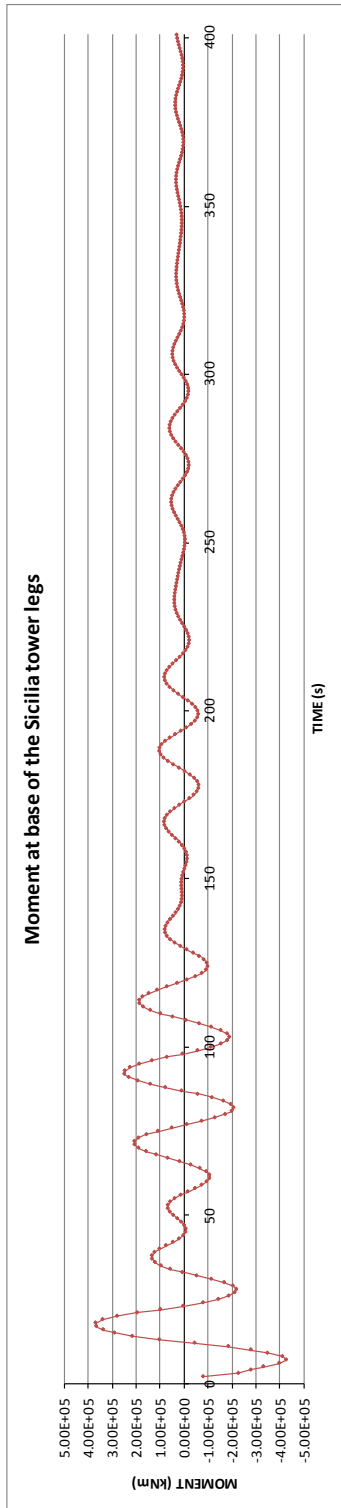


Validazione del modello globale agli  
elementi finiti

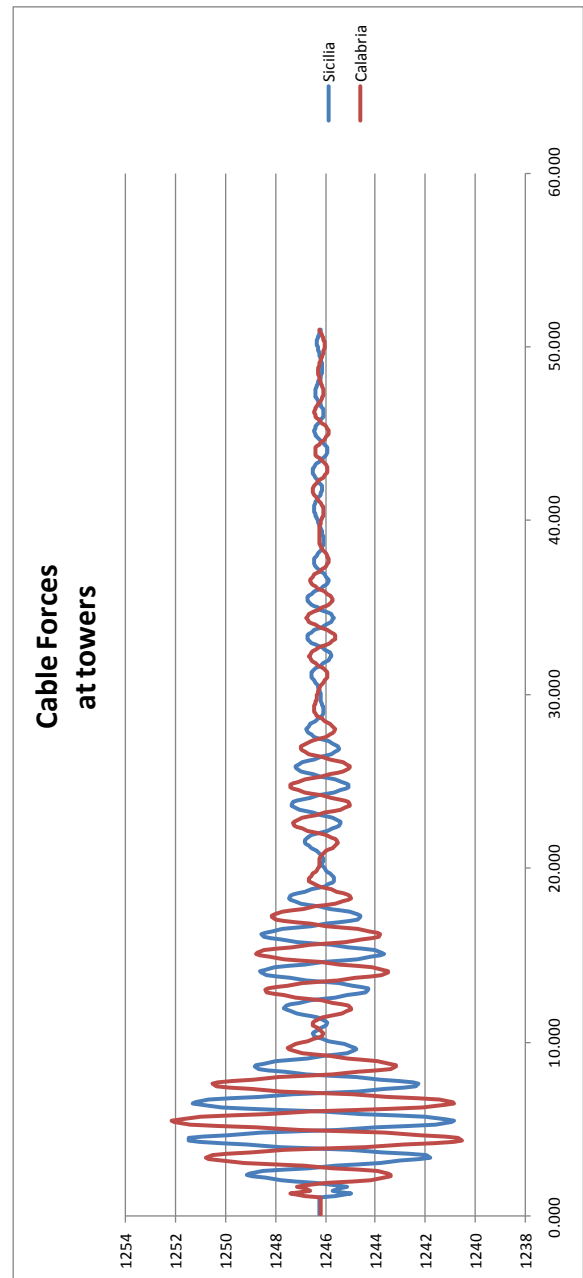
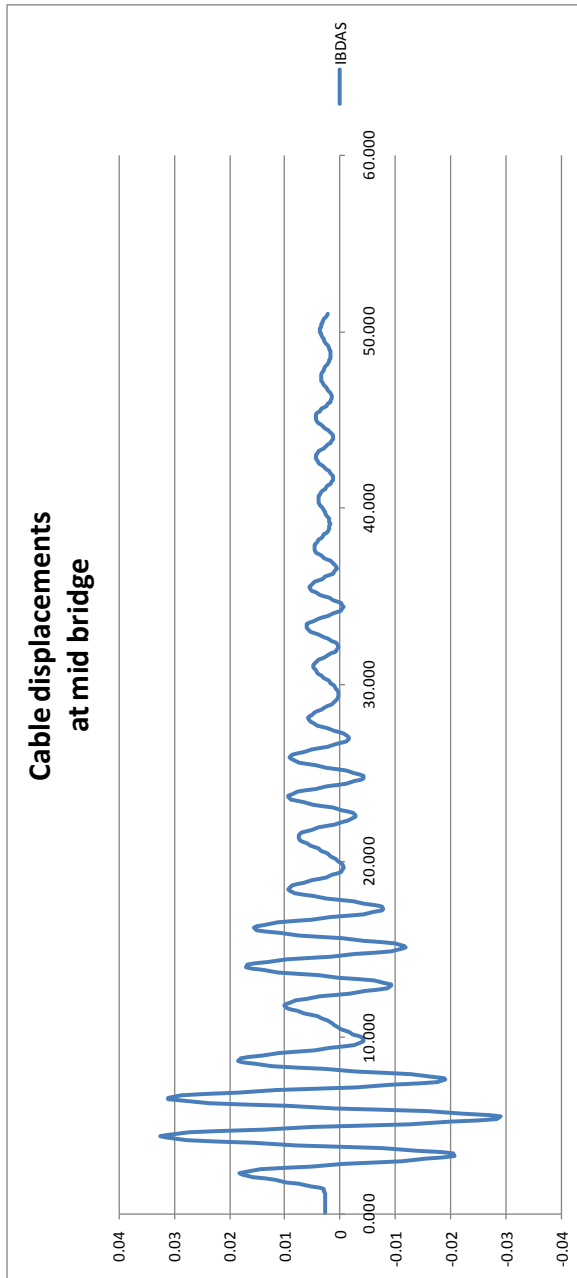
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**Case 2 – Uniform load on the tower (IBDAS)**



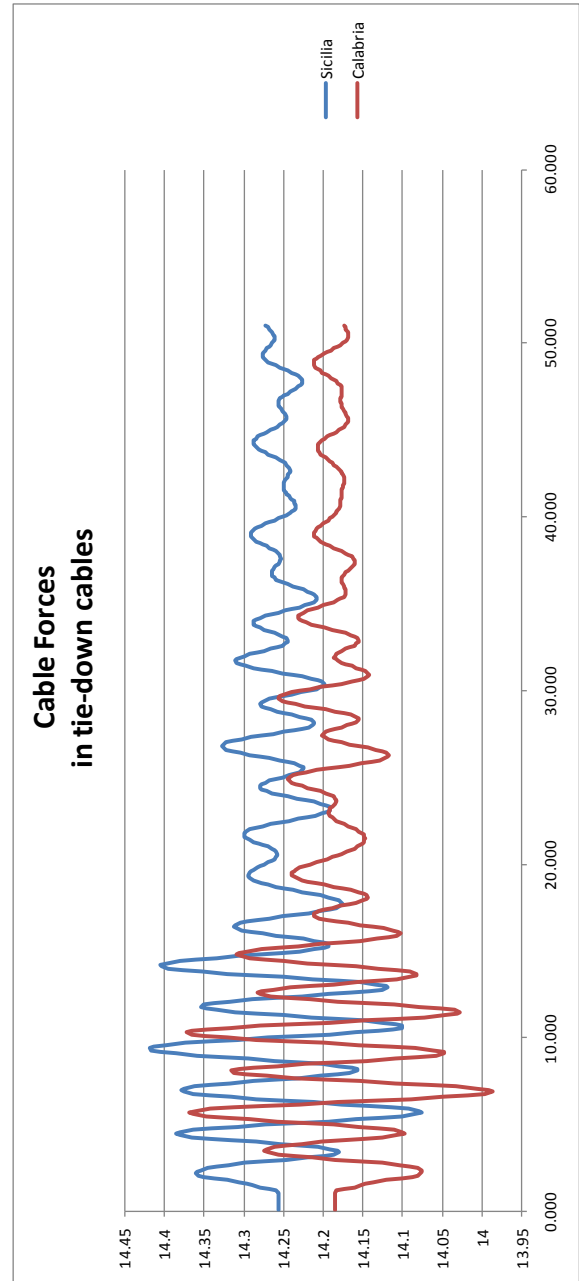
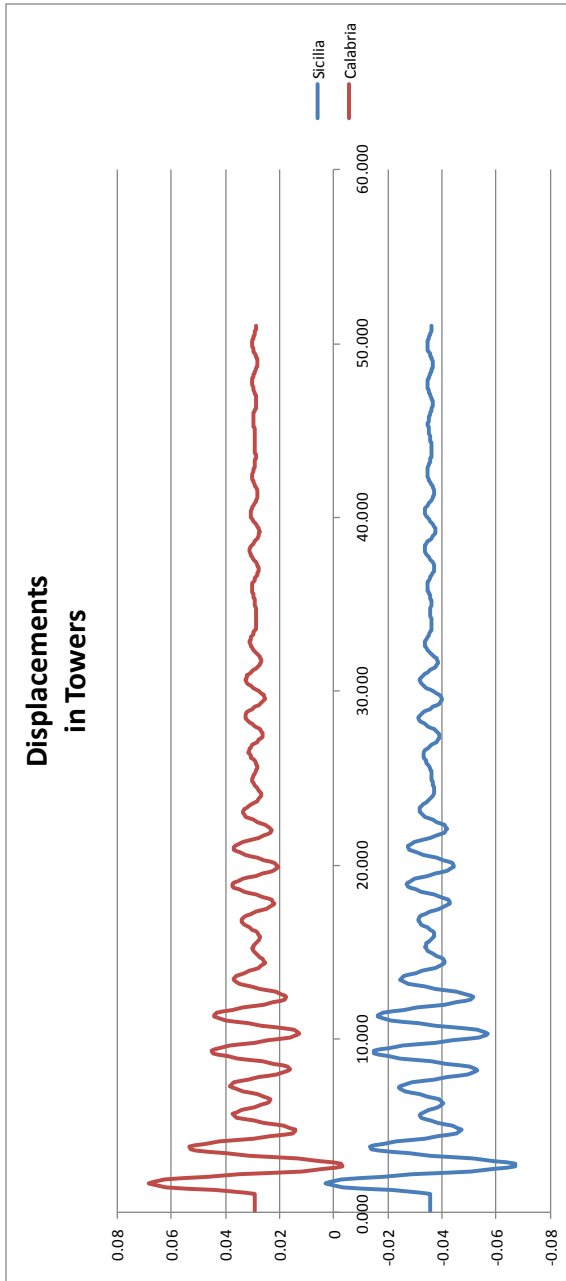


