



**REGIONE SICILIA**  
**COMUNE DI SANT'ALESSIO SICULO**  
**PROVINCIA DI MESSINA**

**OGGETTO:**

**"Lavori di Recupero ristrutturazione e/o costruzione nuovo edificio scolastico scuola A. Gussio".**

**PROGETTO ESECUTIVO**

**PROGETTISTA:**

Ing. Faranna Claudio G.



**ELABORATO C**

**TAV. 1.3**

**TABULATO VERIFICA COLLEGAMENTO  
2 TRAVI COLONNA**

**DATA: 16/05/2022**

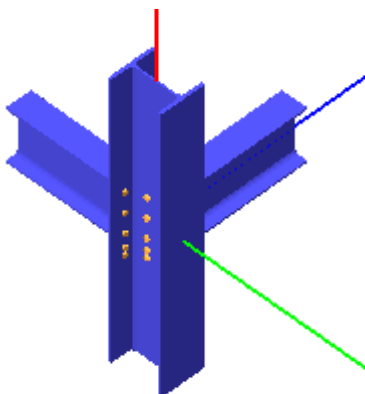
**RUP :**

Ing. Pietro Mifa



N°	Data	Descrizione della Revisione o Sostituisce

## Verifica secondo il D.M. 17/01/2018 del nodo 18



### Colonna

Tipo di profilo: HEB 360

Materiale: Acciaio S355  $f_y = 355 \text{ N/mm}^2$   $f_t = 510 \text{ N/mm}^2$   $\gamma_{ov} = 1.25$

Classe sezione: 1

### Coefficienti di sicurezza utilizzati

$\gamma_{M0} = 1.05$

$\gamma_{M1} = 1.10$

$\gamma_{M2} = 1.25$

### Trave lato 2-

Tipo di profilo: IPE 360

Materiale: Acciaio S355  $f_y = 355 \text{ N/mm}^2$   $f_t = 510 \text{ N/mm}^2$   $\gamma_{ov} = 1.25$

Classe sezione: 1

### Flangia:

Materiale: Acciaio S355  $f_y = 355 \text{ N/mm}^2$   $f_t = 510 \text{ N/mm}^2$   $\gamma_{ov} = 1.25$

Dimensioni (B x H x Sp): 170.0 x 480.0 x 30.0 mm

### Bullonature:

Viti cl. 10.9 Dadi 10 o 12 ( $f_{yb} = 900 \text{ N/mm}^2$ ,  $f_{tb} = 1000 \text{ N/mm}^2$ )

Diametro gambo  $\varnothing = 20 \text{ mm}$   $A_{res} = 314.2 \text{ mm}^2$

Diametro dado/testa  $d_m = 30 \text{ mm}$

Diametro foro  $\varnothing_0 = 21 \text{ mm}$

### Saldature:

Materiale: Acciaio S355  $f_y = 355 \text{ N/mm}^2$   $f_t = 510 \text{ N/mm}^2$   $\beta_1 = 0.70$   $\beta_2 = 0.85$

Spessore cordoni d'angolo  $s_c = 12 \text{ mm}$

### Sollecitazioni nella sezione d'attacco dell'elemento:

Nodo.CMB	V2 [N]	V3 [N]	N [N]	M2 [N mm]	M3 [N mm]	T [N mm]
18.1	22435.1	-0.2	10.1	605.0	-7091682.0	-43.0
18.2	22494.1	-0.2	9.4	612.0	-7241063.0	-0.8
18.3	46193.7	-0.3	15.5	1156.0	-15285130.0	-1398.0
18.4	46252.7	-0.3	14.8	1164.0	-15424510.0	-1356.0
18.5	15839.2	-0.1	7.6	431.0	-4932944.0	34.0
18.6	15898.3	-0.2	6.9	438.0	-5078306.0	77.0
18.7	39597.8	-0.3	13.1	982.0	-13122400.0	-1321.0
18.8	39656.8	-0.3	12.4	989.0	-13261780.0	-1278.0
18.9	22553.2	-0.2	8.6	620.0	-7390424.0	42.0
18.10	39066.1	-0.3	13.9	991.0	-12828100.0	-992.0
18.11	39184.2	-0.3	12.4	1006.0	-13116840.0	-907.0
18.12	15957.3	-0.2	6.2	445.0	-5222686.0	119.0
18.13	32470.2	-0.2	11.5	817.0	-10665360.0	-914.0

