

Synchrotron Soleil

Extension zone RF

Note de calcul

Pré-dimensionnement et vérification des longrines de renforcement - Zone 2

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1. HISTORIQUE DES REVISIONS

Rév.	Date, Signature et repérages des paragraphes modifiés
A	Rédacteur : Hassan ALAMEH Vérificateur : Cédric GARBAY Approbateur : Julien DEROSNE Première émission. 09/2025

2. REFERENCES

2.1. NORMES ET GUIDES

- [1] Eurocode 0 : EN 1990 - Base de calcul des structures
- [2] Eurocode 1 : EN 1991 - Actions sur les structures
- [3] Eurocode 2 : EN 1992 - Calcul des structures en béton
- [4] Eurocode 3 : EN 1993 - Calcul des structures en acier

2.2. DOCUMENTS PROJET

- [5] EXE-L03-A-H-CO-747-D_TOITURE vue en plan
- [6] DOC040725-04072025151318 - Note de calcul des colonnes ballastées
- [7] VULCAIN SOL CH00888 MOE PLA 006 B2 - Carnet de plans extension RF - Scénario 1
- [8] SOFREN SOL CH00888 CIV NTC 001 A - Note de calculs scénario 2

2.3. LOGICIELS

- [9] ROBOT STRUCTURAL ANALYSIS Logiciel de calcul par éléments finis, version 2021

3. OBJET DE L'ETUDE

La présente note de calcul est établie dans le cadre du renforcement de la structure existante de la zone 2. Elle a pour objet de vérifier les longrines qui seront mises en place.

Les charges prises en compte incluent :

- Le poids propre de la charpente ;
- Les charges permanentes des réseaux existants sur la charpente.

4. CONTEXTE DU PROJET

4.1. DESCRIPTION GENERALE

La figure ci-dessous présente la zone d'étude et de modélisation. Elle illustre les dimensions, l'emplacement des poteaux, des poutres et des traverses, ainsi que les profilés qui seront pris en compte dans l'étude.

