



REGIONE BASILICATA

Comune di Pomarico (MT)



Progetto integrato agrivoltaico denominato “MASSERIA GLIONNA”:
riattivazione di una azienda zootecnica dismessa e realizzazione di una
centrale fotovoltaica di potenza nominale pari a 19,9980 MW con le
relative opere connesse ed infrastrutture indispensabili



Tavola:
A.7.

Elaborato:
Relazione preliminare sulle strutture

Scala:

PROPONENTE:

FOTOVOLTAICA SRL



ROMEO GROUP
FOTOVOLTAICA

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REVISIONI

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A.7. RELAZIONE PRELIMINARE SULLE STRUTTURE

Premessa

La presente relazione tecnica è parte integrante del “Progetto integrato agrivoltaico denominato “MASSERIA GLIONNA”: riattivazione di una azienda zootecnica dismessa e realizzazione di una centrale fotovoltaica di potenza nominale pari a 19,9980 MW con le relative opere connesse ed infrastrutture indispensabili”. Il Progetto è stato redatto per l’ottenimento del Provvedimento Unico in materia ambientale (PUA), ai sensi dell’art. 27 del D.Lgs. 152/2006, e per il rilascio dell’Autorizzazione Unica (AU), ai sensi dell’art. 12 del D.Lgs. 387/2003, relativamente alla costruzione e all’esercizio di un impianto di produzione di energia elettrica da fonte solare a tecnologia fotovoltaica denominato “Masseria Glionna” che sorgerà nel comune di Pomarico (MT) e precisamente nel sito identificato dalle coordinate geografiche: 40°28'41,54" N; 16°30'58,90" E a ridosso della zona industriale Valbasento del Comune di Ferrandina (MT). Le opere connesse e le infrastrutture indispensabili si estendono tra il Comune di Pomarico (MT) e la zona industriale Valbasento del Comune di Ferrandina (MT).

A.7.a. Descrizione generale

Informazioni dati progetto

località	Pomarico(MT)
Velocità del vento	27.0 m/s (10 min)
Modulo struttura	1x84
Intervallo di monitoraggio	±45°
Categoria di esposizione	C
Peso modulo	27.2 kg
Dimensione del modulo	2256×1133×35mm

A.7.b. Riferimenti

Software (Finite Element Analysis) SAP 2000 V15.2

ASCE STANDARD ASCE / SEI 7-05

ANSI/AISC 360-05

A.7.c. Materiali e proprietà meccaniche

Steel A572 GR50	Proprietà dei materiali
Carico di rottura	$f_u = 450 \text{ MPa}$
Limite di snervamento	$f_y = 345 \text{ MPa}$
densità	7850 kg/m^3
Modulo di Young	206000 MPa
Steel S350 $\leq 16\text{mm}$	Proprietà dei materiali
Carico di rottura	$f_u = 420 \text{ MPa}$
Limite di snervamento	$f_y = 350 \text{ MPa}$
densità	7850 kg/m^3
Modulo di Young	206000 MPa
Steel S450 $\leq 16\text{mm}$	Proprietà dei materiali
Carico di rottura	$f_u = 510 \text{ MPa}$
Limite di snervamento	$f_y = 450 \text{ MPa}$
densità	7850 kg/m^3
Modulo di Young	206000 MPa

A.7.d. Definizione dei carichi

Classificazione del carico presunto

a) Peso proprio (G)

Il carico ottenuto sommando la massa dei moduli (GM) e la massa della struttura (GK).

b) Carico in tensione (L)

Il carico dinamico sui moduli e sulle strutture non viene considerato in questo calcolo.

c) Carico di pressione del vento (W)

d) Carico da neve (S)

Il carico di neve (S) = 0,084 kN / m²

- **Combinazione di carichi**

La combinazione delle condizioni di carico e del carico deve essere quella fornita secondo la Sezione 2.4 dello STANDARD ASCE / SEI 7-05.



SIMBOLI E DEFINAZIONE	Combinando i carichi nominali utilizzando la tensione ammissibile
D: carico morto W0: Carico del vento in direzione 0° W180: Carico del vento in direzione 180 S: carico di neve	COMB 1=D
	COMB 2 = D+W0-A
	COMB 3 = D+W180-A
	COMB 4 = D+W0-B
	COMB 5 = D+W180-B
	COMB 6= D+S
	COMB 7= D+0.75W0-A+0.75S
	COMB 8= D+0.75W180-A+0.75S
	COMB 9= D+0.75W0-B+0.75S
	COMB 10 = D+0.75W180-B+0.75S
	COMB 11 = 0.6D+W0-A
	COMB 12 = 0.6D+W180-A
	COMB 13 = 0.6D+W0-B
	COMB 14 = 0.6D+W180-B

- **Pesi propri**

$G = G_M + G_K$	Carico morto
GK	Massa della struttura calcolata automaticamente dal software (SAP 2000)
$G_M = 27.2 \times 9.8 = 266.56N$	Peso modulo
$g = 9.8 \text{ N/kg}$	Accelerazione di gravità

- **Carico del vento**

Gli edifici aperti devono essere progettati e costruiti per resistere ai carichi del vento determinati in conformità alla Sezione 6.5.3 di ASCE 7-05. E alcune informazioni di base sono elencate di seguito.

Tipo di edificio	Edificio aperto
V	velocità del vento di base
Categoria di esposizione	C
p	Pressione del vento di progetto (N / m ²)

- **Progettare le pressioni del vento**

La pressione del vento di progetto netta per i componenti e gli elementi di rivestimento di edifici aperti di tutte le altezze con tetti a pendenza singola deve essere determinata dalla seguente equazione:

$P = C_n \times q_p \times G$	formula della pressione del vento di progetto netta
C_n	Coefficiente di pressione netta per tetto monofalda
G	Fattore di effetto raffica
q_p	Pressione di velocità valutata all'altezza media del tetto



- **Carico di pressione di velocità per la progettazione**

La pressione dinamica valutata all'altezza z deve essere calcolata con la seguente equazione in unità SI.

$q_p = 0.613 K_z K_{zt} K_d V^2 I$	Formula velocità pressione
K_z	Coefficiente di esposizione alla pressione di velocità
K_{zt}	Fattore topografico
K_d	Fattore di direzionalità del vento
$V=39.0 \text{ m/s}$	Velocità del vento di base
$I = 0.87$	Fattore importante Tab. 1.1

Category	Non-Hurricane Prone Regions and Hurricane Prone Regions with $V = 85-100 \text{ mph}$ and Alaska	Hurricane Prone Regions with $V > 100 \text{ mph}$
I	0.87	0.77
II	1.00	1.00
III	1.15	1.15
IV	1.15	1.15

Note:

1. The building and structure classification categories are listed in Table 1-1.

L'effetto dell'accelerazione del vento deve essere incluso nel calcolo dei carichi del vento di progetto utilizzando il fattore topografico. Se le condizioni del sito e le posizioni delle strutture non soddisfano tutte le condizioni specificate nella Sezione 6.5.7.1 $K_{zt} = 1.0$.