18.14	32588.3	-0.3	10.0	831.0	-10954110.0	-829.0
18.15	-38516.1	2645.6	2637.1	-2037000.0	118267100.0	-9336.0
18.16	-47052.0	1230.8	2440.2	-850509.9	136130600.0	-36034.0
18.17	89837.4	-1231.2	-2422.6	851630.9	-149829300.0	35484.0
18.18	81301.6	-2645.9	-2619.5	2038000.0	-131965700.0	8786.0
18.19	-41689.9	3212.9	2631.1	-2434000.0	124895800.0	-7761.0
18.20	-43878.2	663.4	2446.2	-453139.0	129501900.0	-37609.0
18.21	86663.7	-663.8	-2428.6	454261.0	-143200500.0	37059.0
18.22	84475.4	-3213.3	-2613.5	2436000.0	-138594400.0	7211.0
18.23	-38581.5	1314.8	3268.2	-1055000.0	118355300.0	6274.0
18.24	-47117.3	-100.0	3071.3	131833.0	136218900.0	-20424.0
18.25	89902.8	99.6	-3053.7	-130712.0	-149917500.0	19875.0
18.26	81366.9	-1315.2	-3250.6	1056000.0	-132054000.0	-6824.0
18.27	-41755.2	1882.2	3262.2	-1452000.0	124984100.0	7849.0
18.28	-43943.6	-667.3	3077.3	529204.0	129590200.0	-22000.0
18.29	86729.0	667.0	-3059.7	-528083.0	-143288800.0	21450.0
18.30	84540.7	-1882.5	-3244.6	1453000.0	-138682700.0	-8399.0
18.31	16366.1	2939.3	1096.0	-2410000.0	3552102.0	37499.0
18.32	-12086.8	-1776.6	439.5	1545000.0	63124380.0	-51495.0
18.33	54872.2	1776.3	-421.9	-1544000.0	-76863010.0	50945.0
18.34	26419.3	-2939.7	-1078.4	2412000.0	-17284530.0	-38049.0
18.35	16346.5	2540.1	1285.3	-2116000.0	3586505.0	42182.0
18.36	-12106.4	-2175.9	628.8	1840000.0	63160850.0	-46812.0
18.37	54891.8	2175.5	-611.2	-1838000.0	-76899470.0	46262.0
18.38	26438.9	-2540.4	-1267.7	2117000.0	-17321000.0	-42732.0
18.39	5786.9	4830.5	1076.0	-3735000.0	25691640.0	42750.0
18.40	-1507.5	-3667.8	459.6	2869000.0	40988650.0	-56745.0
18.41	44292.9	3667.5	-442.0	-2868000.0	-54727280.0	56196.0
18.42	36998.6	-4830.9	-1058.4	3736000.0	-39430250.0	-43300.0
18.43	5767.3	4431.3	1265.3	-3440000.0	25728110.0	47433.0
18.44	-1527.1	-4067.1	648.9	3164000.0	41025120.0	-52063.0
18.45	44312.5	4066.7	-631.3	-3163000.0	-54753750.0	51513.0
18.46	37018.2	-4431.6	-1247.7	3441000.0	-39466720.0	-47982.0

### Calcolo resistenze

Resistenza a trazione dei bulloni

$$F_{tb,Rd} = 0.9 \cdot f_{tb} \cdot A_{res} / \gamma_{M2} = 226194.7 \text{ N}$$

Resistenza a punzonamento flangia

$$B_{pf,Rd} = 0.6 \cdot \pi \cdot d_m \cdot t_f \cdot f_{tk} / \gamma_{M2} = 692155.7 \text{ N}$$

Resistenza a punzonamento ala passante

$$B_{pa,Rd} = 0.6 \cdot \pi \cdot d_m \cdot t_a \cdot f_{tk} / \gamma_{M2} = 519116.8 \text{ N}$$

Bull.	$F_{f,Rd} \text{ [N]}$	$F_{t,Rd} \text{ [N]}$
1	69325.5	69325.5
2	210189.0	210189.0
3	207854.8	207854.8
4	179805.2	179805.2
5	207854.8	207854.8
6	69325.5	69325.5
7	210189.0	210189.0
8	207854.8	207854.8
9	179805.2	179805.2
10	207854.8	207854.8