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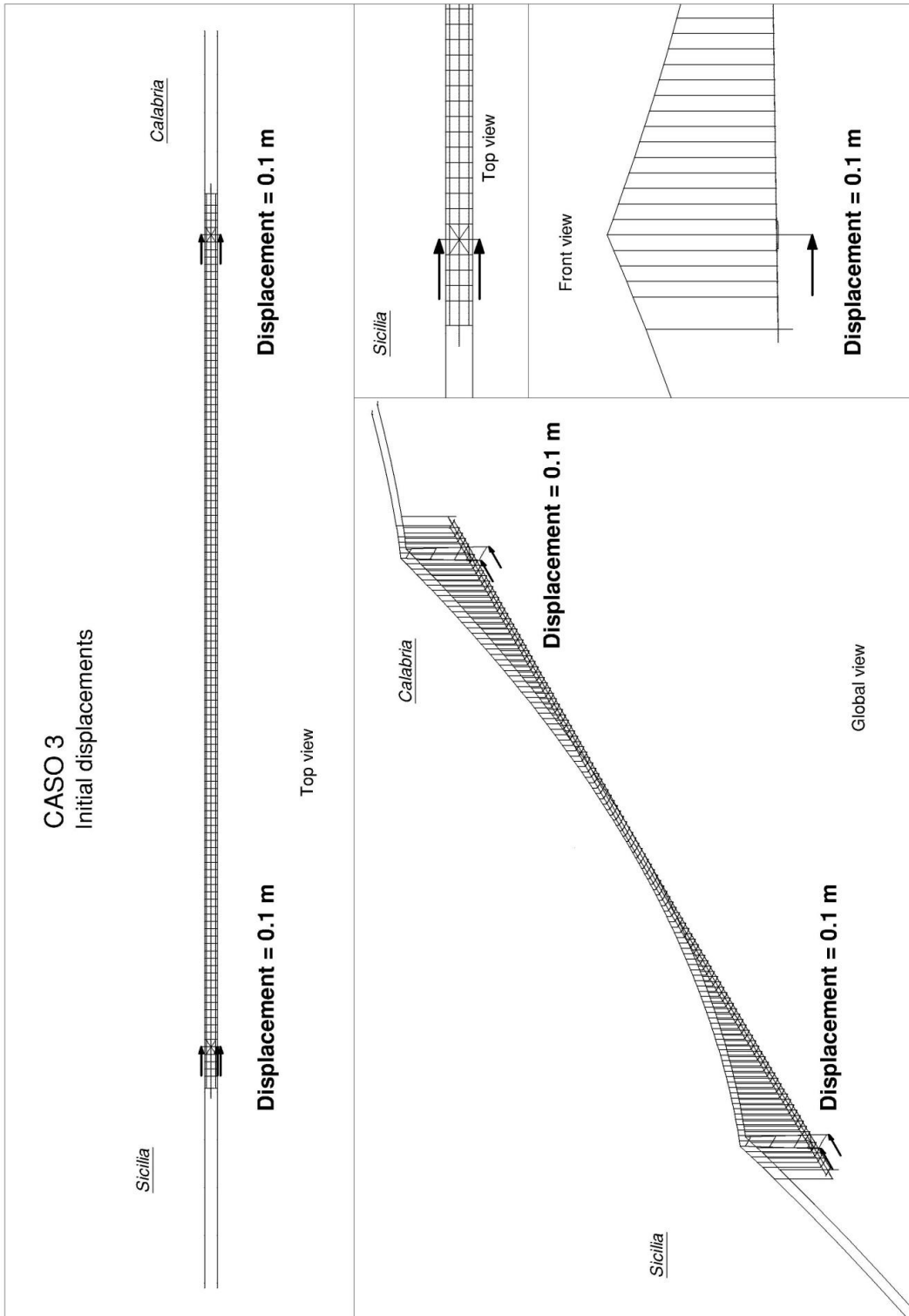
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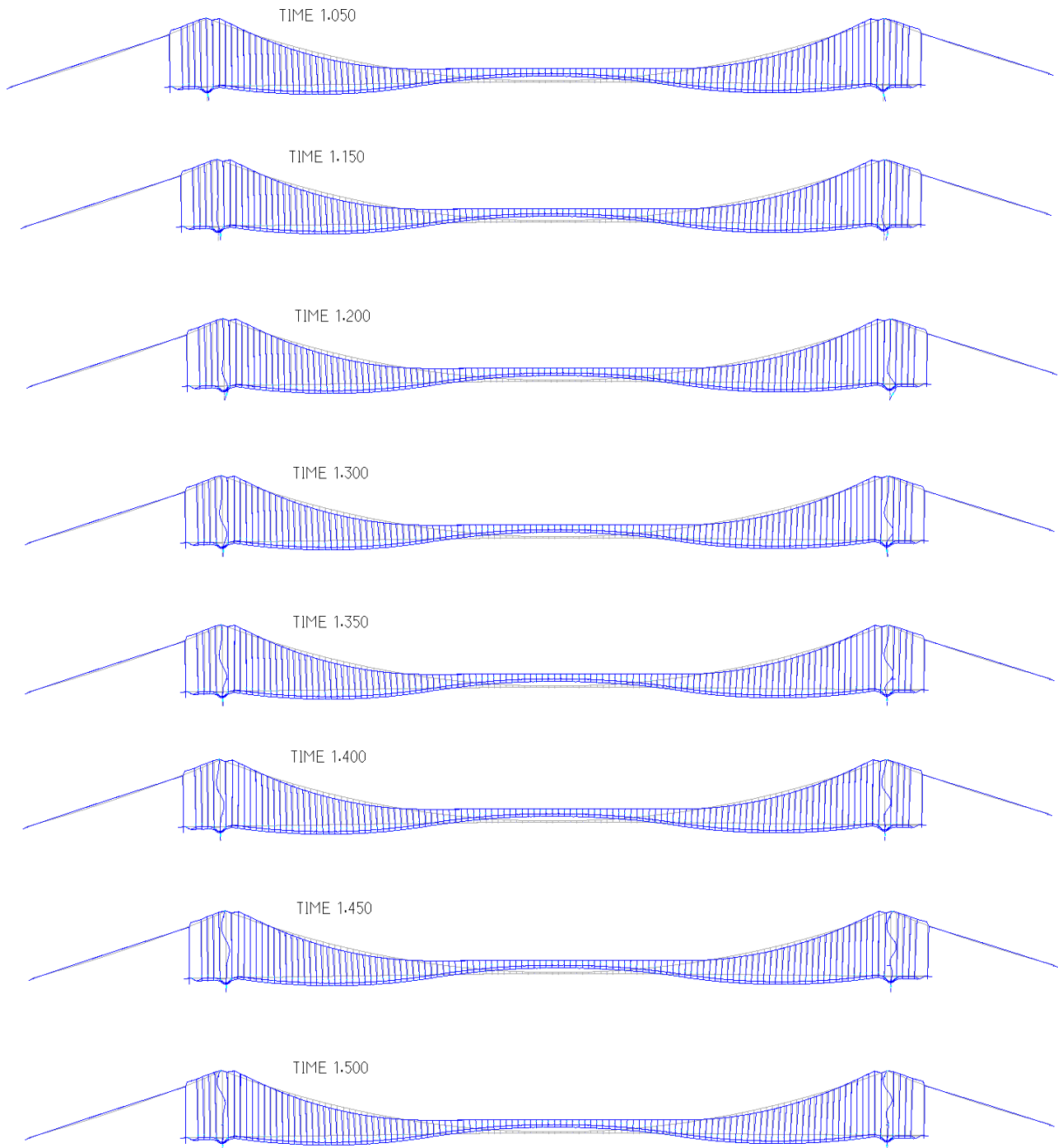
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**8.3 Caso 3 – Spostamento iniziale alla base delle torri (buffer free-free)**