$K_{zt} = 1.0$	Fattore topografico
$K_{zt} = (1 + K_1 K_2 K_3)^2$	dove K_1 , K_2 e K_3 sono riportati nella Fig. 6-4

6.5.7.2 Topographic Factor. The wind speed-up effect shall be included in the calculation of design wind loads by using the factor K_{zt} :

$$K_{zt} = (1 + K_1 K_2 K_3)^2 \quad (6-3)$$

where K_1 , K_2 , and K_3 are given in Fig. 6-4.

If site conditions and locations of structures do not meet all the conditions specified in Section 6.5.7.1 then $K_{zt} = 1.0$.

- **Fattore di direzionalità del vento**

Il fattore di direzionalità del vento deve essere determinato dalla tabella 6-4. Questo fattore di direzionalità deve essere incluso solo nella determinazione dei carichi del vento quando le combinazioni di carico sono utilizzate per il progetto.



Kd = 0.85	Il fattore di direzionalità del vento è fornito di seguito																													
Categoria	Segni aperti e struttura reticolare																													
	<table border="1"><thead><tr><th>Structure Type</th><th>Directionality Factor K_d^*</th></tr></thead><tbody><tr><td>Buildings</td><td></td></tr><tr><td> Main Wind Force Resisting System</td><td>0.85</td></tr><tr><td> Components and Cladding</td><td>0.85</td></tr><tr><td>Arched Roofs</td><td>0.85</td></tr><tr><td>Chimneys, Tanks, and Similar Structures</td><td></td></tr><tr><td> Square</td><td>0.90</td></tr><tr><td> Hexagonal</td><td>0.95</td></tr><tr><td> Round</td><td>0.95</td></tr><tr><td>Solid Freestanding Walls and Solid Freestanding and Attached Signs</td><td>0.85</td></tr><tr><td>Open Signs and Lattice Framework</td><td>0.85</td></tr><tr><td>Trussed Towers</td><td></td></tr><tr><td> Triangular, square, rectangular</td><td>0.85</td></tr><tr><td> All other cross sections</td><td>0.95</td></tr></tbody></table>	Structure Type	Directionality Factor K_d^*	Buildings		Main Wind Force Resisting System	0.85	Components and Cladding	0.85	Arched Roofs	0.85	Chimneys, Tanks, and Similar Structures		Square	0.90	Hexagonal	0.95	Round	0.95	Solid Freestanding Walls and Solid Freestanding and Attached Signs	0.85	Open Signs and Lattice Framework	0.85	Trussed Towers		Triangular, square, rectangular	0.85	All other cross sections	0.95	
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Sulla base della categoria di esposizione determinata nella sezione 6.5.6, un coefficiente di esposizione pressione-velocità K_z , come applicabile, deve essere determinato dalla formula e dalla tabella 6-3.



$$K_z = 2.01(15/zg)^{2/\alpha} = 0.85$$

For Z = 0m < 4.6 m

Height above ground level, z		Exposure (Note 1)			
		B		C	D
ft	(m)	Case 1	Case 2	Cases 1 & 2	Cases 1 & 2
0-15	(0-4.6)	0.70	0.57	0.85	1.03
20	(6.1)	0.70	0.62	0.90	1.08
25	(7.6)	0.70	0.66	0.94	1.12
30	(9.1)	0.70	0.70	0.98	1.16
40	(12.2)	0.76	0.76	1.04	1.22
50	(15.2)	0.81	0.81	1.09	1.27
60	(18)	0.85	0.85	1.13	1.31
70	(21.3)	0.89	0.89	1.17	1.34
80	(24.4)	0.93	0.93	1.21	1.38
90	(27.4)	0.96	0.96	1.24	1.40
100	(30.5)	0.99	0.99	1.26	1.43
120	(36.6)	1.04	1.04	1.31	1.48
140	(42.7)	1.09	1.09	1.36	1.52
160	(48.8)	1.13	1.13	1.39	1.55
180	(54.9)	1.17	1.17	1.43	1.58
200	(61.0)	1.20	1.20	1.46	1.61
250	(76.2)	1.28	1.28	1.53	1.68
300	(91.4)	1.35	1.35	1.59	1.73
350	(106.7)	1.41	1.41	1.64	1.78
400	(121.9)	1.47	1.47	1.69	1.82
450	(137.2)	1.52	1.52	1.73	1.86
500	(152.4)	1.56	1.56	1.77	1.89

- **Fattore effetto raffica**

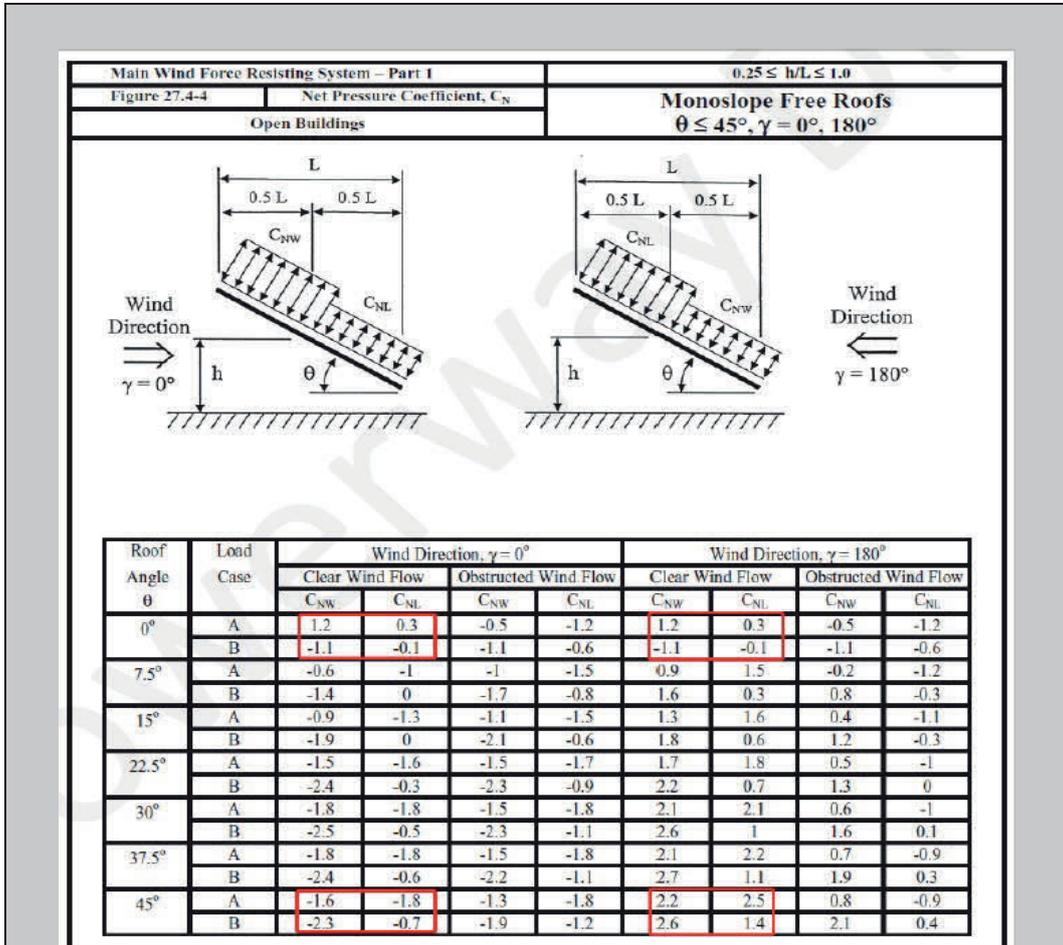
Secondo la Sezione 6.5.8 di ASCE 7-05, il fattore dell'effetto raffica per la struttura rigida può essere preso come 0.85. E la frequenza naturale approssimativa inferiore (n_a), in Hertz, di edifici in acciaio strutturale che soddisfano le condizioni della Sezione C6.5.8, può essere determinata dalle seguenti equazioni.