### Legenda

$F_{f,Rd} = M_{res,m} / (B_m \cdot R_m)$  resistenza a flessione flangia

$F_{t,Rd} = \min [ F_{tb,Rd} , B_{pf,Rd} , B_{pa,Rd} , F_{f,Rd} ]$  resistenza a trazione di progetto

Resistenza a taglio dei bulloni

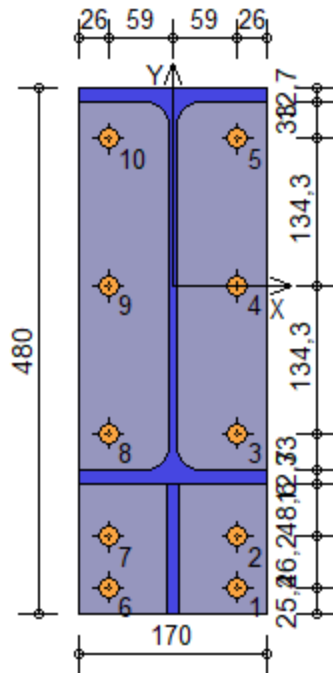
$$F_{vb,Rd} = 0.6 \cdot f_{tb} \cdot A_{res} / \gamma_{M2} = 150796.5 \text{ N}$$

Bull.	$F_{bf,x,Rd} \text{ [N]}$	$F_{ba,x,Rd} \text{ [N]}$	$F_{v,x,Rd} \text{ [N]}$	$F_{bf,y,Rd} \text{ [N]}$	$F_{ba,y,Rd} \text{ [N]}$	$F_{v,y,Rd} \text{ [N]}$
1	167707.6	459000.0	150796.5	172992.1	459000.0	150796.5
2	139419.3	253367.8	139419.3	209031.9	221849.9	150796.5
3	252571.4	459000.0	150796.5	432480.0	459000.0	150796.5
4	252571.4	459000.0	150796.5	432480.0	459000.0	150796.5
5	252571.4	459000.0	150796.5	313719.6	459000.0	150796.5
6	167707.6	459000.0	150796.5	172992.1	459000.0	150796.5

7	139419.3	253367.8	139419.3	209031.9	221849.9	150796.5
8	252571.4	459000.0	150796.5	432480.0	459000.0	150796.5
9	252571.4	459000.0	150796.5	432480.0	459000.0	150796.5
10	252571.4	459000.0	150796.5	313719.6	459000.0	150796.5

#### Legenda

$F_{bf,x,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \emptyset \cdot t_f / \gamma_{M2}$  resistenza a rifollamento flangia in direzione x  
 $F_{ba,x,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \emptyset \cdot t_a / \gamma_{M2}$  resistenza a rifollamento ala passante in direzione x  
 $F_{v,x,Rd} = \min [ F_{vb,Rd} , F_{bf,x,Rd} , F_{ba,x,Rd} ]$  resistenza a taglio di progetto in direzione x  
 $F_{bf,y,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \emptyset \cdot t_f / \gamma_{M2}$  resistenza a rifollamento flangia in direzione y  
 $F_{ba,y,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \emptyset \cdot t_a / \gamma_{M2}$  resistenza a rifollamento ala passante in direzione y  
 $F_{v,y,Rd} = \min [ F_{vb,Rd} , F_{bf,y,Rd} , F_{ba,y,Rd} ]$  resistenza a taglio di progetto in direzione y



#### Verifiche sui bulloni

##### 1-Taglio e trazione (Nodo n. 18, CMB n. 16)

Bull.	X [mm]	Y [mm]	$F_{v,Ed}$ [N]	$F_{v,Rd}$ [N]	$F_{t,Ed}$ [N]	$F_{t,Rd}$ [N]	$FV_1$	VER
1	59.00	-274.80	4698.1	150796.5	69787.6	69325.5	0.750202	Ok
2	59.00	-228.60	4698.2	150796.5	60956.5	210189.0	0.238305	Ok
3	59.00	-134.30	4698.6	150796.5	42931.3	207854.8	0.178690	Ok
4	59.00	0.00	4699.1	150796.5	17260.0	179805.2	0.099728	Ok
5	59.00	134.30	4699.6	150796.5	0.0	207854.8	0.031165	Ok
6	-59.00	-274.80	4714.4	150796.5	70529.6	69325.5	0.757955	Ok
7	-59.00	-228.60	4714.5	150796.5	61698.5	210189.0	0.240934	Ok
8	-59.00	-134.30	4714.8	150796.5	43673.2	207854.8	0.181348	Ok
9	-59.00	0.00	4715.3	150796.5	18002.0	179805.2	0.102784	Ok
10	-59.00	134.30	4715.9	150796.5	0.0	207854.8	0.031273	Ok