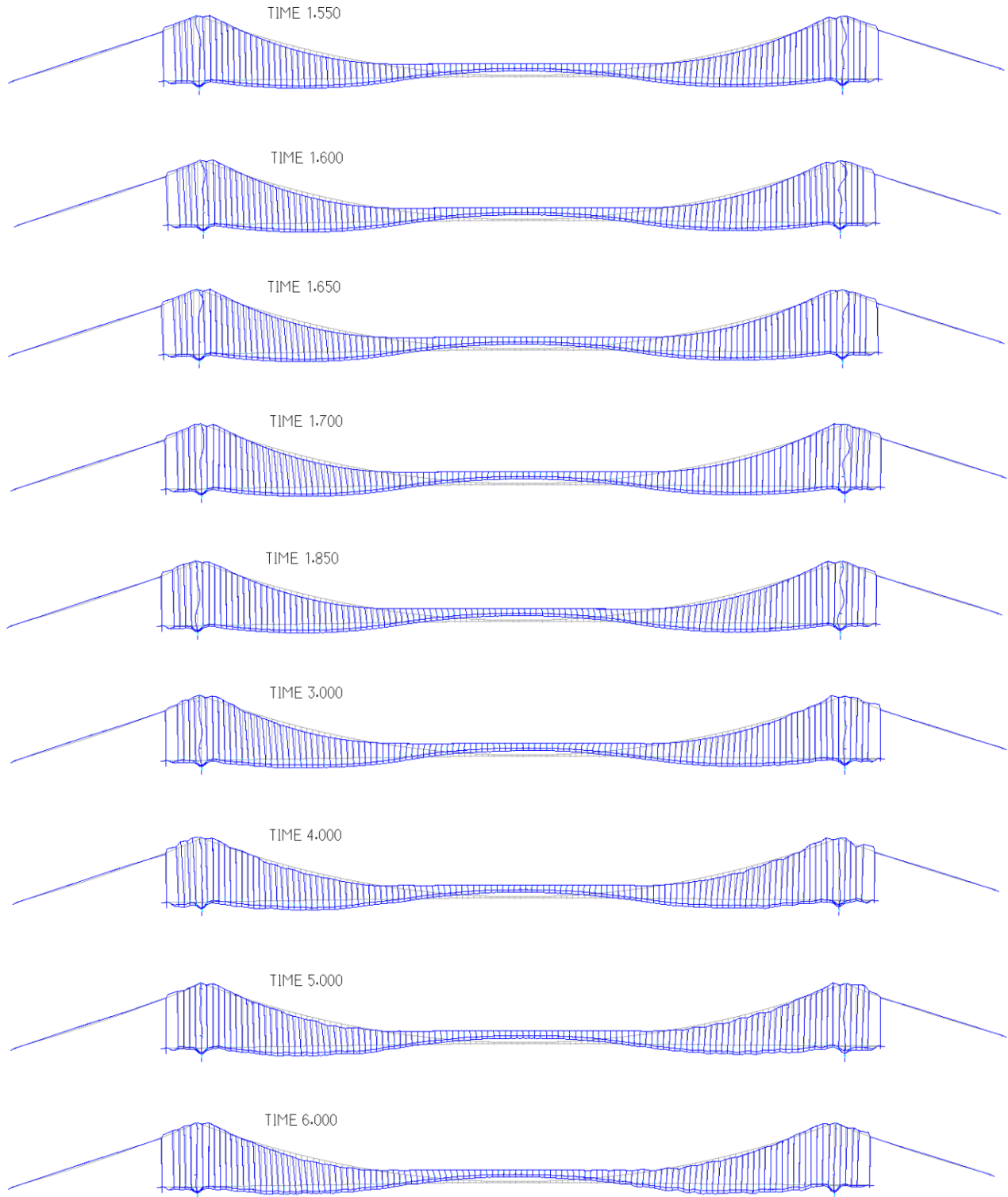
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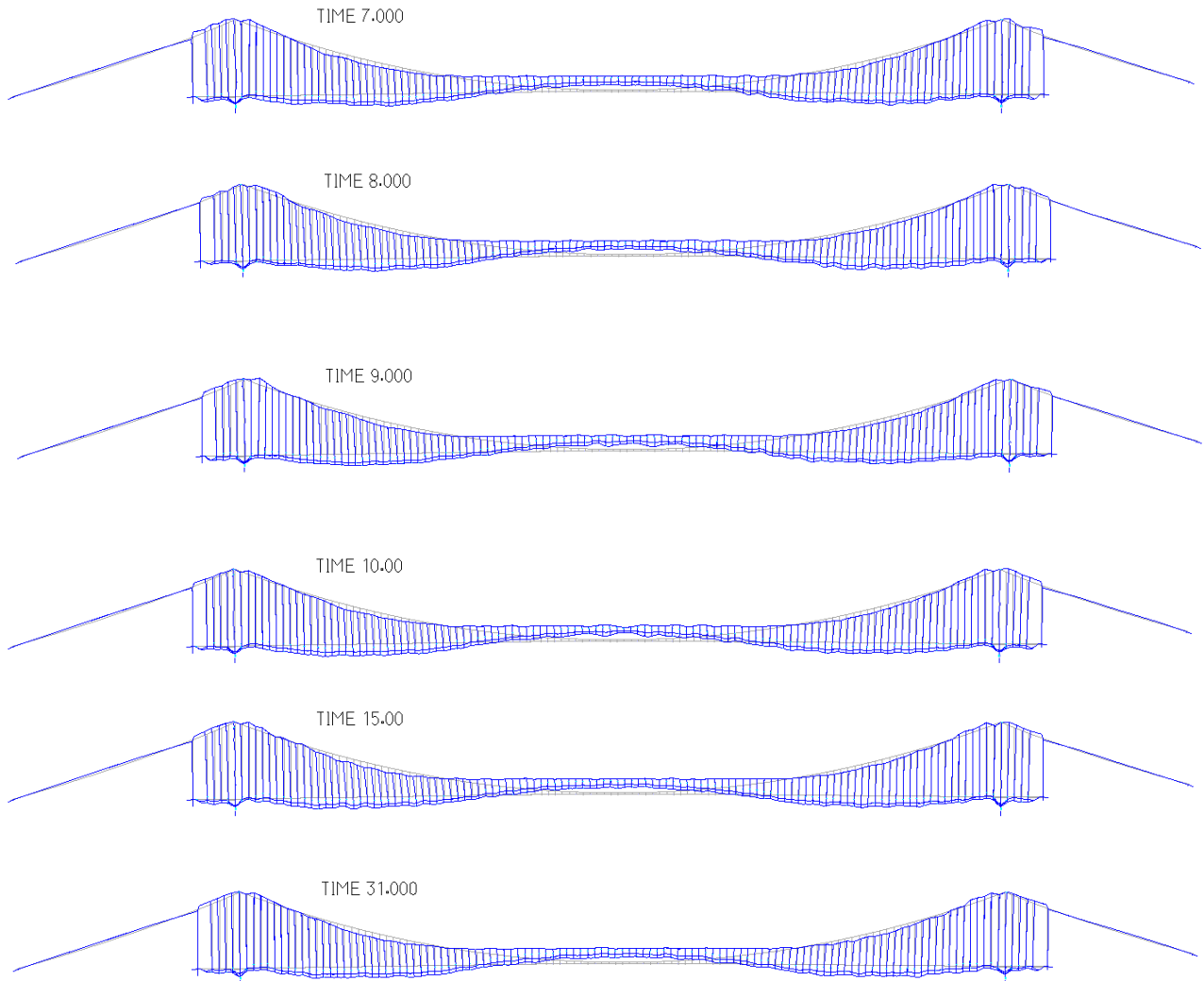
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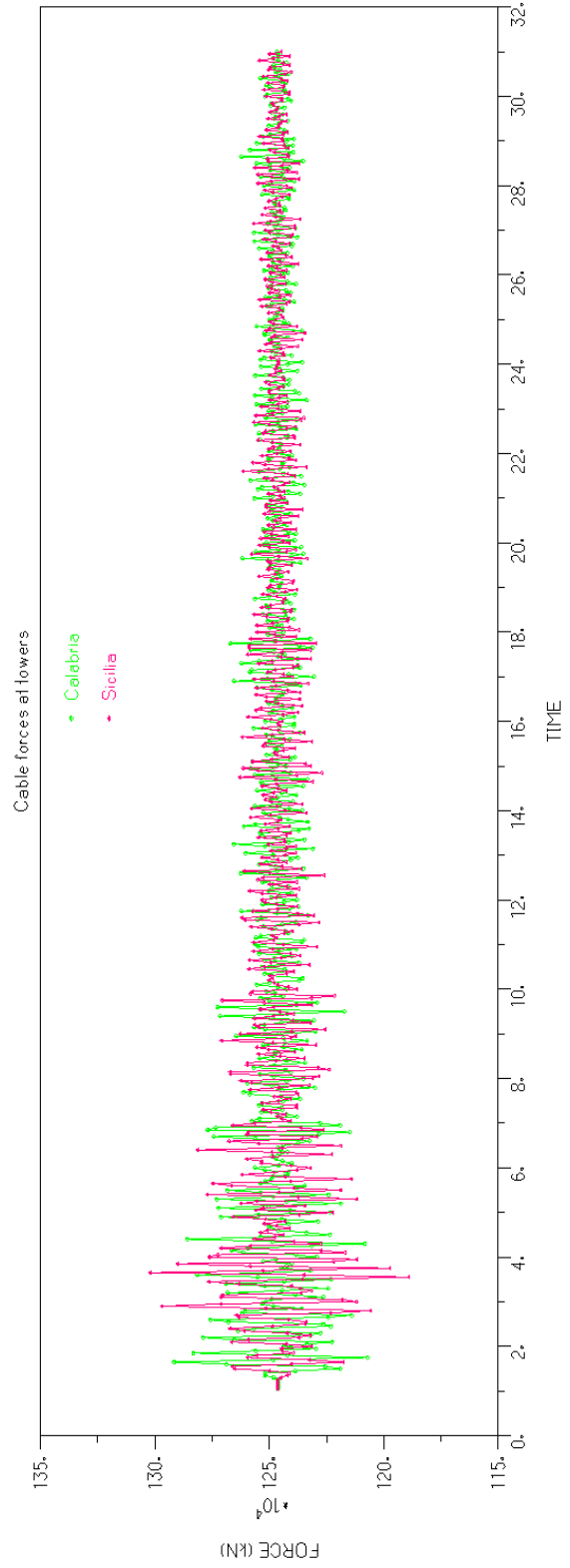
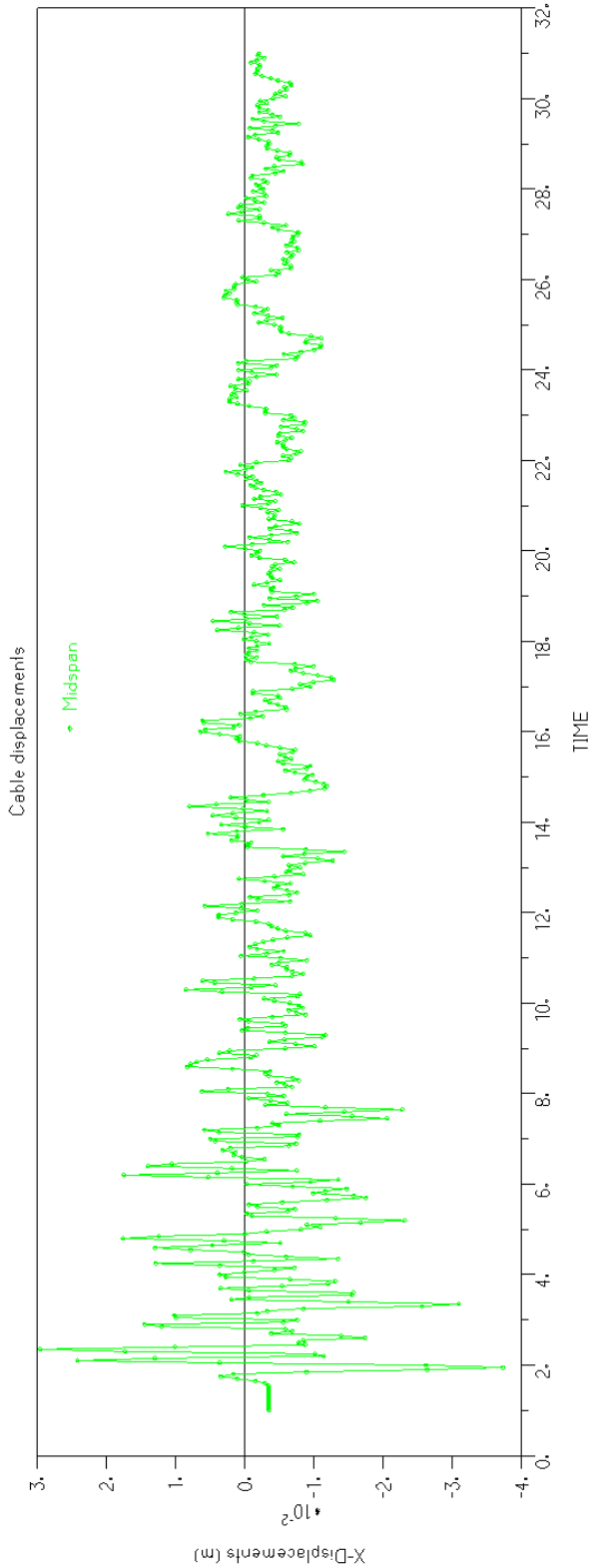


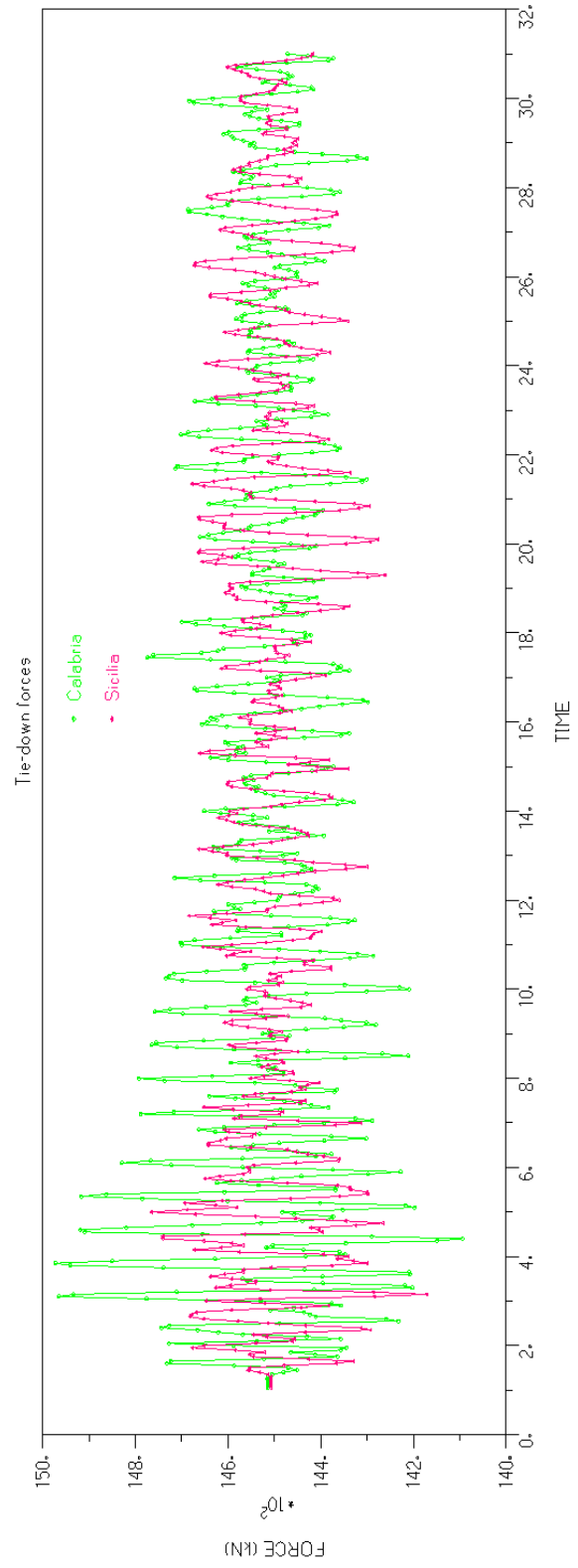
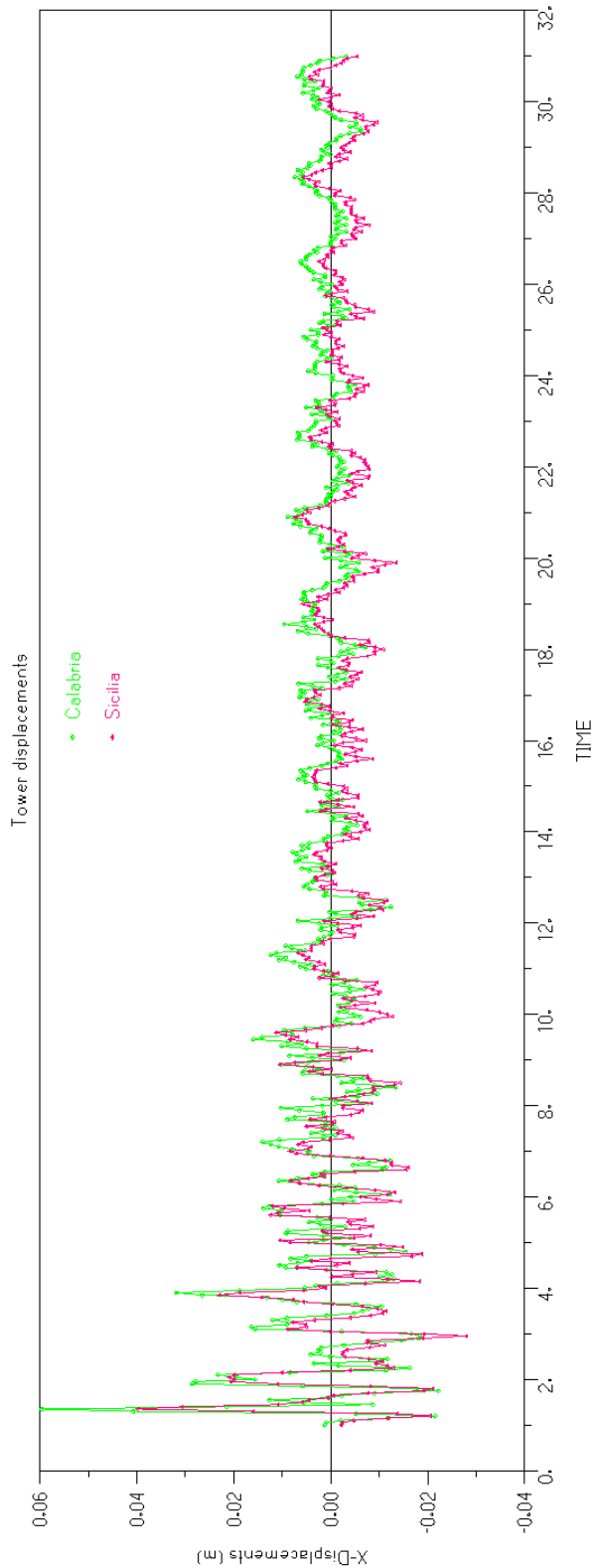
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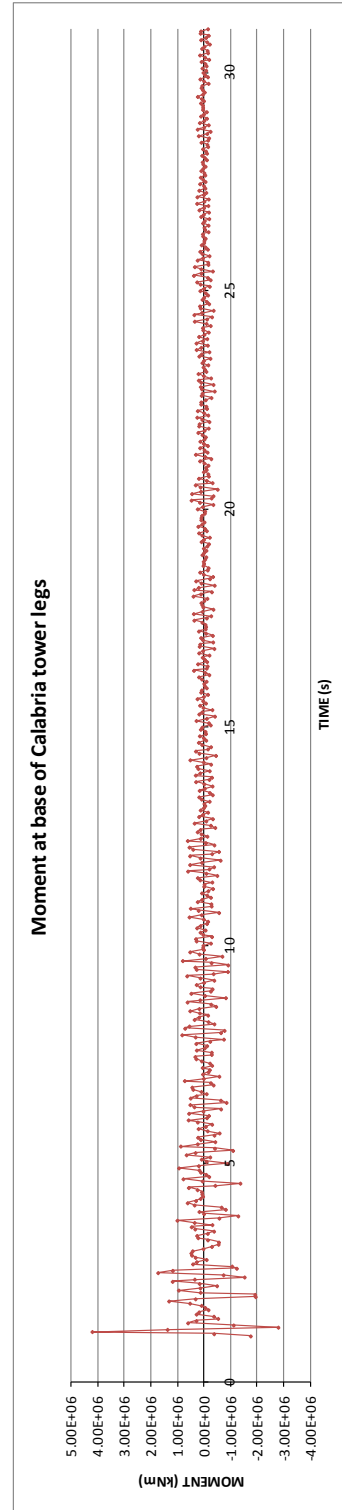
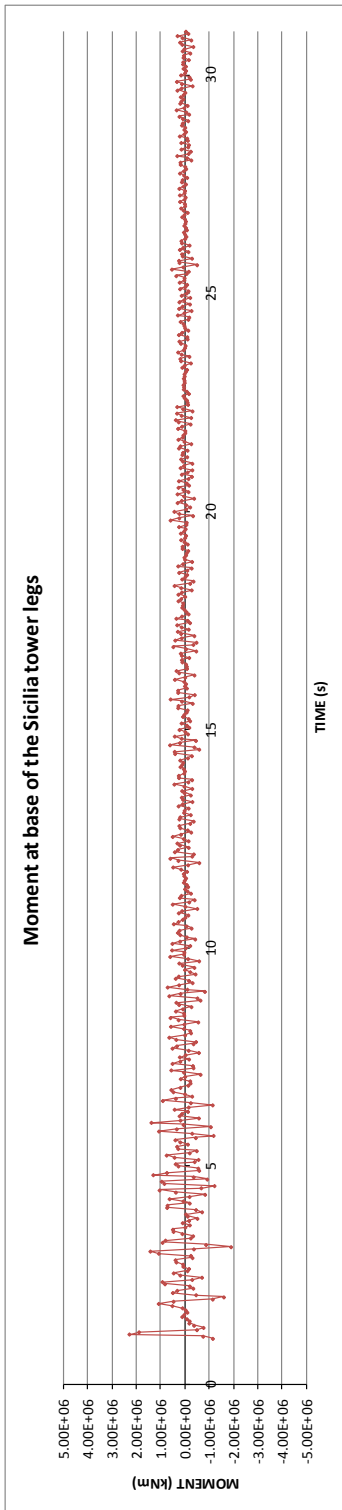