G=0.85	Fattore effetto raffica
$Na=22.2/H^{0.8}$	Per edifici con telaio resistente al momento in acciaio strutturale
H =2.12 m	altezza media del tetto (m)

I coefficienti di pressione netta sono riportati nella Fig. 6-18A per i tetti monoslop. Per valori di θ diversi da quelli indicati, è consentita l'interpolazione lineare.

Tipo di flusso del vento	Chiaro flusso del vento
Tipo di edificio	Edificio aperto
θ	$\pm 45^\circ$



(1) Angolo del tetto $\theta=0^\circ$

La formula del carico del vento di progetto e il valore dei fattori rilevanti sono elencati di seguito nella tabella



P= Cn x qp x G					Progettare il carico del vento																													
<table border="1"> <thead> <tr> <th colspan="5">Cn</th> </tr> <tr> <th rowspan="3"></th> <th colspan="2">γ=0°</th> <th colspan="2">γ=180°</th> </tr> <tr> <th colspan="2">Flusso di vento chiaro</th> <th colspan="2">Flusso di vento chiaro</th> </tr> <tr> <th>CNW</th> <th>CLN</th> <th>CNW</th> <th>CLN</th> </tr> </thead> <tbody> <tr> <td>Caso A</td> <td>1.2</td> <td>0.3</td> <td>1.2</td> <td>0.3</td> </tr> <tr> <td>Caso B</td> <td>-1.1</td> <td>-0.1</td> <td>-1.1</td> <td>-0.1</td> </tr> </tbody> </table>					Cn						γ=0°		γ=180°		Flusso di vento chiaro		Flusso di vento chiaro		CNW	CLN	CNW	CLN	Caso A	1.2	0.3	1.2	0.3	Caso B	-1.1	-0.1	-1.1	-0.1	Coefficiente di pressione netto	
Cn																																		
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Kd = 0.85					Fattore di direzionalità del vento																													
V=39.0 m/s					Velocità del vento di base																													
I =0.87					Fattore di importanza Tab. 1.1																													
G=0.85					Fattore effetto raffica																													

Progetto carico del vento (N/m²) (P= Cn x qh x G)

P (N/m ²)				
	γ=0°		γ=180°	
	pNW	pNL	pNW	pNl
Caso A	597.3	149.325	597.3	149.325
Caso B	-547.525	-49.775	547.525	-49.775

Carico del vento di progetto della guida secondaria (N / mm)

La larghezza del modulo monopezzo è $d = 1133 \text{ mm}$

	$\gamma=0^\circ$		$\gamma=180^\circ$	
	W_{NW}	W_{NL}	W_{NW}	W_{NL}
Caso A	0.677	0.169	0.677	0.169
Caso B	-0.62	-0.056	-0.62	-0.056

(2) Angolo del tetto $\theta=45^\circ$

La formula del carico del vento di progetto e il valore dei fattori rilevanti sono elencati di seguito nella tabella

$P = C_n \times q_p \times G$	Progettare il carico del vento																												
<table border="1"> <thead> <tr> <th colspan="5">Cn</th> </tr> <tr> <th rowspan="3"></th> <th colspan="2">$\gamma=0^\circ$</th> <th colspan="2">$\gamma=180^\circ$</th> </tr> <tr> <th colspan="2">Flusso di vento chiaro</th> <th colspan="2">Flusso di vento chiaro</th> </tr> <tr> <th>C_{NW}</th> <th>C_{NL}</th> <th>C_{NW}</th> <th>C_{NL}</th> </tr> </thead> <tbody> <tr> <td>Caso A</td> <td>-1.6</td> <td>-1.8</td> <td>2.2</td> <td>2.5</td> </tr> <tr> <td>Caso B</td> <td>-2.3</td> <td>-0.7</td> <td>2.6</td> <td>1.4</td> </tr> </tbody> </table>	Cn						$\gamma=0^\circ$		$\gamma=180^\circ$		Flusso di vento chiaro		Flusso di vento chiaro		C_{NW}	C_{NL}	C_{NW}	C_{NL}	Caso A	-1.6	-1.8	2.2	2.5	Caso B	-2.3	-0.7	2.6	1.4	Coefficiente di pressione netto
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Progetto carico del vento (N/m²) (P= Cn x qh x G)

P (N/m ²)				
	$\gamma=0^\circ$		$\gamma=180^\circ$	
	p _{NW}	p _{NI}	p _{NW}	p _{NI}
Caso A	-169.647	-190.853	233.265	265.074
Caso B	-243.868	-74.221	275.677	148.441

Carico del vento di progetto della guida secondaria (N / mm)

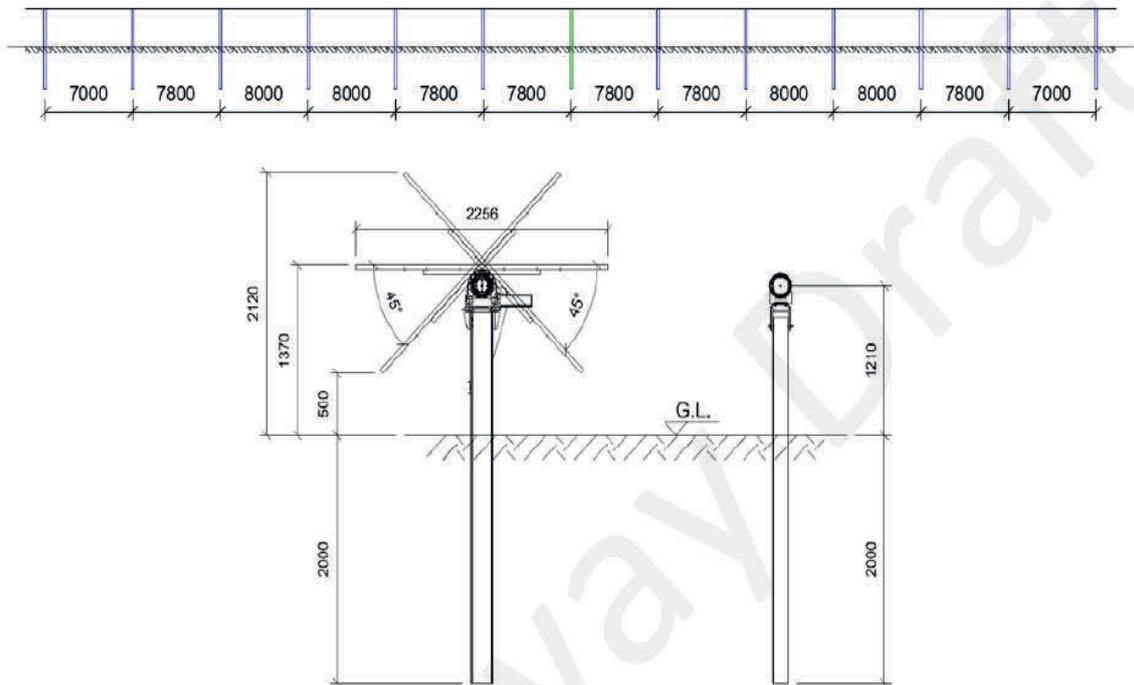
La larghezza del modulo mono pezzo è d = 1133 mm