##### 2-Trazione (Nodo n. 18, CMB n. 16)

Bull.	X [mm]	Y [mm]	$F_{t,Ed}$ [N]	$F_{t,Rd}$ [N]	$FV_2$	VER
1	59.00	-274.80	69787.6	69325.5	1.006666	N.V.
2	59.00	-228.60	60956.5	210189.0	0.290008	Ok
3	59.00	-134.30	42931.3	207854.8	0.206544	Ok
4	59.00	0.00	17260.0	179805.2	0.095993	Ok
5	59.00	134.30	0.0	207854.8	0.000000	Ok
6	-59.00	-274.80	70529.6	69325.5	1.017369	N.V.
7	-59.00	-228.60	61698.5	210189.0	0.293538	Ok
8	-59.00	-134.30	43673.2	207854.8	0.210114	Ok
9	-59.00	0.00	18002.0	179805.2	0.100120	Ok
10	-59.00	134.30	0.0	207854.8	0.000000	Ok

#### Legenda

$F_{v,Ed}$  forza di taglio agente sul bullone  
 $F_{v,Rd}$  resistenza a taglio di progetto del bullone  
 $F_{t,Ed}$  forza di trazione agente sul bullone  
 $F_{t,Rd}$  resistenza a trazione di progetto del bullone  
 $FV_1 = F_{v,Ed} / F_{v,Rd} + F_{t,Ed} / (1.4 \cdot F_{t,Rd})$   
 $FV_2 = F_{t,Ed} / F_{t,Rd}$   
 $VER \rightarrow FV_i \leq 1$

### Verifiche sulle saldature profilo-flangia (versione beta)

Si considera la sezione di gola (avente altezza  $a = s_c / 2^{0.5} = 8.485$ ) in posizione ribaltata: vengono considerate positive le tensioni normali di trazione e le tensioni tangenziali agenti verso destra e verso il basso. Tutte le tensioni sono espresse in N/mm<sup>2</sup>.

Verifica formula (4.2.84) (Nodo n. 18, CMB n. 25)

Cordoni	$n_{\perp}$	$t_{\perp}$	$\tau_{\parallel}$	$FV_1$	$VER_1$
Nervatura inferiore lato destro	-175.85	0.00	13.03	176.33	Ok
Nervatura inferiore lato sinistro	-175.85	0.00	13.03	176.33	Ok
Ala inferiore esterno	-108.11	0.00	0.03	108.11	Ok
Ala inferiore interno lato destro	-96.79	0.00	0.03	96.79	Ok
Ala inferiore interno lato sinistro	-95.43	0.00	0.03	95.43	Ok
Anima lato destro	-87.66	0.00	13.03	88.62	Ok
Anima lato sinistro	-87.66	0.00	13.03	88.62	Ok
Ala superiore interno lato destro	94.85	0.00	0.03	94.85	Ok
Ala superiore interno lato sinistro	96.21	0.00	0.03	96.21	Ok

Verifica formula (4.2.85) (Nodo n. 18, CMB n. 25)

Cordoni	$n_{\perp}$	$t_{\perp}$	$\tau_{\parallel}$	$FV_2$	$VER_2$
Nervatura inferiore lato destro	-175.85	0.00	13.03	175.85	Ok
Nervatura inferiore lato sinistro	-175.85	0.00	13.03	175.85	Ok
Ala inferiore esterno	-108.11	0.00	0.03	108.11	Ok
Ala inferiore interno lato destro	-96.79	0.00	0.03	96.79	Ok
Ala inferiore interno lato sinistro	-95.43	0.00	0.03	95.43	Ok
Anima lato destro	-87.66	0.00	13.03	87.66	Ok
Anima lato sinistro	-87.66	0.00	13.03	87.66	Ok
Ala superiore interno lato destro	94.85	0.00	0.03	94.85	Ok
Ala superiore interno lato sinistro	96.21	0.00	0.03	96.21	Ok