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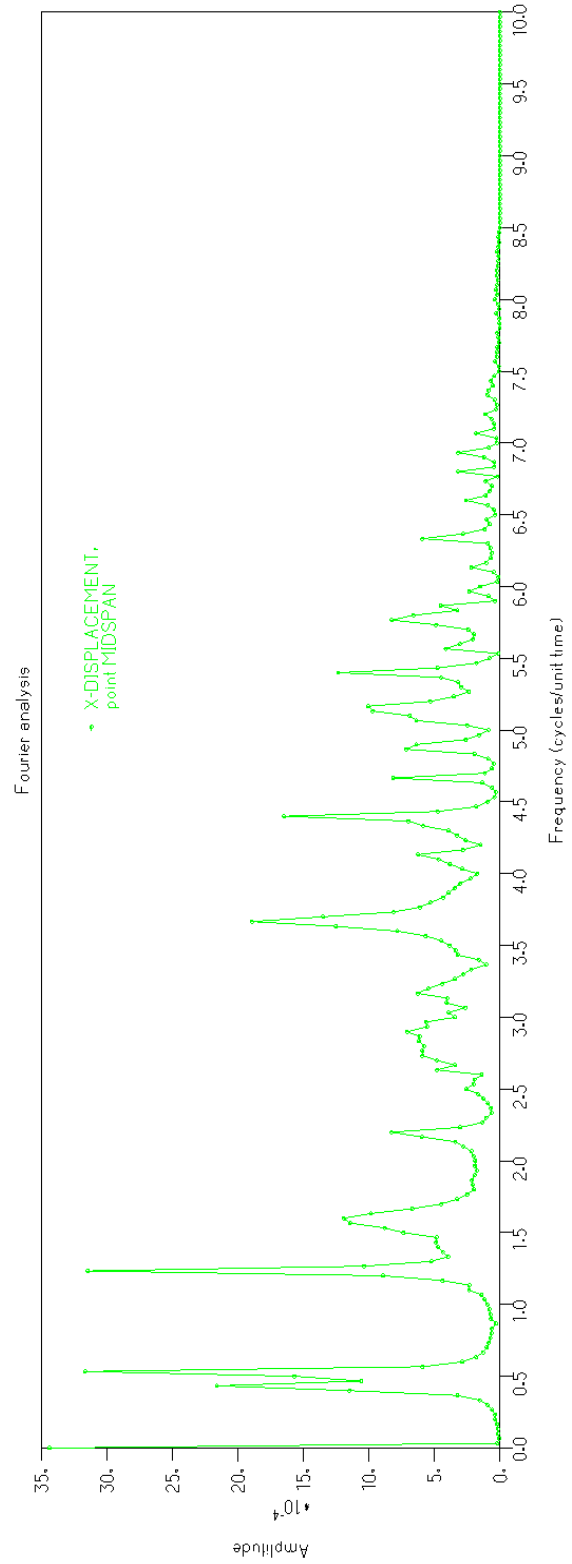
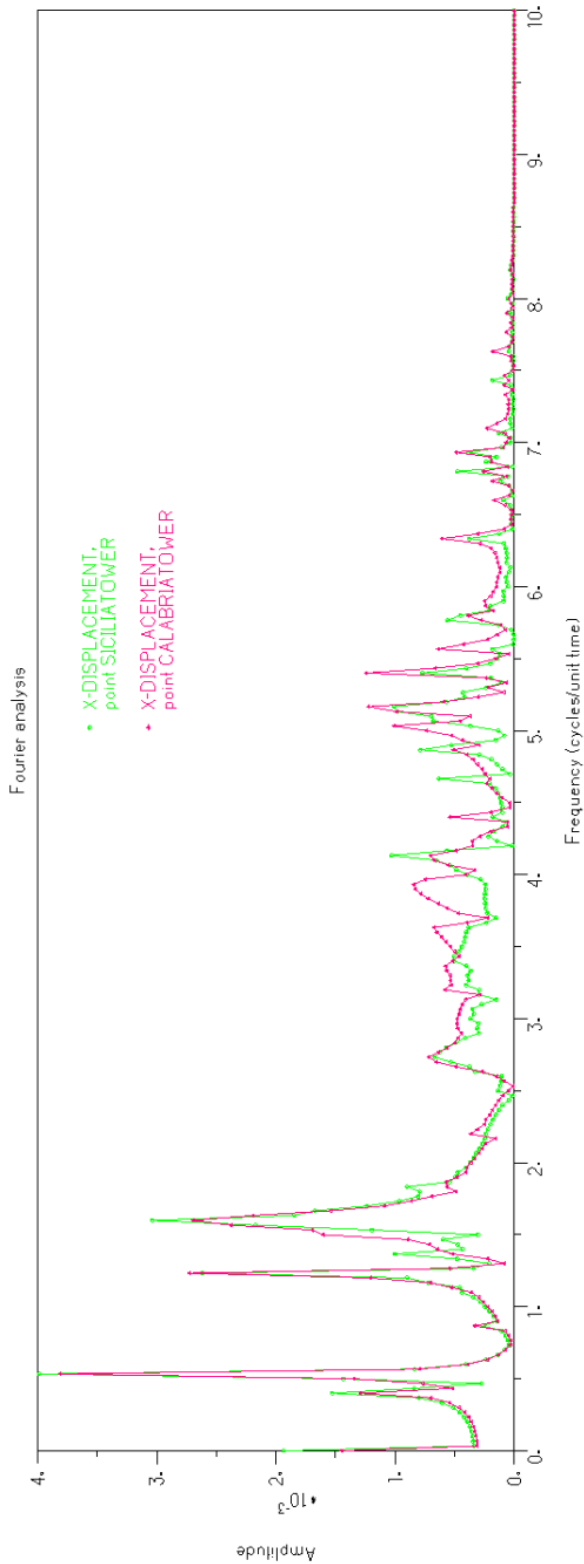


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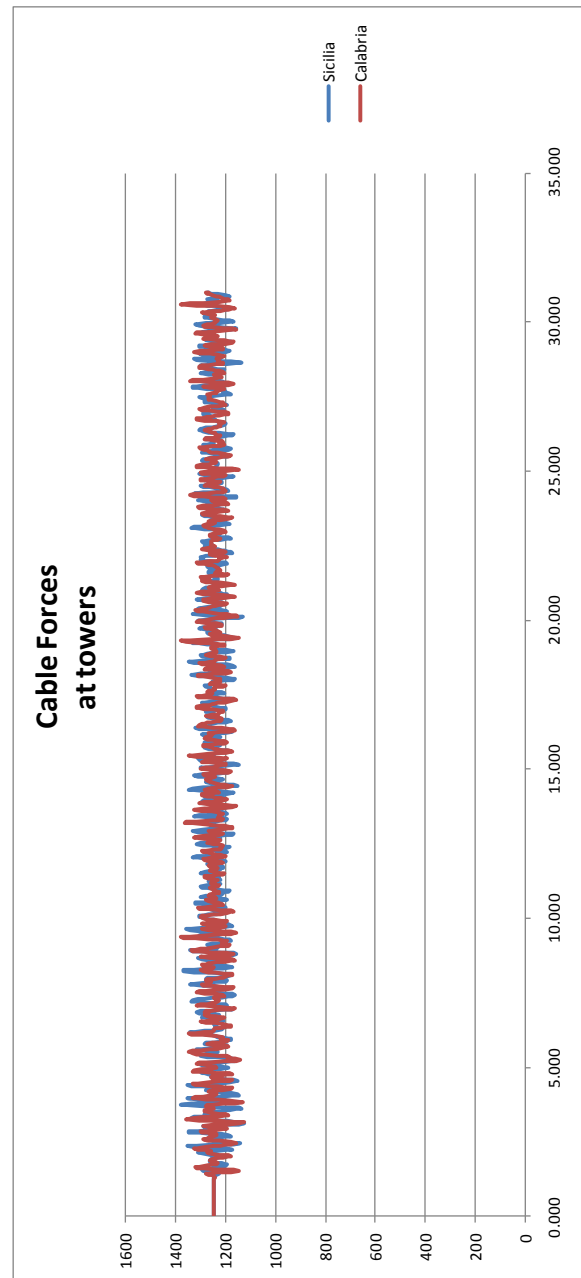
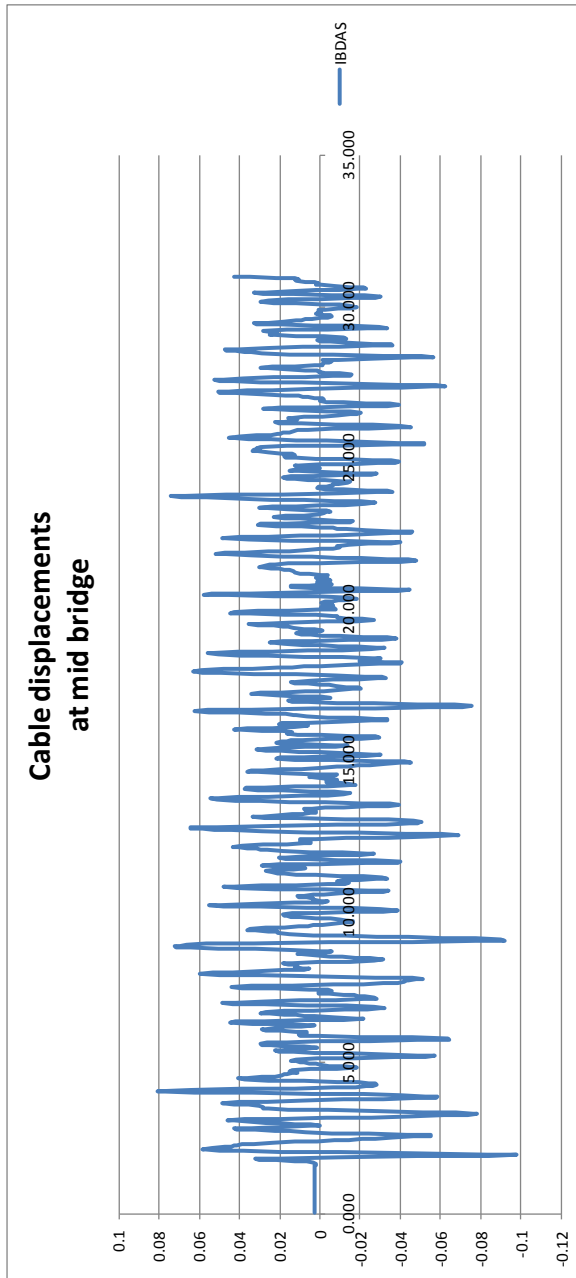
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**Case 3 – free-free buffers (IBDAS)**