	$\gamma=0^\circ$		$\gamma=180^\circ$	
	W _{NW}	W _{LN}	W _{NW}	W _{LN}
Caso A	-0.192	-0.216	0.264	0.3
Caso B	-0.276	-0.084	0.312	0.168



A.7.e. Modello di calcolo

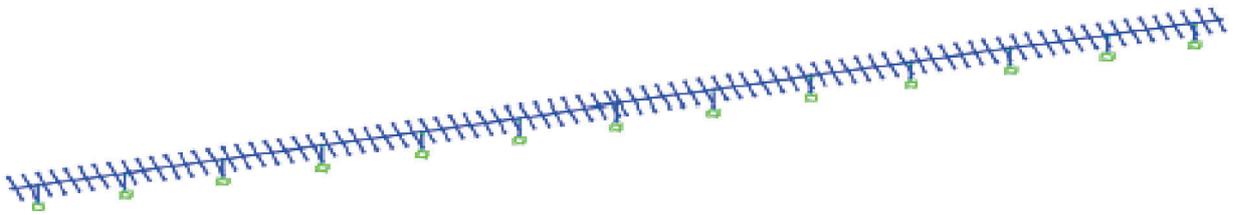
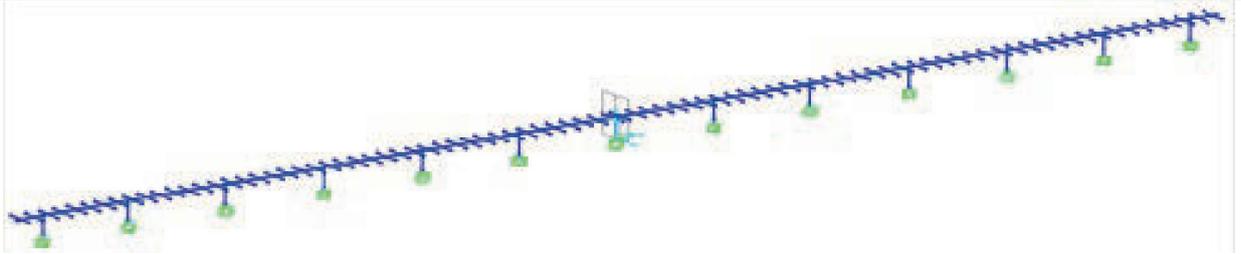
Visualizzazione dettagliata



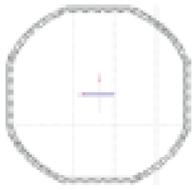


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Modello statico (0° & 45°)





Elemento	Sezione trasversale	Disegno	Materiale
trave	8 Side Tube_D146×d135×4.0 8 Side Tube_D146×d135×3.5 8 Side Tube_D146×d135×3.0 8 Side Tube_D146×d135×2.5		S450

Property Data

Section Name: 8 Side Tube_4.0mm_S450

Properties			
Cross-section (axial) area	1761.3548	Section modulus about 3 axis	62385.64
Moment of Inertia about 3 axis	4242257.	Section modulus about 2 axis	62385.65
Moment of Inertia about 2 axis	4242253.	Plastic modulus about 3 axis	61658.45
Product of Inertia about 2-3	-47.02	Plastic modulus about 2 axis	61658.41
Shear area in 2 direction	1129.8983	Radius of Gyration about 3 axis	49.0767
Shear area in 3 direction	1129.8992	Radius of Gyration about 2 axis	49.0766
Torsional constant	8311616.	Shear Center Eccentricity (x3)	0.

OK

Property Data

Section Name: 8 Side Tube_3.5mm_S450

Properties			
Cross-section (axial) area	1546.6621	Section modulus about 3 axis	55169.48
Moment of Inertia about 3 axis	3751555.	Section modulus about 2 axis	55170.2
Moment of Inertia about 2 axis	3751601.	Plastic modulus about 3 axis	69859.31
Product of Inertia about 2-3	-19.8397	Plastic modulus about 2 axis	69859.81
Shear area in 2 direction	991.7392	Radius of Gyration about 3 axis	49.2502
Shear area in 3 direction	991.7291	Radius of Gyration about 2 axis	49.2505
Torsional constant	7350462.	Shear Center Eccentricity (x3)	0.

OK



Property Data

Section Name: 8 Side Tube_3.0mm_S450

Properties

Cross-section (axial) area	1330.4742	Section modulus about 3 axis	47794.87
Moment of Inertia about 3 axis	3250067.	Section modulus about 2 axis	47795.07
Moment of Inertia about 2 axis	3250095.	Plastic modulus about 3 axis	60308.19
Product of Inertia about 2-3	-36.373	Plastic modulus about 2 axis	60308.5
Shear area in 2 direction	852.7637	Radius of Gyration about 3 axis	49.4246
Shear area in 3 direction	852.7507	Radius of Gyration about 2 axis	49.4248
Torsional constant	6368378.	Shear Center Eccentricity (x3)	0.

OK

Property Data

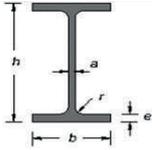
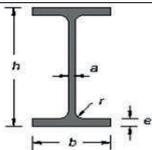
Section Name: 8 Side Tube_2.5mm_S450

Properties

Cross-section (axial) area	1112.6582	Section modulus about 3 axis	40253.28
Moment of Inertia about 3 axis	2737285.6	Section modulus about 2 axis	40254.05
Moment of Inertia about 2 axis	2737275.9	Plastic modulus about 3 axis	39366.45
Product of Inertia about 2-3	-39.47	Plastic modulus about 2 axis	39366.37
Shear area in 2 direction	712.8928	Radius of Gyration about 3 axis	49.5997
Shear area in 3 direction	712.8949	Radius of Gyration about 2 axis	49.5996
Torsional constant	5363041.	Shear Center Eccentricity (x3)	0.