### Legenda

$n_{\perp}$  tensione normale perpendicolare all'asse del cordone

$t_{\perp}$  tensione tangenziale perpendicolare all'asse del cordone

$\tau_{\parallel}$  tensione tangenziale parallela all'asse del cordone

$$FV_1 = (n_{\perp}^2 + t_{\perp}^2 + \tau_{\parallel}^2)^{0.5}$$

$$FV_2 = |n_{\perp}| + |t_{\perp}|$$

$$VER_i \rightarrow FV_i \leq \beta_i \cdot f_{yk} \quad (\beta_1 \cdot f_{yk} = 248.50 \text{ N/mm}^2 \quad \beta_2 \cdot f_{yk} = 301.75 \text{ N/mm}^2)$$

### Verifica del momento di progetto del giunto (Nodo n. 18, CMB n. 17)

Momento resistente del giunto	$M_{j,Rd} =$	328065200.0 N mm
Momento di progetto	$M_{j,Ed} =$	149162000.0 N mm
$M_{j,Ed} / M_{j,Rd} = 0.454672 \quad \text{Ok}$		

### Trave lato 3+

Tipo di profilo: IPE 360

Materiale: Acciaio S355  $f_y = 355 \text{ N/mm}^2$   $f_t = 510 \text{ N/mm}^2$   $\gamma_{ov} = 1.25$

Classe sezione: 1

### Flangia:

Materiale: Acciaio S355  $f_y = 355 \text{ N/mm}^2$   $f_t = 510 \text{ N/mm}^2$   $\gamma_{ov} = 1.25$

Dimensioni (B x H x Sp): 170.0 x 464.4 x 30.0 mm

### Bullonature:

Viti cl. 10.9 Dadi 10 o 12 ( $f_{yb} = 900 \text{ N/mm}^2$ ,  $f_{tb} = 1000 \text{ N/mm}^2$ )

Diametro gambo  $\varnothing = 20 \text{ mm}$   $A_{res} = 314.2 \text{ mm}^2$

Diametro dado/testa  $d_m = 30$  mm

Diametro foro  $\varnothing_0 = 21$  mm

Saldature:

Materiale: Acciaio S355  $f_y = 355$  N/mm<sup>2</sup>  $f_t = 510$  N/mm<sup>2</sup>  $\beta_1 = 0.70$   $\beta_2 = 0.85$

Spessore cordoni d'angolo  $s_c = 12$  mm

Sollecitazioni nella sezione d'attacco dell'elemento:

Nodo.CMB	V2 [N]	V3 [N]	N [N]	M2 [N mm]	M3 [N mm]	T [N mm]
18.1	-1218.0	-0.3	-13.5	671.0	10162390.0	-1295.0
18.2	-1209.5	-0.3	-13.0	655.0	10142440.0	-1306.0
18.3	-3250.6	-0.6	-27.6	1419.0	19979680.0	-2610.0
18.4	-3242.1	-0.6	-27.1	1403.0	19949740.0	-2621.0
18.5	-819.6	-0.2	-9.7	477.0	7245878.0	-915.0
18.6	-811.0	-0.2	-9.2	461.0	7223931.0	-926.0
18.7	-2852.2	-0.5	-23.8	1224.0	17062170.0	-2231.0
18.8	-2843.6	-0.5	-23.3	1209.0	17032230.0	-2241.0
18.9	-1200.9	-0.3	-12.4	640.0	10122500.0	-1316.0
18.10	-2640.8	-0.5	-23.4	1194.0	17033500.0	-2216.0
18.11	-2623.7	-0.5	-22.3	1163.0	16983600.0	-2237.0
18.12	-802.5	-0.2	-8.6	446.0	7200985.0	-937.0
18.13	-2242.4	-0.4	-19.6	1000.0	14115980.0	-1836.0
18.14	-2225.3	-0.4	-18.5	969.0	14066090.0	-1857.0
18.15	-13232.2	-822.3	-296.6	2021000.0	38567300.0	-10476.0
18.16	-43346.0	-352.9	-112.6	870865.1	113929100.0	-8711.0
18.17	40761.1	352.4	86.7	-869568.0	-94835240.0	6263.0
18.18	10647.3	821.8	270.8	-2020000.0	-19513450.0	8028.0
18.19	-11323.5	-977.7	-299.0	2404000.0	33869230.0	-9909.0
18.20	-45254.7	-197.5	-110.3	487677.0	118617200.0	-9279.0
18.21	42669.8	197.0	84.4	-486380.0	-99543310.0	6831.0
18.22	8738.6	977.2	273.1	-2403000.0	-14805380.0	7460.0
18.23	21421.9	-422.7	-295.4	1038000.0	-47256110.0	-4660.0
18.24	-8691.9	46.6	-111.3	-112498.0	28065680.0	-2894.0
18.25	6107.0	-47.1	85.5	113795.0	-9005831.0	446.0
18.26	-24006.7	422.2	269.5	-1037000.0	66319960.0	2211.0
18.27	23330.6	-578.2	-297.7	1421000.0	-51964180.0	-4092.0
18.28	-10600.6	202.1	-109.0	-495685.0	32773750.0	-3462.0
18.29	8015.7	-202.6	83.1	496982.0	-13709900.0	1014.0
18.30	-25915.5	577.7	271.8	-1420000.0	71028020.0	1644.0
18.31	40798.1	-958.7	-377.2	2351000.0	-96005020.0	-6677.0
18.32	-59581.0	605.8	236.3	-1483000.0	155127600.0	-793.0
18.33	56996.1	-606.3	-262.2	1484000.0	-136043800.0	-1655.0
18.34	-43383.0	958.2	351.3	-2350000.0	115028900.0	4229.0
18.35	51194.3	-838.9	-376.8	2056000.0	-121780000.0	-4932.0
18.36	-49184.8	725.7	236.7	-1778000.0	129292600.0	952.0
18.37	46599.9	-726.2	-262.5	1779000.0	-110308800.0	-3400.0
18.38	-53779.2	838.4	350.9	-2055000.0	140863900.0	2484.0
18.39	47160.6	-1476.9	-384.9	3629000.0	-111705200.0	-4785.0
18.40	-65943.5	1124.0	244.0	-2760000.0	170787900.0	-2685.0
18.41	63358.6	-1124.5	-269.9	2762000.0	-151704000.0	237.0
18.42	-49745.5	1476.4	359.0	-3627000.0	130789100.0	2336.0
18.43	57556.9	-1357.1	-384.5	3334000.0	-137440300.0	-3040.0
18.44	-55547.3	1243.9	244.4	-3055000.0	145052800.0	-940.0
18.45	52962.4	-1244.4	-270.3	3057000.0	-125969000.0	-1508.0
18.46	-60141.8	1356.6	358.7	-3332000.0	156524100.0	591.0

**Calcolo resistenze**

Resistenza a trazione dei bulloni

$$F_{tb,Rd} = 0.9 \cdot f_{tb} \cdot A_{res} / \gamma_{M2} = 226194.7 \text{ N}$$

Resistenza a punzonamento flangia

$$B_{pf,Rd} = 0.6 \cdot \pi \cdot d_m \cdot t_f \cdot f_{tk} / \gamma_{M2} = 692155.7 \text{ N}$$

Resistenza a punzonamento anima passante

$$B_{pa,Rd} = 0.6 \cdot \pi \cdot d_m \cdot t_a \cdot f_{tk} / \gamma_{M2} = 288398.2 \text{ N}$$

Bull.  $F_{f,Rd}$  [N]  $F_{t,Rd}$  [N]

1	80752.7	80752.7
2	225685.0	225685.0
3	246302.2	226194.7
4	184172.9	184172.9
5	246302.2	226194.7
6	80752.7	80752.7
7	225685.0	225685.0
8	246302.2	226194.7
9	184172.9	184172.9
10	246302.2	226194.7

#### Legenda

$F_{f,Rd} = M_{res,m} / (B_m \cdot R_m)$  resistenza a flessione flangia

$F_{t,Rd} = \min [ F_{tb,Rd} , B_{pf,Rd} , B_{pa,Rd} , F_{f,Rd} ]$  resistenza a trazione di progetto

#### Resistenza a taglio dei bulloni

$$F_{vb,Rd} = 0.6 \cdot f_{tb} \cdot A_{res} / \gamma_{M2} =$$

150796.5 N

Bull.	$F_{bf,x,Rd}$ [N]	$F_{ba,x,Rd}$ [N]	$F_{v,x,Rd}$ [N]	$F_{bf,y,Rd}$ [N]	$F_{ba,y,Rd}$ [N]	$F_{v,y,Rd}$ [N]
1	216084.4	255000.0	150796.5	244799.9	255000.0	150796.5
2	179636.7	140760.1	140760.1	295800.1	123250.0	123250.0
3	325428.6	255000.0	150796.5	611514.3	254797.6	150796.5
4	325428.6	255000.0	150796.5	612000.0	255000.0	150796.5
5	325428.6	255000.0	150796.5	443942.8	255000.0	150796.5
6	216084.4	255000.0	150796.5	244799.9	255000.0	150796.5
7	179636.7	140760.1	140760.1	295800.1	123250.0	123250.0
8	325428.6	255000.0	150796.5	611514.3	254797.6	150796.5
9	325428.6	255000.0	150796.5	612000.0	255000.0	150796.5
10	325428.6	255000.0	150796.5	443942.8	255000.0	150796.5