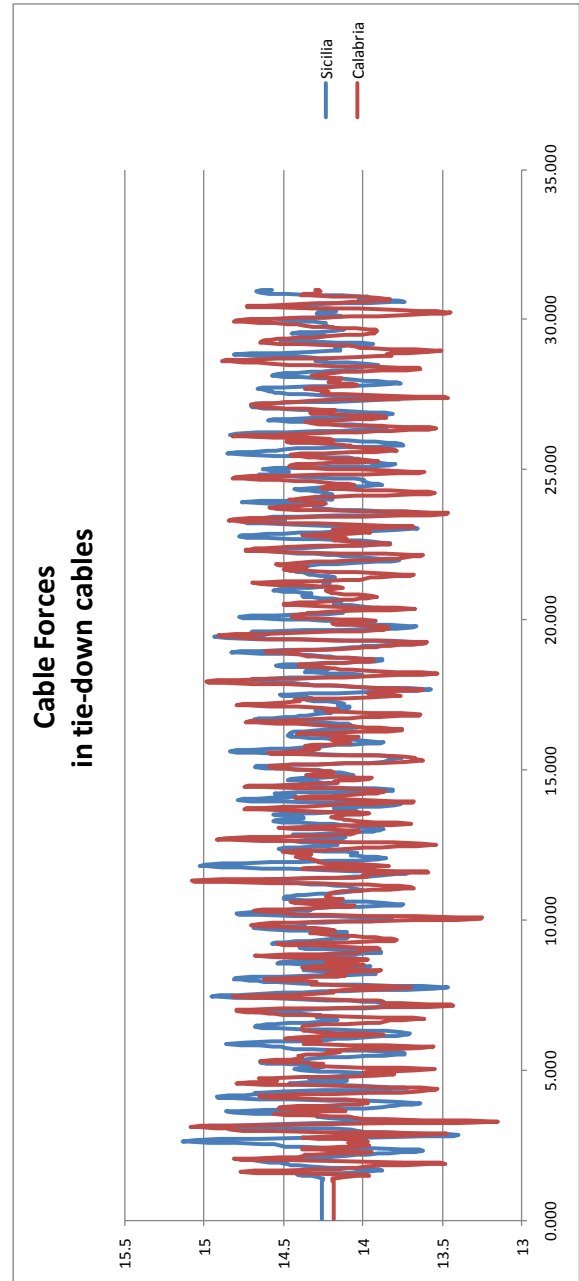
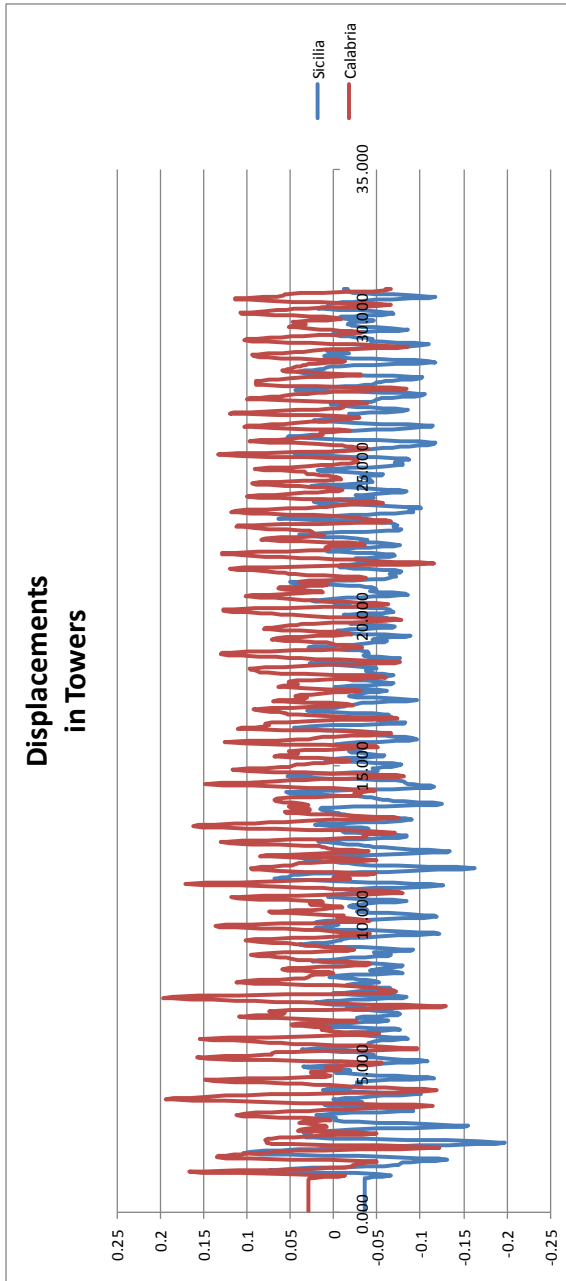


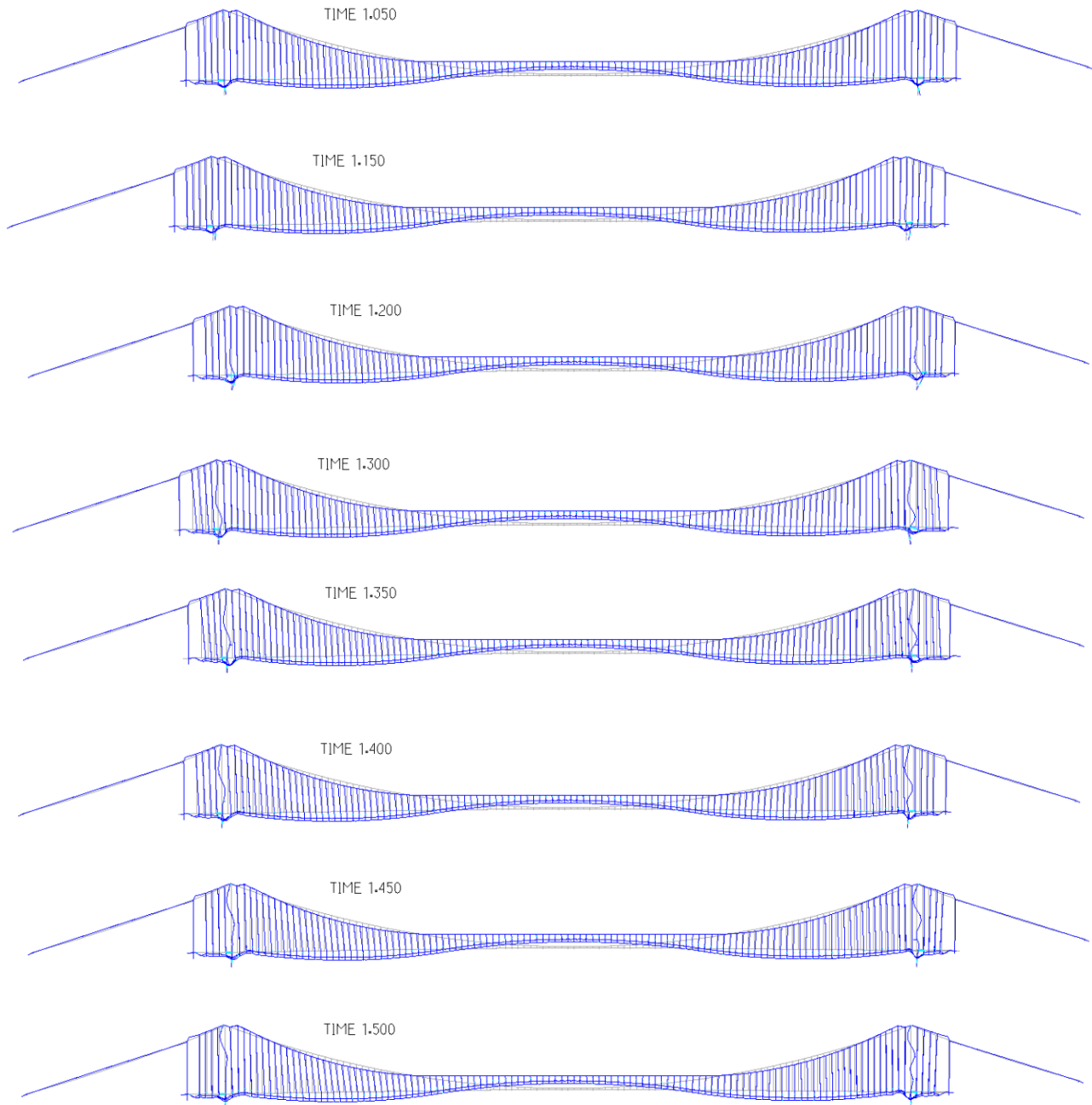
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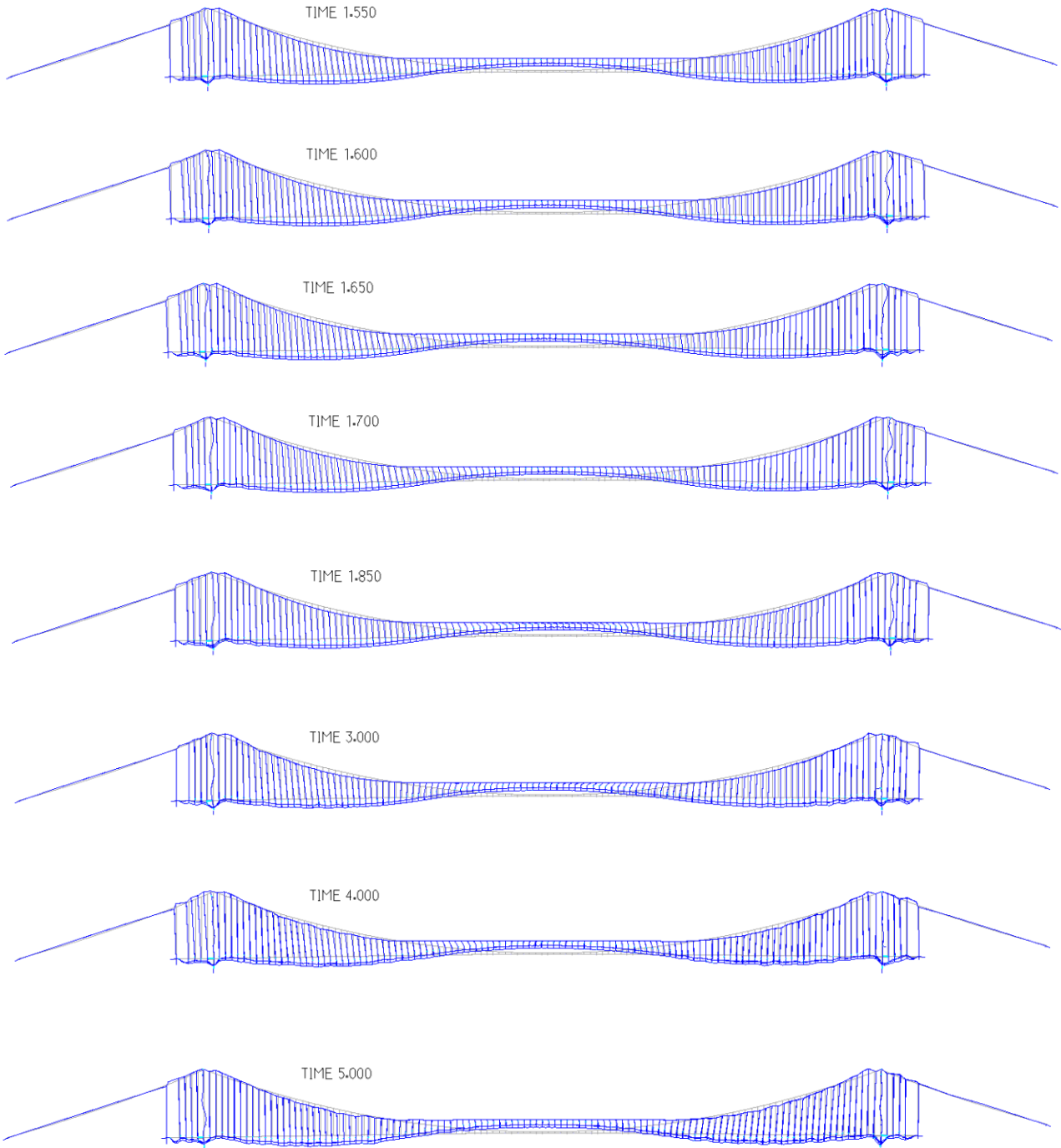
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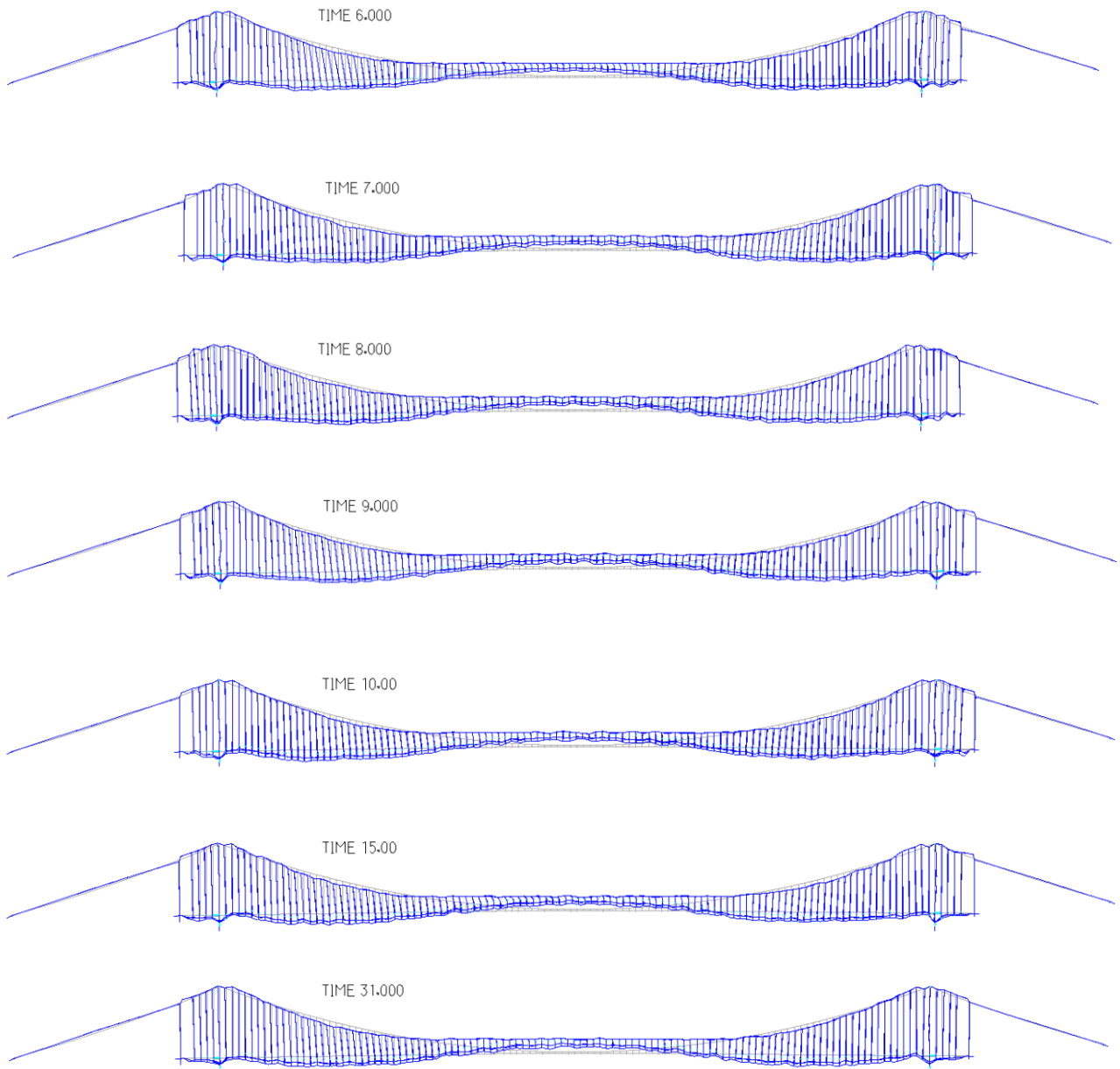