OK



<p>Colonna motore</p>	<p>W8x15</p>		<p>A572 –Gr50</p>																												
<div style="display: flex; justify-content: space-around;"> <div data-bbox="347 680 743 1025"> <p>Section Name: W8x15 A572Gr50</p> <p>Section Notes: Modify/Show Notes</p> <p>Properties: Section Properties</p> <p>Property Modifiers: Set Modifiers</p> <p>Material: A572Gr50</p> <p>Dimensions:</p> <ul style="list-style-type: none"> Outside height (h): 206 Top flange width (b): 102 Top flange thickness (t): 8 Web thickness (tw): 6.2 Bottom flange width (b): 102 Bottom flange thickness (tb): 8 <p>Display Color: ■</p> <p>OK Cancel</p> </div> <div data-bbox="743 775 1216 1025"> <p>Section Name: W8x16 A572Gr50</p> <p>Properties:</p> <table border="1"> <tr> <td>Cross section (axial) area:</td> <td>2810</td> <td>Section modulus about 3 axis:</td> <td>185784.01</td> </tr> <tr> <td>Moment of inertia about 3 axis:</td> <td>18547763</td> <td>Section modulus about 2 axis:</td> <td>27817.891</td> </tr> <tr> <td>Moment of inertia about 2 axis:</td> <td>1418717.5</td> <td>Plastic modulus about 3 axis:</td> <td>217623</td> </tr> <tr> <td>Product of inertia about 2-3:</td> <td>0</td> <td>Plastic modulus about 2 axis:</td> <td>43441.9</td> </tr> <tr> <td>Shear area in 2 direction:</td> <td>1277.2</td> <td>Radius of Gyration about 3 axis:</td> <td>83.4096</td> </tr> <tr> <td>Shear area in 3 direction:</td> <td>1280</td> <td>Radius of Gyration about 2 axis:</td> <td>22.4636</td> </tr> <tr> <td>Torsional constant:</td> <td>47879.48</td> <td>Shear Center Eccentricity (e):</td> <td>0</td> </tr> </table> <p>OK</p> </div> </div>				Cross section (axial) area:	2810	Section modulus about 3 axis:	185784.01	Moment of inertia about 3 axis:	18547763	Section modulus about 2 axis:	27817.891	Moment of inertia about 2 axis:	1418717.5	Plastic modulus about 3 axis:	217623	Product of inertia about 2-3:	0	Plastic modulus about 2 axis:	43441.9	Shear area in 2 direction:	1277.2	Radius of Gyration about 3 axis:	83.4096	Shear area in 3 direction:	1280	Radius of Gyration about 2 axis:	22.4636	Torsional constant:	47879.48	Shear Center Eccentricity (e):	0
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<p>Colonna 2 Non motore</p>	<p>W6x7</p>		<p>A572 –Gr50</p>																												
<div style="display: flex; justify-content: space-around;"> <div data-bbox="328 1274 743 1637"> <p>Section Name: W6x7 A572Gr50</p> <p>Section Notes: Modify/Show Notes</p> <p>Properties: Section Properties</p> <p>Property Modifiers: Set Modifiers</p> <p>Material: A572Gr50</p> <p>Dimensions:</p> <ul style="list-style-type: none"> Outside height (h): 147 Top flange width (b): 100 Top flange thickness (t): 4.2 Web thickness (tw): 3.3 Bottom flange width (b): 100 Bottom flange thickness (tb): 4.2 <p>Display Color: <input type="checkbox"/></p> <p>OK Cancel</p> </div> <div data-bbox="743 1382 1227 1637"> <p>Section Name: W6x7 A572Gr50</p> <p>Properties:</p> <table border="1"> <tr> <td>Cross section (axial) area:</td> <td>1297.38</td> <td>Section modulus about 3 axis:</td> <td>18240.94</td> </tr> <tr> <td>Moment of inertia about 3 axis:</td> <td>5015793</td> <td>Section modulus about 2 axis:</td> <td>14088.301</td> </tr> <tr> <td>Moment of inertia about 2 axis:</td> <td>700415.1</td> <td>Plastic modulus about 3 axis:</td> <td>75604.22</td> </tr> <tr> <td>Product of inertia about 2-3:</td> <td>0</td> <td>Plastic modulus about 2 axis:</td> <td>21377.339</td> </tr> <tr> <td>Shear area in 2 direction:</td> <td>486.1</td> <td>Radius of Gyration about 3 axis:</td> <td>62.1774</td> </tr> <tr> <td>Shear area in 3 direction:</td> <td>700</td> <td>Radius of Gyration about 2 axis:</td> <td>23.2351</td> </tr> <tr> <td>Torsional constant:</td> <td>8443.9538</td> <td>Shear Center Eccentricity (e):</td> <td>0</td> </tr> </table> <p>OK</p> </div> </div>				Cross section (axial) area:	1297.38	Section modulus about 3 axis:	18240.94	Moment of inertia about 3 axis:	5015793	Section modulus about 2 axis:	14088.301	Moment of inertia about 2 axis:	700415.1	Plastic modulus about 3 axis:	75604.22	Product of inertia about 2-3:	0	Plastic modulus about 2 axis:	21377.339	Shear area in 2 direction:	486.1	Radius of Gyration about 3 axis:	62.1774	Shear area in 3 direction:	700	Radius of Gyration about 2 axis:	23.2351	Torsional constant:	8443.9538	Shear Center Eccentricity (e):	0
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Binario secondario	88x38x2		S350																												
<div style="border: 1px solid gray; padding: 10px; width: fit-content; margin: auto;"><p>Section Name <input type="text" value="38x30x88x2.0 S350"/></p><p>Properties</p><table border="1"><tr><td>Cross-section (axial) area</td><td><input type="text" value="320"/></td><td>Section modulus about 3 axis</td><td><input type="text" value="3036.7906"/></td></tr><tr><td>Moment of Inertia about 3 axis</td><td><input type="text" value="68631.47"/></td><td>Section modulus about 2 axis</td><td><input type="text" value="3223.8788"/></td></tr><tr><td>Moment of Inertia about 2 axis</td><td><input type="text" value="141850.67"/></td><td>Plastic modulus about 3 axis</td><td><input type="text" value="4272.1714"/></td></tr><tr><td>Product of Inertia about 2-3</td><td><input type="text" value="0"/></td><td>Plastic modulus about 2 axis</td><td><input type="text" value="5972.1143"/></td></tr><tr><td>Shear area in 2 direction</td><td><input type="text" value="147.6304"/></td><td>Radius of Gyration about 3 axis</td><td><input type="text" value="14.6449"/></td></tr><tr><td>Shear area in 3 direction</td><td><input type="text" value="139.5369"/></td><td>Radius of Gyration about 2 axis</td><td><input type="text" value="21.0543"/></td></tr><tr><td>Torsional constant</td><td><input type="text" value="430.1265"/></td><td>Shear Center Eccentricity (x3)</td><td><input type="text" value="0"/></td></tr></table><p style="text-align: center;"><input type="button" value="OK"/></p></div>				Cross-section (axial) area	<input type="text" value="320"/>	Section modulus about 3 axis	<input type="text" value="3036.7906"/>	Moment of Inertia about 3 axis	<input type="text" value="68631.47"/>	Section modulus about 2 axis	<input type="text" value="3223.8788"/>	Moment of Inertia about 2 axis	<input type="text" value="141850.67"/>	Plastic modulus about 3 axis	<input type="text" value="4272.1714"/>	Product of Inertia about 2-3	<input type="text" value="0"/>	Plastic modulus about 2 axis	<input type="text" value="5972.1143"/>	Shear area in 2 direction	<input type="text" value="147.6304"/>	Radius of Gyration about 3 axis	<input type="text" value="14.6449"/>	Shear area in 3 direction	<input type="text" value="139.5369"/>	Radius of Gyration about 2 axis	<input type="text" value="21.0543"/>	Torsional constant	<input type="text" value="430.1265"/>	Shear Center Eccentricity (x3)	<input type="text" value="0"/>
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A.7.f. Verifica progettuale della struttura