#### Legenda

$F_{bf,x,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \varnothing \cdot t_f / \gamma_{M2}$  resistenza a rifollamento flangia in direzione x

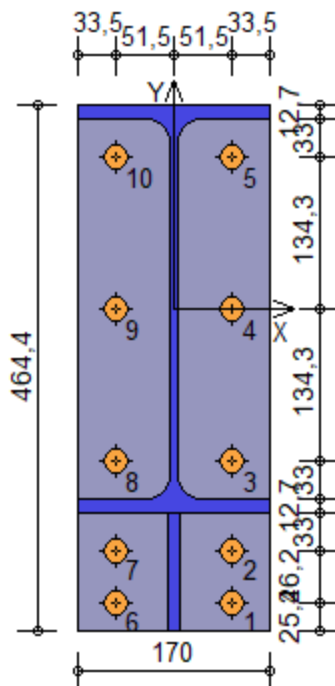
$F_{ba,x,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \varnothing \cdot t_a / \gamma_{M2}$  resistenza a rifollamento anima passante in direzione x

$F_{v,x,Rd} = \min [ F_{vb,Rd} , F_{bf,x,Rd} , F_{ba,x,Rd} ]$  resistenza a taglio di progetto in direzione x

$F_{bf,y,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \varnothing \cdot t_f / \gamma_{M2}$  resistenza a rifollamento flangia in direzione y

$F_{ba,y,Rd} = k \cdot \alpha \cdot f_{tk} \cdot \varnothing \cdot t_a / \gamma_{M2}$  resistenza a rifollamento anima passante in direzione y

$F_{v,y,Rd} = \min [ F_{vb,Rd} , F_{bf,y,Rd} , F_{ba,y,Rd} ]$  resistenza a taglio di progetto in direzione y



#### Verifiche sui bulloni

##### 1-Taglio e trazione (Nodo n. 18, CMB n. 40)

Bull.	X [mm]	Y [mm]	$F_{v,Ed}$ [N]	$F_{v,Rd}$ [N]	$F_{t,Ed}$ [N]	$F_{t,Rd}$ [N]	FV1	VER
1	51.50	-259.20	6594.7	150796.5	88573.2	80752.7	0.827193	Ok

2	51.50	-213.00	6594.7	123250.0	76818.7	225685.0	0.296635	Ok
3	51.50	-134.30	6594.7	150796.5	56795.4	226194.7	0.223083	Ok
4	51.50	0.00	6594.7	150796.5	22625.9	184172.9	0.131484	Ok
5	51.50	134.30	6594.8	150796.5	0.0	226194.7	0.043733	Ok
6	-51.50	-259.20	6595.9	150796.5	90777.8	80752.7	0.846701	Ok
7	-51.50	-213.00	6595.9	123250.0	79023.3	225685.0	0.303622	Ok
8	-51.50	-134.30	6595.9	150796.5	58999.9	226194.7	0.230052	Ok
9	-51.50	0.00	6595.9	150796.5	24830.5	184172.9	0.140042	Ok
10	-51.50	134.30	6595.9	150796.5	0.0	226194.7	0.043741	Ok

#### 2-Trazione (Nodo n. 18, CMB n. 40)

Bull.	X [mm]	Y [mm]	F <sub>t,Ed</sub> [N]	F <sub>t,Rd</sub> [N]	FV <sub>2</sub>	VER
1	51.50	-259.20	88573.2	80752.7	0.096845	Ok
2	51.50	-213.00	76818.7	225685.0	0.340380	Ok
3	51.50	-134.30	56795.4	226194.7	0.251091	Ok
4	51.50	0.00	22625.9	184172.9	0.122852	Ok
5	51.50	134.30	0.0	226194.7	0.000000	Ok
6	-51.50	-259.20	90777.8	80752.7	0.124145	Ok
7	-51.50	-213.00	79023.3	225685.0	0.350148	Ok
8	-51.50	-134.30	58999.9	226194.7	0.260837	Ok
9	-51.50	0.00	24830.5	184172.9	0.134821	Ok
10	-51.50	134.30	0.0	226194.7	0.000000	Ok