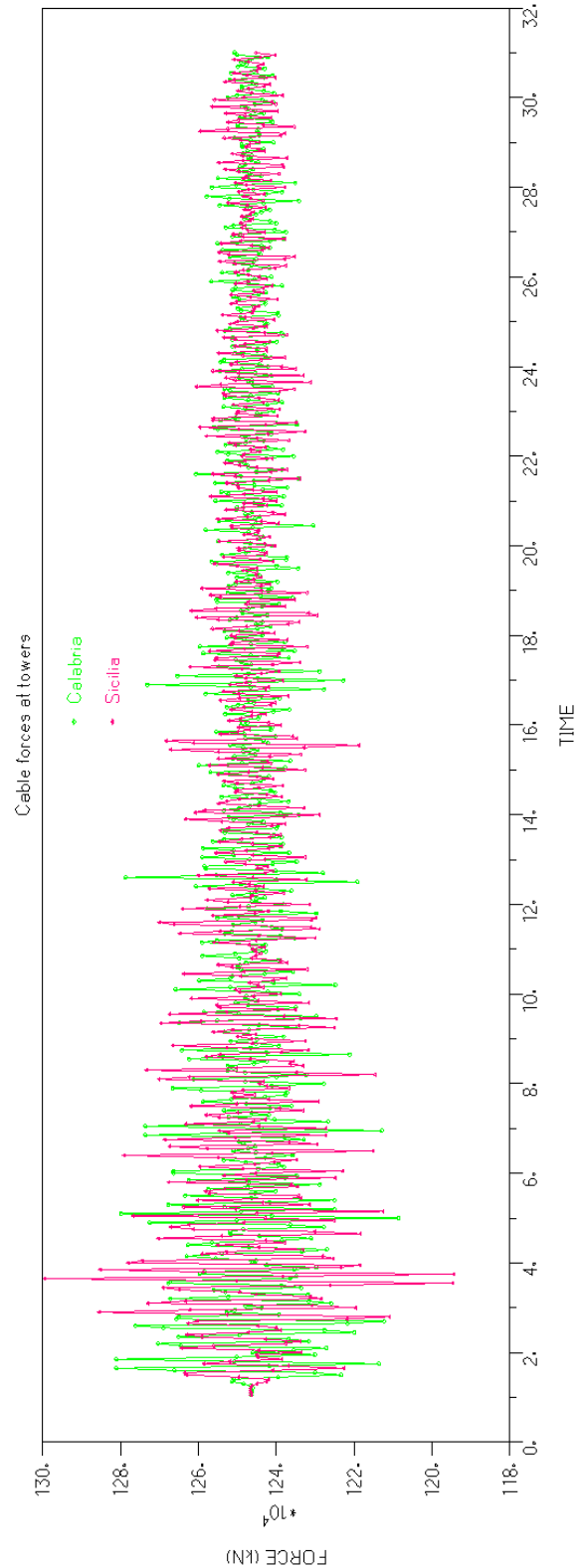
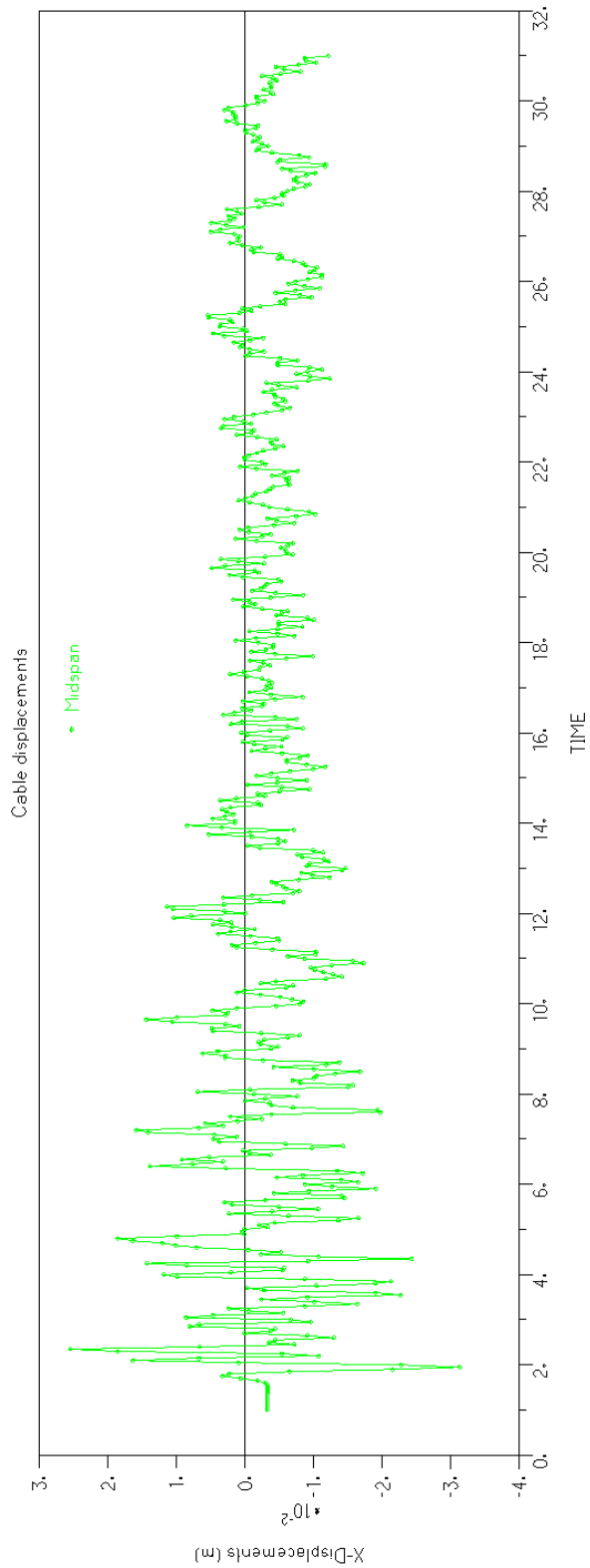
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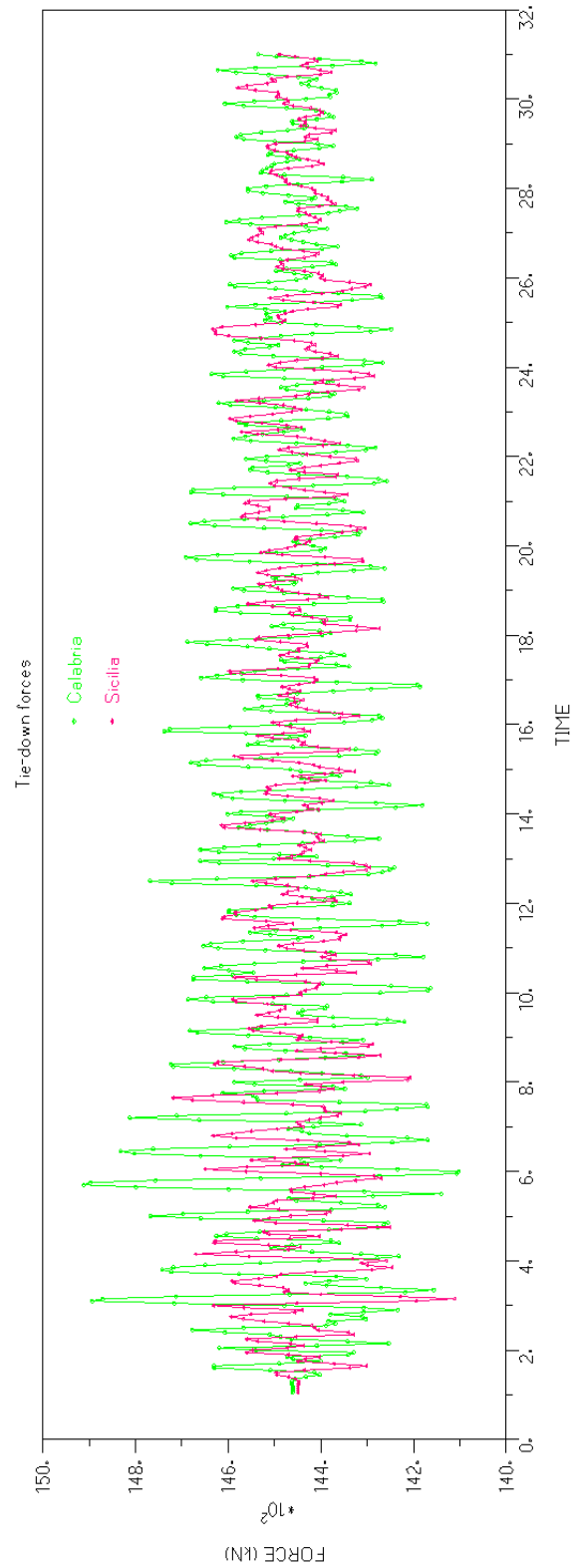
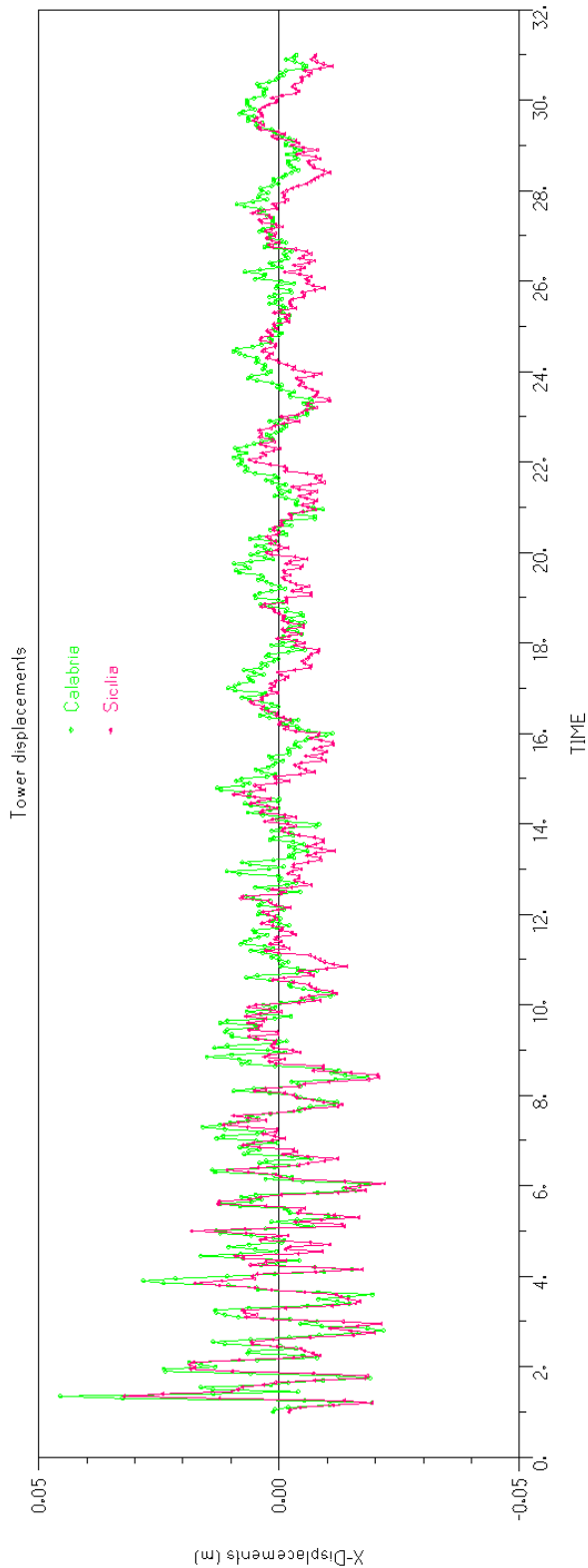