Standard di progettazione	ANSI / AISC 360-05 standard nazionale americano specifico per edifici in acciaio strutturale
Software (analisi agli elementi finiti)	SAP 2000 V15.2



(1) formula di controllo per montante di trasmissione, montante non di guida, binario secondario

(1) checking formula for Drive Post, Non-Drive Post, Sub Rail

H1. DOUBLY AND SINGLY SYMMETRIC MEMBERS SUBJECT TO FLEXURE AND AXIAL FORCE

1. Doubly and Singly Symmetric Members in Flexure and Compression

The interaction of flexure and compression in doubly symmetric members and singly symmetric members for which $0.1 \leq (I_{yc}/I_y) \leq 0.9$, that are constrained to bend about a *geometric axis* (x and/or y) shall be limited by Equations H1-1a and H1-1b, where I_{yc} is the moment of inertia about the y-axis referred to the compression flange, in⁴ (mm⁴).

User Note: Section H2 is permitted to be used in lieu of the provisions of this section.

(a) For $\frac{P_r}{P_c} \geq 0.2$

$$\frac{P_r}{P_c} + \frac{8}{9} \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0 \quad \text{(H1-1a)}$$

(b) For $\frac{P_r}{P_c} < 0.2$

$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0 \quad \text{(H1-1b)}$$

(2) formula di controllo per elementi strutturali

2. HSS Subject to Combined Torsion, Shear, Flexure and Axial Force

When the *required torsional strength*, T_r , is less than or equal to 20 percent of the *available torsional strength*, T_c , the interaction of torsion, shear, flexure and/or axial force for HSS shall be determined by Section H1 and the torsional effects shall be neglected. When T_r exceeds 20 percent of T_c , the interaction of torsion, shear, flexure and/or axial force shall be limited by

$$\left(\frac{P_r}{P_c} + \frac{M_r}{M_c} \right) + \left(\frac{V_r}{V_c} + \frac{T_r}{T_c} \right)^2 \leq 1.0 \quad \text{(H3-6)}$$



Rapporto massimo di sollecitazione della trave principale	$0.893 < 1$ (0.6D+W180-A, $\theta=0^\circ$)
Rapporto di sollecitazione massimo del palo motore	$0.847 < 1$ (0.6D+W0-B, $\theta=0^\circ$)
Rapporto di sollecitazione massimo del palo non motore	$0.351 < 1$ (D+W180-A, $\theta=45^\circ$)
Rapporto di sollecitazione massimo della guida secondaria	$0.822 < 1$ (D+W180-A, $\theta=0^\circ$)



A.7.g. Reazioni vincolari supporto della struttura

Le reazioni di supporto della struttura di montaggio devono essere utilizzate per progettare le fondamenta del sistema Tracker e sono elencate nella tabella seguente.

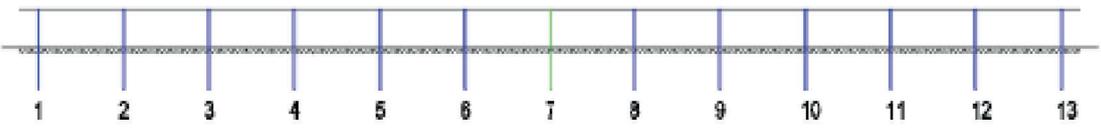
			
Forza di reazione vincolare del palo di guida, $\theta=0^\circ$			
Carico di progetto	Max valore	nodo	combinazione
Compressione F3	10.79 (KN)	7	D+W180-A
Tensione F3	3.30 (KN)	7	0.6D+W0-B
Forza laterale F1	0.22 (KN)	7	0.6D+W0-B / D+W180-B
Momento flessione (M2)	30.53 (KN)	7	D+W180-B
Forza di reazione vincolare del palo non motore, $\theta=0^\circ$			
Carico di progetto	Max valore	nodo	combinazione
Compressione F3	10.01 (KN)	4, 10	D+W180-A
Tensione F3	10.54 (KN)	3, 4, 10, 11	0.6D+W0-B
Forza laterale F2	0.16 (KN)	6, 8	0.6D+W0-B / D+W180-B
Momento flessione (M1)	0.33 (KN)	1, 13	D+W180-B



Tabella: Reazioni vincolari per $\theta = 0^\circ$

TABLE: Joint Reactions (1x84-39m/s-C-0°)								
Joint	OutputCase	CaseType	F1	F2	F3	M1	M2	M3
Text	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
1	D+W180-A	Combination	0.00	0.00	6.96	0.33	0.00	-0.00
1	D+0.75W180-A+0.75S	Combination	0.00	0.00	6.48	0.31	0.00	-0.00
1	0.6D+W0-A	Combination	-0.00	0.00	6.07	0.29	-0.00	0.00
1	D+0.75W180-B+0.75S	Combination	-0.00	0.00	0.10	0.01	-0.00	0.00
1	D+W180-B	Combination	-0.00	0.00	-1.54	-0.06	-0.00	0.00
1	0.6D+W0-B	Combination	0.00	0.00	-2.44	-0.11	0.00	-0.00
10	D+W180-B	Combination	0.01	0.00	-2.08	0.01	0.02	0.00
10	D+0.75W180-B+0.75S	Combination	0.01	0.00	0.26	0.01	0.02	0.00
10	0.6D+W0-B	Combination	-0.01	0.00	-3.40	0.00	-0.02	-0.00
10	D+0.75W180-A+0.75S	Combination	-0.01	0.00	9.33	0.00	-0.01	-0.00
10	D+W180-A	Combination	-0.01	0.00	10.01	0.00	-0.02	-0.00
10	0.6D+W0-A	Combination	0.01	0.00	8.69	-0.00	0.02	0.00
11	0.6D+W0-B	Combination	0.00	0.00	-3.40	0.00	0.00	0.00
11	D+W180-B	Combination	-0.00	0.00	-2.12	-0.01	-0.00	-0.00
11	D+0.75W180-B+0.75S	Combination	-0.00	0.00	0.19	-0.01	-0.00	-0.00
11	0.6D+W0-A	Combination	-0.00	0.00	8.55	-0.03	-0.00	-0.00
11	D+0.75W180-A+0.75S	Combination	0.00	0.00	9.15	-0.04	0.00	0.00
11	D+W180-A	Combination	0.00	0.00	9.82	-0.04	0.00	0.00
12	0.6D+W0-B	Combination	-0.00	0.00	-3.28	0.03	-0.00	-0.00
12	D+W180-B	Combination	0.00	0.00	-2.09	0.03	0.00	0.00
12	D+0.75W180-B+0.75S	Combination	0.00	0.00	0.13	0.01	0.00	0.00
12	0.6D+W0-A	Combination	0.00	0.00	8.14	-0.07	0.00	0.00