#### Legenda

F<sub>v,Ed</sub> forza di taglio agente sul bullone  
 F<sub>v,Rd</sub> resistenza a taglio di progetto del bullone  
 F<sub>t,Ed</sub> forza di trazione agente sul bullone  
 F<sub>t,Rd</sub> resistenza a trazione di progetto del bullone  
 $FV_1 = F_{v,Ed} / F_{v,Rd} + F_{t,Ed} / (1.4 \cdot F_{t,Rd})$   
 $FV_2 = F_{t,Ed} / F_{t,Rd}$   
 VER → FV<sub>i</sub> ≤ 1

#### Verifiche sulle saldature profilo-flangia (versione beta)

Si considera la sezione di gola (avente altezza  $a = s_c / 2^{0.5} = 8.485$ ) in posizione ribaltata: vengono considerate positive le tensioni normali di trazione e le tensioni tangenziali agenti verso destra e verso il basso. Tutte le tensioni sono espresse in N/mm<sup>2</sup>.

#### Verifica formula (4.2.84) (Nodo n. 18, CMB n. 40)

Cordoni	n <sub>⊥</sub>	t <sub>⊥</sub>	τ <sub>  </sub>	FV <sub>1</sub>	VER <sub>1</sub>
Nervatura inferiore lato destro	207.97	0.00	-9.94	208.21	Ok
Nervatura inferiore lato sinistro	207.97	0.00	-9.94	208.21	Ok
Ala inferiore esterno	157.51	0.00	0.31	157.51	Ok
Ala inferiore interno lato destro	113.35	0.00	0.31	113.35	Ok
Ala inferiore interno lato sinistro	142.02	0.00	0.31	142.02	Ok
Anima lato destro	109.19	0.00	-9.94	109.64	Ok
Anima lato sinistro	109.19	0.00	-9.94	109.64	Ok
Ala superiore interno lato destro	-141.97	0.00	0.31	141.97	Ok
Ala superiore interno lato sinistro	-113.31	0.00	0.31	113.31	Ok

#### Verifica formula (4.2.85) (Nodo n. 18, CMB n. 40)

Cordoni	n <sub>⊥</sub>	t <sub>⊥</sub>	τ <sub>  </sub>	FV <sub>2</sub>	VER <sub>2</sub>
Nervatura inferiore lato destro	207.97	0.00	-9.94	207.97	Ok
Nervatura inferiore lato sinistro	207.97	0.00	-9.94	207.97	Ok
Ala inferiore esterno	157.51	0.00	0.31	157.51	Ok
Ala inferiore interno lato destro	113.35	0.00	0.31	113.35	Ok
Ala inferiore interno lato sinistro	142.02	0.00	0.31	142.02	Ok
Anima lato destro	109.19	0.00	-9.94	109.19	Ok
Anima lato sinistro	109.19	0.00	-9.94	109.19	Ok
Ala superiore interno lato destro	-141.97	0.00	0.31	141.97	Ok
Ala superiore interno lato sinistro	-113.31	0.00	0.31	113.31	Ok

#### Legenda

n<sub>⊥</sub> tensione normale perpendicolare all'asse del cordone  
 t<sub>⊥</sub> tensione tangenziale perpendicolare all'asse del cordone  
 τ<sub>||</sub> tensione tangenziale parallela all'asse del cordone  
 $FV_1 = (n_{\perp}^2 + t_{\perp}^2 + \tau_{||}^2)^{0.5}$



$$FV_2 = |n_{\perp}| + |t_{\perp}|$$

$$VER_i \rightarrow FV_i \leq \beta_i \cdot f_{yk} \quad (\beta_1 \cdot f_{yk} = 248.50 \text{ N/mm}^2 \quad \beta_2 \cdot f_{yk} = 301.75 \text{ N/mm}^2)$$

**Verifica del momento di progetto del giunto** (Nodo n. 18, CMB n. 41)

Momento resistente del giunto  $M_{j,Rd} = 331672400.0 \text{ N mm}$

Momento di progetto  $M_{j,Ed} = 151633700.0 \text{ N mm}$

$$M_{j,Ed} / M_{j,Rd} = 0.457179 \quad \text{Ok}$$