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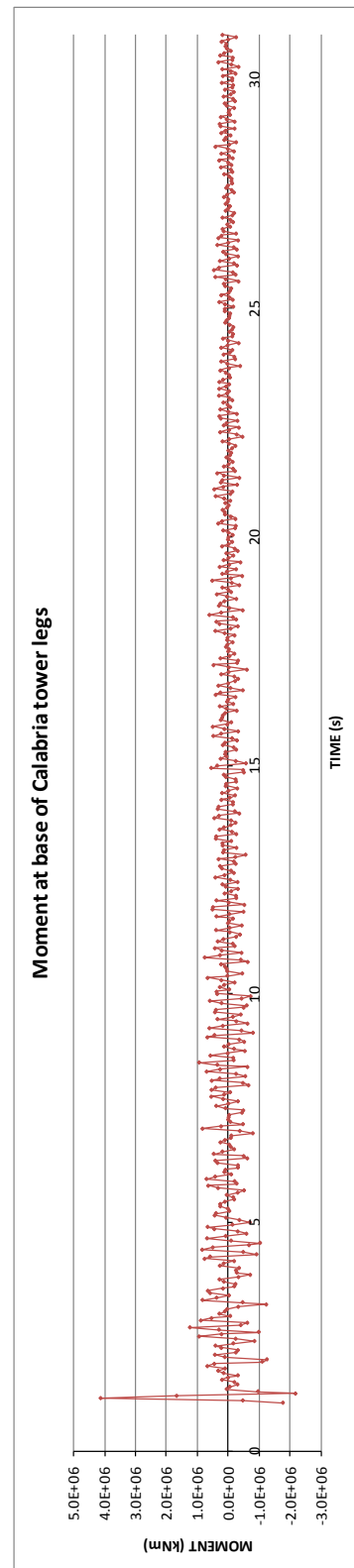
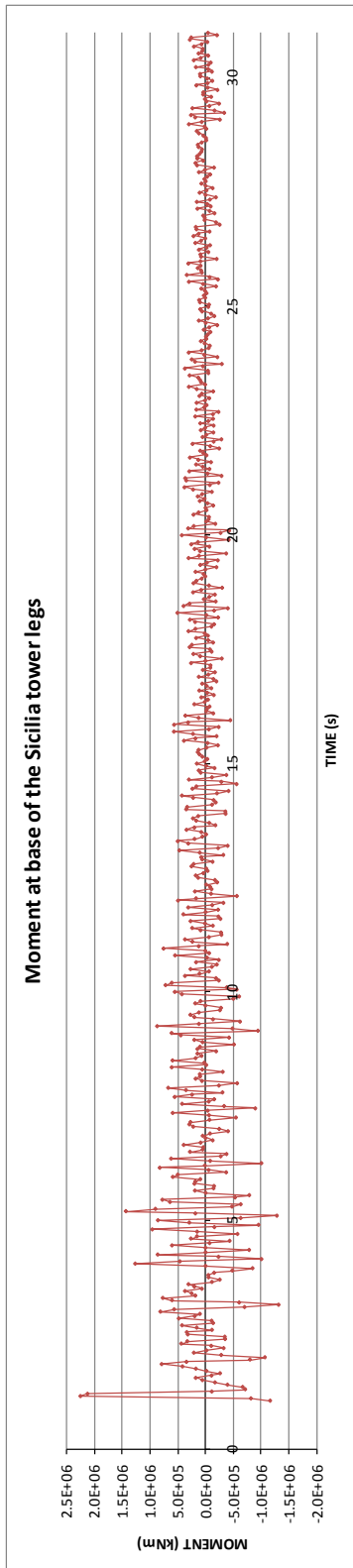


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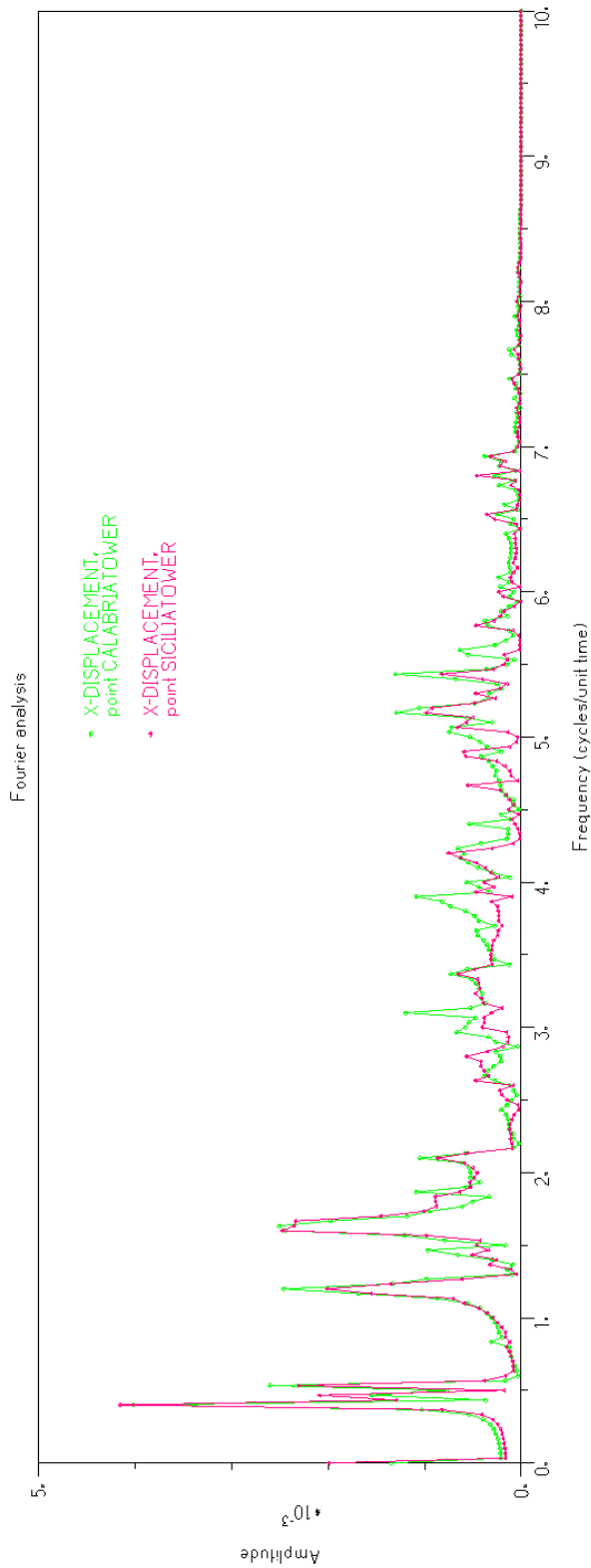