12	D+0.75W180-A+0.75S	Combination	-0.00	0.00	8.69	-0.07	-0.00	-0.00
12	D+W180-A	Combination	-0.00	0.00	9.33	-0.08	-0.00	-0.00
13	0.6D+W0-B	Combination	0.00	0.00	-2.44	0.11	0.00	0.00
13	D+W180-B	Combination	-0.00	0.00	-1.54	0.06	-0.00	-0.00
13	D+0.75W180-B+0.75S	Combination	-0.00	0.00	0.10	-0.01	-0.00	-0.00
13	0.6D+W0-A	Combination	-0.00	0.00	6.07	-0.29	-0.00	-0.00
13	D+0.75W180-A+0.75S	Combination	0.00	0.00	6.48	-0.31	0.00	0.00
13	D+W180-A	Combination	0.00	0.00	6.96	-0.33	0.00	0.00
2	D+W180-A	Combination	-0.00	0.00	9.33	0.08	-0.00	0.00
2	D+0.75W180-A+0.75S	Combination	-0.00	0.00	8.69	0.07	-0.00	0.00
2	0.6D+W0-A	Combination	0.00	0.00	8.14	0.07	0.00	-0.00
2	D+0.75W180-B+0.75S	Combination	0.00	0.00	0.13	-0.01	0.00	-0.00
2	D+W180-B	Combination	0.00	0.00	-2.09	-0.03	0.00	-0.00
2	0.6D+W0-B	Combination	-0.00	0.00	-3.28	-0.03	-0.00	0.00
3	D+W180-A	Combination	0.00	0.00	9.82	0.04	0.00	-0.00
3	D+0.75W180-A+0.75S	Combination	0.00	0.00	9.15	0.04	0.00	-0.00
3	0.6D+W0-A	Combination	-0.00	0.00	8.55	0.03	-0.00	0.00
3	D+0.75W180-B+0.75S	Combination	-0.00	0.00	0.19	0.01	-0.00	0.00
3	D+W180-B	Combination	-0.00	0.00	-2.12	0.01	-0.00	0.00
3	0.6D+W0-B	Combination	0.00	0.00	-3.40	-0.00	0.00	-0.00
4	0.6D+W0-A	Combination	0.01	0.00	8.69	0.00	0.02	-0.00
4	D+W180-A	Combination	-0.01	0.00	10.01	-0.00	-0.02	0.00
4	D+0.75W180-A+0.75S	Combination	-0.01	0.00	9.33	-0.00	-0.01	0.00
4	0.6D+W0-B	Combination	-0.01	0.00	-3.40	-0.00	-0.02	0.00
4	D+0.75W180-B+0.75S	Combination	0.01	0.00	0.26	-0.01	0.02	-0.00
4	D+W180-B	Combination	0.01	0.00	-2.08	-0.01	0.02	-0.00
5	0.6D+W0-B	Combination	0.06	0.00	-3.31	0.02	0.09	-0.00
5	D+W180-B	Combination	-0.06	0.00	-1.99	0.02	-0.09	0.00
5	D+0.75W180-B+0.75S	Combination	-0.05	0.00	0.31	0.01	-0.07	0.00
5	D+0.75W180-A+0.75S	Combination	0.04	0.00	9.23	-0.03	0.06	-0.00
5	0.6D+W0-A	Combination	-0.05	0.00	8.58	-0.03	-0.08	0.00
5	D+W180-A	Combination	0.05	0.00	9.90	-0.03	0.08	-0.00
6	D+W180-A	Combination	-0.14	0.00	9.89	0.01	-0.21	0.00
6	D+0.75W180-A+0.75S	Combination	-0.11	0.00	9.23	0.01	-0.16	0.00
6	0.6D+W0-A	Combination	0.14	0.00	8.53	0.01	0.21	-0.00
6	D+0.75W180-B+0.75S	Combination	0.12	0.00	0.46	0.01	0.18	-0.00
6	D+W180-B	Combination	0.16	0.00	-1.81	0.00	0.23	-0.00
6	0.6D+W0-B	Combination	-0.16	0.00	-3.16	0.00	-0.23	0.00
7	0.6D+W0-B	Combination	0.22	-0.00	-3.30	0.00	-30.53	-0.00
7	D+W180-A	Combination	0.19	0.00	10.79	-0.00	-27.50	-0.00
7	D+0.75W180-A+0.75S	Combination	0.15	0.00	10.08	-0.00	-20.63	-0.00
7	D+0.75W180-B+0.75S	Combination	-0.16	-0.00	0.65	0.00	22.90	0.00



7	0.6D+W0-A	Combination	-0.19	0.00	9.27	-0.00	27.50	0.00
7	D+W180-B	Combination	-0.22	-0.00	-1.78	0.00	30.53	0.00
8	0.6D+W0-B	Combination	-0.16	0.00	-3.16	-0.00	-0.23	-0.00
8	D+W180-B	Combination	0.16	0.00	-1.81	-0.00	0.23	0.00
8	D+0.75W180-B+0.75S	Combination	0.12	0.00	0.46	-0.01	0.18	0.00
8	0.6D+W0-A	Combination	0.14	0.00	8.53	-0.01	0.21	0.00
8	D+0.75W180-A+0.75S	Combination	-0.11	0.00	9.23	-0.01	-0.16	-0.00
8	D+W180-A	Combination	-0.14	0.00	9.89	-0.01	-0.21	-0.00
9	D+W180-A	Combination	0.05	0.00	9.90	0.03	0.08	0.00
9	0.6D+W0-A	Combination	-0.05	0.00	8.58	0.03	-0.08	-0.00
9	D+0.75W180-A+0.75S	Combination	0.04	0.00	9.23	0.03	0.06	0.00
9	D+0.75W180-B+0.75S	Combination	-0.05	0.00	0.31	-0.01	-0.07	-0.00
9	D+W180-B	Combination	-0.06	0.00	-1.99	-0.02	-0.09	-0.00
9	0.6D+W0-B	Combination	0.06	0.00	-3.31	-0.02	0.09	0.00



Forza di reazione vincolare del palo di guida, $\theta=45^\circ$			
Carico di progetto	Max valore	nodo	combinazione
Compressione F3	7.10 (KN)	7	D+W180-A
Tensione F3	0.10 (KN)	7	0.6D+W0-A
Forza laterale F2	3.34 (KN)	7	D+W180-A
Momento flessione (M2)	13.61 (KN)	7	D+W180-B



Forza di reazione vincolare del palo non motore, $\theta=45^\circ$			
Carico di progetto	Max valore	nodo	combinazione
Compressione F3	6.46 (KN)	4, 10	D+W180-A
Tensione F3	0.37 (KN)	2, 12	0.6D+W0-A
Forza laterale F1	3.17 (KN)	4, 10	D+W180-A
Momento flessione (M2)	4.75 (KN)	4, 10	D+W180-A



Tabella: Reazioni vincolari per $\theta = 45^\circ$

TABLE: Joint Reactions (1x84-39m/s-C-45°)								
Joint	OutputCase	CaseType	F1	F2	F3	M1	M2	M3
Text	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
1	D+W180-A	Combination	2.21	0.00	4.46	0.21	3.31	-0.00
1	D+W180-B	Combination	1.88	0.00	4.13	0.20	2.82	-0.00
1	0.6D+W0-A	Combination	-1.60	0.00	-0.27	-0.01	-2.40	0.00
1	0.6D+W0-B	Combination	-1.41	0.00	-0.08	0.00	-2.12	0.00
1	D+0.75W180-A+0.75S	Combination	1.66	0.00	4.40	0.21	2.49	-0.00
1	D+0.75W180-B+0.75S	Combination	1.41	0.00	4.15	0.20	2.12	-0.00
2	D+W180-A	Combination	3.01	0.00	5.98	0.05	4.51	-0.00
2	D+W180-B	Combination	2.56	0.00	5.53	0.04	3.84	-0.00
2	0.6D+W0-A	Combination	-2.18	0.00	-0.37	-0.01	-3.27	0.00
2	0.6D+W0-B	Combination	-1.92	0.00	-0.12	-0.01	-2.88	0.00
2	D+0.75W180-A+0.75S	Combination	2.26	0.00	5.90	0.05	3.39	-0.00
2	D+0.75W180-B+0.75S	Combination	1.92	0.00	5.57	0.04	2.88	-0.00
3	D+W180-A	Combination	3.13	0.00	6.31	0.03	4.69	-0.00
3	D+W180-B	Combination	2.66	0.00	5.84	0.03	4.00	-0.00
3	0.6D+W0-A	Combination	-2.26	0.00	-0.36	0.01	-3.40	0.00
3	0.6D+W0-B	Combination	-2.00	0.00	-0.09	0.01	-2.99	0.00
3	D+0.75W180-A+0.75S	Combination	2.35	0.00	6.23	0.03	3.52	-0.00
3	D+0.75W180-B+0.75S	Combination	2.00	0.00	5.88	0.03	3.00	-0.00
4	D+W180-A	Combination	3.17	0.00	6.46	-0.00	4.75	-0.00
4	D+W180-B	Combination	2.69	0.00	5.99	-0.00	4.04	0.00
4	0.6D+W0-A	Combination	-2.29	0.00	-0.32	-0.00	-3.43	-0.00
4	0.6D+W0-B	Combination	-2.03	0.00	-0.05	-0.00	-3.04	0.00
4	D+0.75W180-A+0.75S	Combination	2.38	0.00	6.37	-0.00	3.56	-0.00
4	D+0.75W180-B+0.75S	Combination	2.02	0.00	6.02	-0.00	3.03	0.00
5	D+W180-A	Combination	3.13	0.00	6.41	-0.02	4.69	0.00
5	D+W180-B	Combination	2.68	0.00	5.94	-0.01	4.02	0.00
5	0.6D+W0-A	Combination	-2.27	0.00	-0.28	0.01	-3.40	-0.00
5	0.6D+W0-B	Combination	-1.98	0.00	-0.02	0.01	-2.97	-0.00



5	D+0.75W180-A+0.75S	Combination	2.35	0.00	6.32	-0.02	3.52	0.00
5	D+0.75W180-B+0.75S	Combination	2.01	0.00	5.97	-0.01	3.02	0.00
6	D+W180-A	Combination	3.03	0.00	6.45	0.01	4.54	0.00
6	D+W180-B	Combination	2.53	0.00	5.99	0.01	3.79	0.00
6	0.6D+W0-A	Combination	-2.18	0.00	-0.19	0.00	-3.27	-0.00
6	0.6D+W0-B	Combination	-1.98	0.00	0.08	0.00	-2.97	0.00
6	D+0.75W180-A+0.75S	Combination	2.27	0.00	6.37	0.01	3.41	0.00
6	D+0.75W180-B+0.75S	Combination	1.90	0.00	6.03	0.01	2.84	0.00
7	D+W180-A	Combination	3.34	0.00	7.10	-0.00	6.98	-0.00
7	D+W180-B	Combination	2.91	-0.00	6.61	0.00	-3.51	-0.00
7	0.6D+W0-A	Combination	-2.44	0.00	-0.10	-0.00	-2.34	-0.00
7	0.6D+W0-B	Combination	-2.07	-0.00	0.18	0.00	-13.61	-0.00
7	D+0.75W180-A+0.75S	Combination	2.51	0.00	7.01	-0.00	5.24	-0.00
7	D+0.75W180-B+0.75S	Combination	2.18	-0.00	6.64	0.00	-2.63	-0.00
8	D+W180-A	Combination	3.03	0.00	6.45	-0.01	4.54	-0.00
8	D+W180-B	Combination	2.53	0.00	5.99	-0.01	3.79	-0.00
8	0.6D+W0-A	Combination	-2.18	0.00	-0.19	-0.00	-3.27	0.00
8	0.6D+W0-B	Combination	-1.98	0.00	0.08	-0.00	-2.97	-0.00
8	D+0.75W180-A+0.75S	Combination	2.27	0.00	6.37	-0.01	3.41	-0.00
8	D+0.75W180-B+0.75S	Combination	1.90	0.00	6.03	-0.01	2.84	-0.00
9	D+W180-A	Combination	3.13	0.00	6.41	0.02	4.69	-0.00
9	D+W180-B	Combination	2.68	0.00	5.94	0.01	4.02	-0.00
9	0.6D+W0-A	Combination	-2.27	0.00	-0.28	-0.01	-3.40	0.00
9	0.6D+W0-B	Combination	-1.98	0.00	-0.02	-0.01	-2.97	0.00
9	D+0.75W180-A+0.75S	Combination	2.35	0.00	6.32	0.02	3.52	-0.00
9	D+0.75W180-B+0.75S	Combination	2.01	0.00	5.97	0.01	3.02	-0.00
10	D+W180-A	Combination	3.17	0.00	6.46	0.00	4.75	0.00
10	D+W180-B	Combination	2.69	0.00	5.99	0.00	4.04	-0.00
10	0.6D+W0-A	Combination	-2.29	0.00	-0.32	0.00	-3.43	0.00
10	0.6D+W0-B	Combination	-2.03	0.00	-0.05	0.00	-3.04	-0.00
10	D+0.75W180-A+0.75S	Combination	2.38	0.00	6.37	0.00	3.56	0.00
10	D+0.75W180-B+0.75S	Combination	2.02	0.00	6.02	0.00	3.03	-0.00
11	D+W180-A	Combination	3.13	0.00	6.31	-0.03	4.69	0.00
11	D+W180-B	Combination	2.66	0.00	5.84	-0.03	4.00	0.00
11	0.6D+W0-A	Combination	-2.26	0.00	-0.36	-0.01	-3.40	-0.00
11	0.6D+W0-B	Combination	-2.00	0.00	-0.09	-0.01	-2.99	-0.00
11	D+0.75W180-A+0.75S	Combination	2.35	0.00	6.23	-0.03	3.52	0.00
11	D+0.75W180-B+0.75S	Combination	2.00	0.00	5.88	-0.03	3.00	0.00
12	D+W180-A	Combination	3.01	0.00	5.98	-0.05	4.51	0.00
12	D+W180-B	Combination	2.56	0.00	5.53	-0.04	3.84	0.00
12	0.6D+W0-A	Combination	-2.18	0.00	-0.37	0.01	-3.27	-0.00
12	0.6D+W0-B	Combination	-1.92	0.00	-0.12	0.01	-2.88	-0.00