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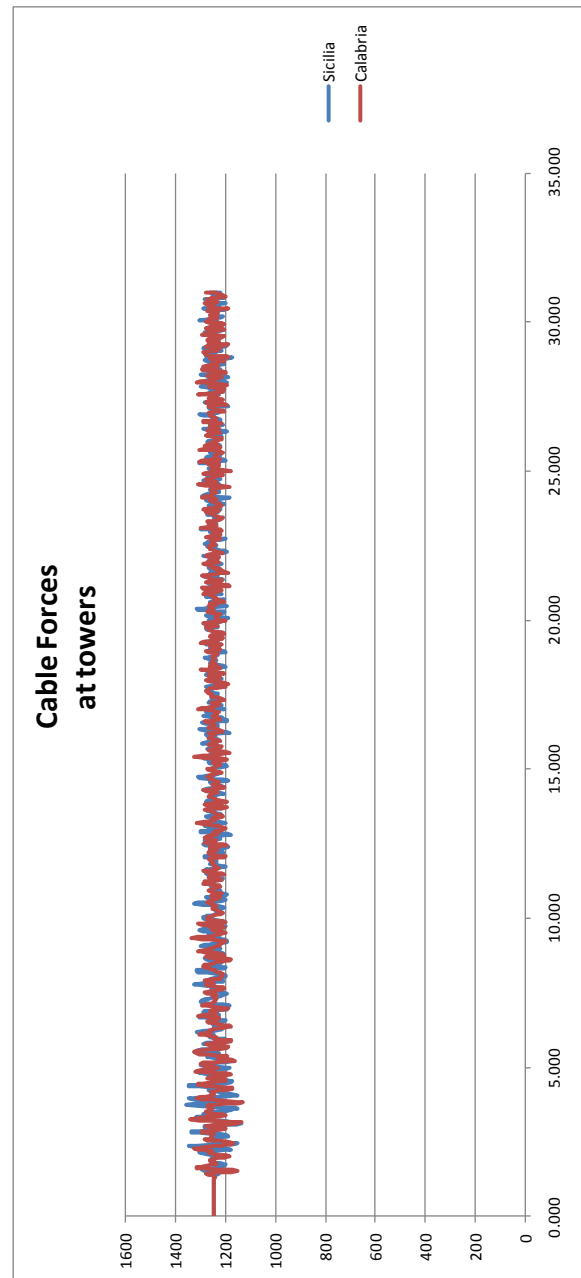
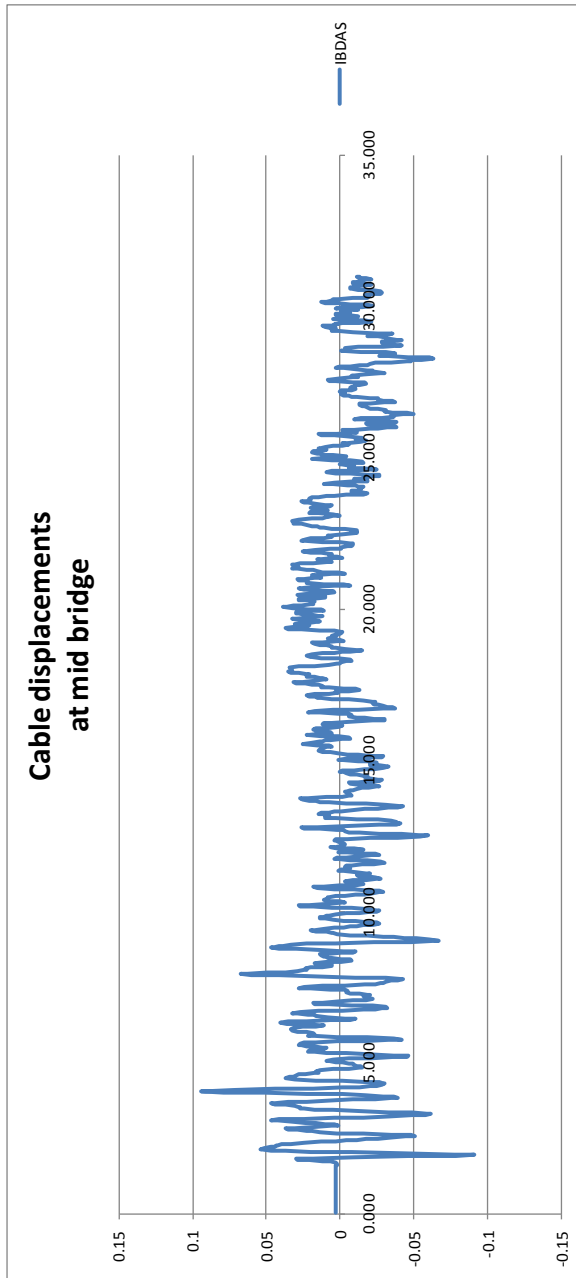
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**Case 3 – fixed-fixed buffers (IBDAS)**

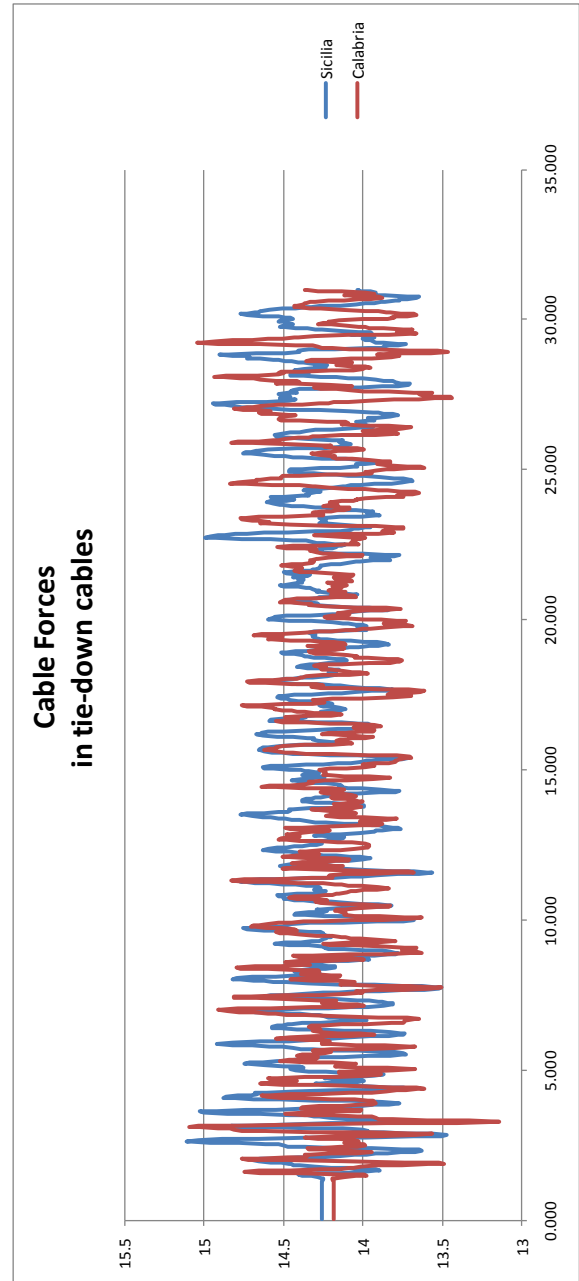
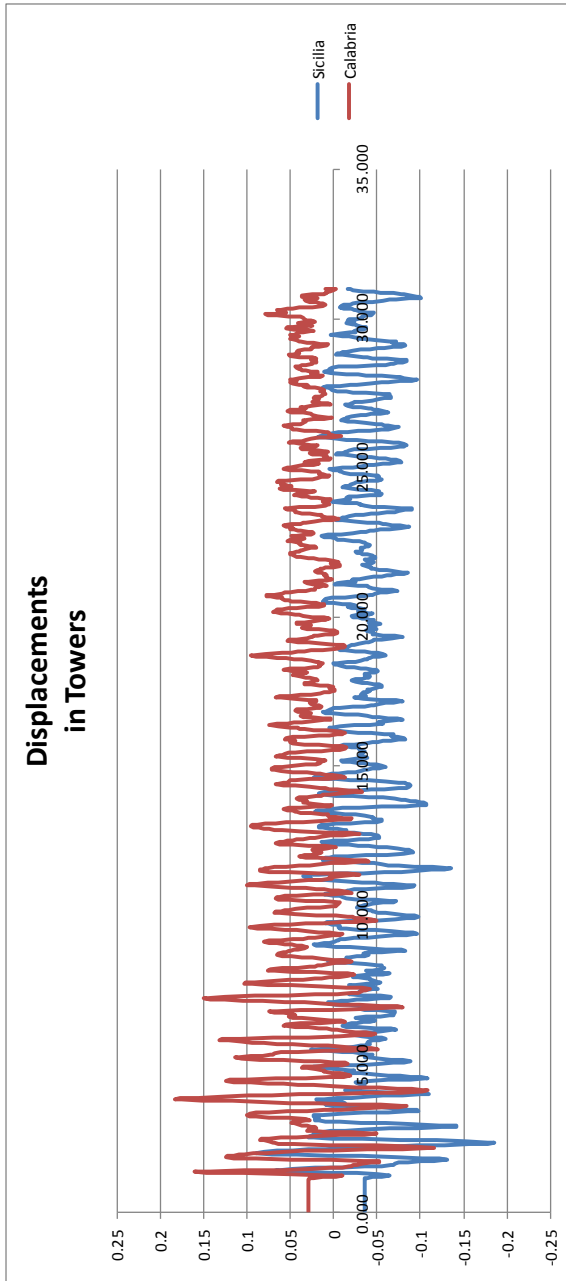




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## 9 Conclusioni

Per la validazione comparata tra i software IBDAS e ADINA sono stati messi a confronto i risultati ottenuti da diverse analisi e condizioni di carico. Le analisi hanno riguardato sia il condizionamento del modello a fine costruzione, sia il condizionamento delle caratteristiche proprie di vibrazione tramite l'analisi modale. Entrambe queste due analisi preliminari sono state propedeutiche alle vere e proprie analisi di confronto statiche e dinamiche. Si osserva che le condizioni di carico considerate non intendono riprodurre fedelmente situazioni di progetto, ma sono individuate in modo da rappresentare situazioni tipiche limite di sollecitazione del ponte. I risultati distinti per analisi hanno mostrato quanto segue.



Configurazione di riferimento a fine costruzione. La forma della configurazione a fine costruzione è molto simile tra IBDAS e ADINA con un differenziale di spostamento massimo (in mezzera) di circa 17 cm (sollevamento di 11 cm ADINA e abbassamento di 6 cm IBDAS rispetto allo zero teorico). Anche le sollecitazioni nel sistema di sospensione sono molto prossime (cavi e pendini) con un lieve incremento nei cavi di riva per IBDAS.

Analisi modale. Le caratteristiche dinamiche di base espresse dal comportamento modale del ponte sono assai simili tra i due modelli. La sostanziale identità di comportamento riguarda i valori di frequenza, l'ordine di apparizione dei modi (con particolare riguardo a quelli di bassa frequenza) e la frazione di massa modale eccitata.

Analisi statiche. Le grandezze di confronto comprendono spostamenti e sollecitazioni. In entrambi i casi i controlli hanno mostrato un buon accordo tra i risultati di IBDAS e di ADINA. Nello specifico, per quanto riguarda gli spostamenti si osserva che, per tutte le condizioni di carico e per tutte le configurazioni di buffer (free-free o fixed-fixed) esaminati, l'accordo in spostamento è buono. Il confronto in parola riguarda le componenti di spostamento di torri, impalcato e cavi depurate dalla configurazione iniziale, cioè vengono messi a confronto i soli incrementi dovuti alla particolare

condizione di carico. E' anche importante sottolineare che la corrispondenza non riguarda solo le componenti di spostamento sensibili alla particolare condizione di carico (p. es. spostamenti verticali per carico verticale), ma anche le componenti di spostamento meno sensibili di valore assoluto prossime a zero (ordine dei millimetri). Le massime differenze si osservano per condizioni di carico per comportamento pendolare longitudinale e trasversale dell'impalcato. In questi casi occorre però fare una precisazione. Infatti sebbene le differenze (dell'ordine dei 20 cm) sono un buon indicatore delle variazioni, queste non devono essere considerate solo in valore assoluto, ma anche relativamente agli spostamenti reali dell'impalcato (superiori ai 6 m); così facendo si osservano scarti inferiori al 3%. Per quanto riguarda invece il tiro nei cavi e nelle funi di tie-down la corrispondenza risulta ottima. Riferendosi ai valori percentuali che misurano la variazione di tiro in rapporto al tiro iniziale si osservano percentuali inferiori a 1% nei cavi per tutte le condizioni di carico; lo stesso accade nelle funi di tie-down con l'unica eccezione del caso di carico per comportamento pendolare in direzione longitudinale dove si osservano valori dell'ordine del 8%. Per quanto riguarda infine lo stato di sollecitazione alla base delle torri significative sono le condizioni di carico LC4, LC5, LC6 specificamente orientate allo scopo. In tutti i casi si riscontra una corrispondenza puntuale nelle direzioni di massima sollecitazione e comunque una buona corrispondenza anche nelle direzioni a queste ortogonali. Risultati analoghi si osservano anche per le altre condizioni di carico.

Analisi impulsive. Le analisi dinamiche per carichi impulsivi hanno riguardato tre condizioni di carico specifiche idonee ad eccitare prevalentemente alcuni modi deformativi del ponte rispetto ad altri. Anche il passo di integrazione è stato calibrato su tali modi. Sono stati considerati carichi impulsivi per eccitare i modi pendolari trasversali (caso 1) e longitudinali (caso 3) e carichi impulsivi per eccitare i modi di torre (caso 2). Il caso 3 si differenzia dagli altri per lo smorzamento (assente quello strutturale con presenza dei soli smorzatori concentrati a livello delle fondazioni) e per il tipo di forzante (spostamento applicato alla base). Sono state diagrammate le deformate relative ad istanti specifici e eseguite analisi di Fourier per controllare i modi coinvolti. Sia le deformate istantanee che le FFT delle storie degli spostamenti indicano che sono coinvolti almeno altri 2 modi oltre quello dominante per i casi 1 e 3 mentre sembra emergere solo il modo dominante di torre nel caso 2. In ogni caso si osserva un'ottima corrispondenza sia qualitativa (come profilo delle time history, presenza o meno di battimenti, oscillazioni sincrone e in fase/opposizione di fase) che quantitativa (come entità della risposta e periodo fondamentale di vibrazione). Nel caso 3 il confronto è meno immediato rispetto agli altri due a causa dello smorzamento residuo nel modello

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ADINA (smorzatori alla base delle fondazioni) rispetto al modello IBDAS (assenza di smorzamento). Comunque i valori conservano ancora un buon accordo tenuto conto che l'amplificazione in ADINA è inferiore a IBDAS.

In definitiva si può concludere osservando che esiste una ottima corrispondenza di comportamento tra i due modelli ADINA e IBDAS sia come risposta statica che come risposta dinamica.