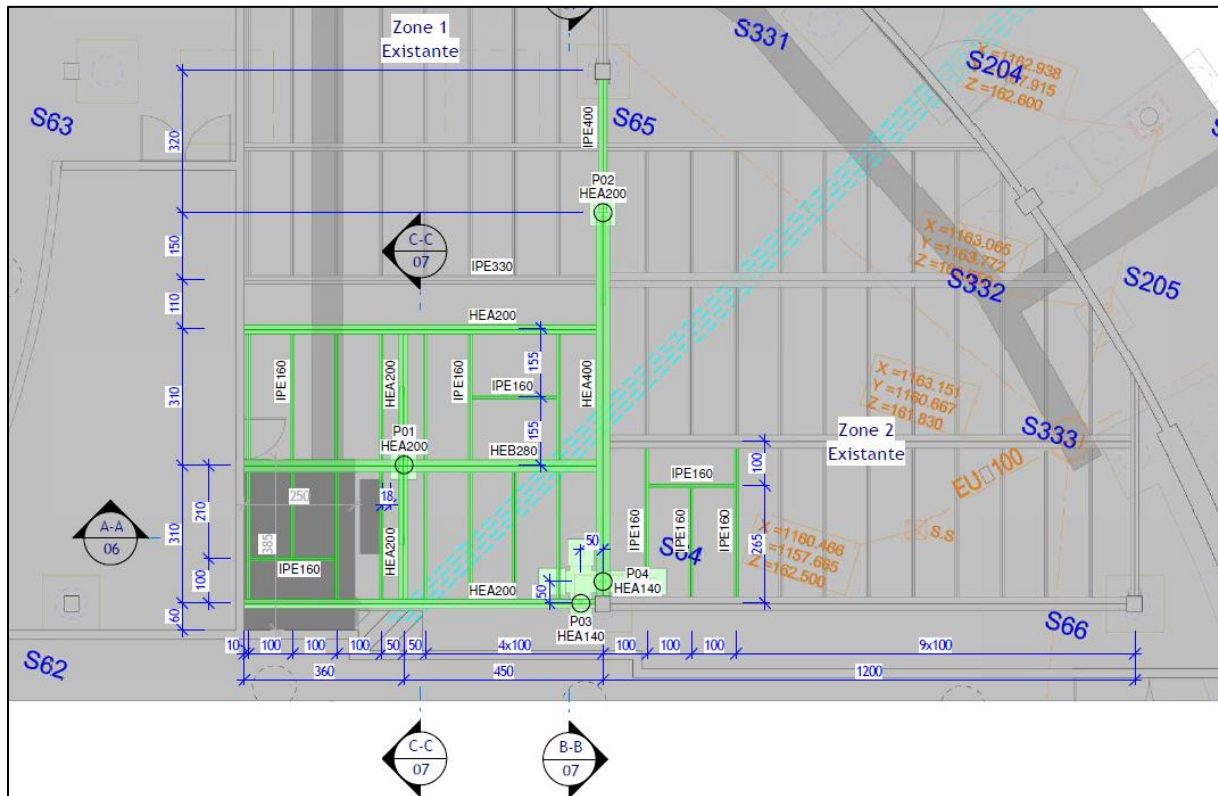


Figure 4-1 : Zone modélisée - Extrait de [7]

4.2. DESCRIPTION DU MODELE

Ci-dessous les vues et les caractéristiques de la charpente :

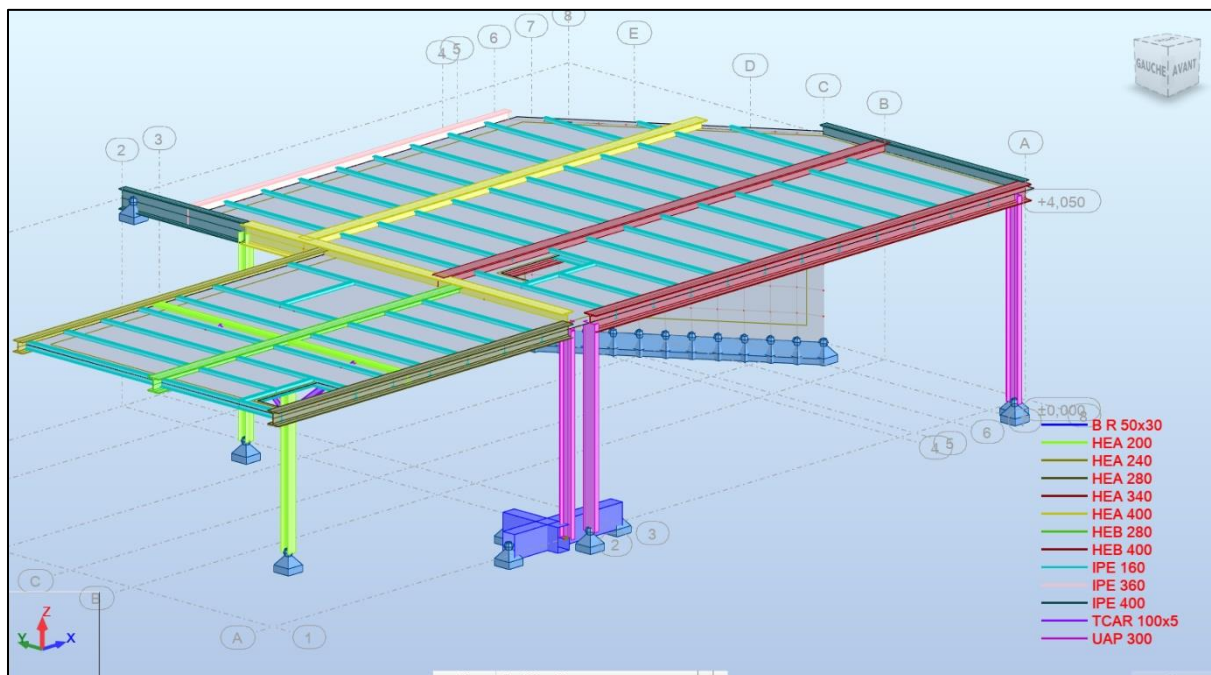


Figure 4-2 : Profilés

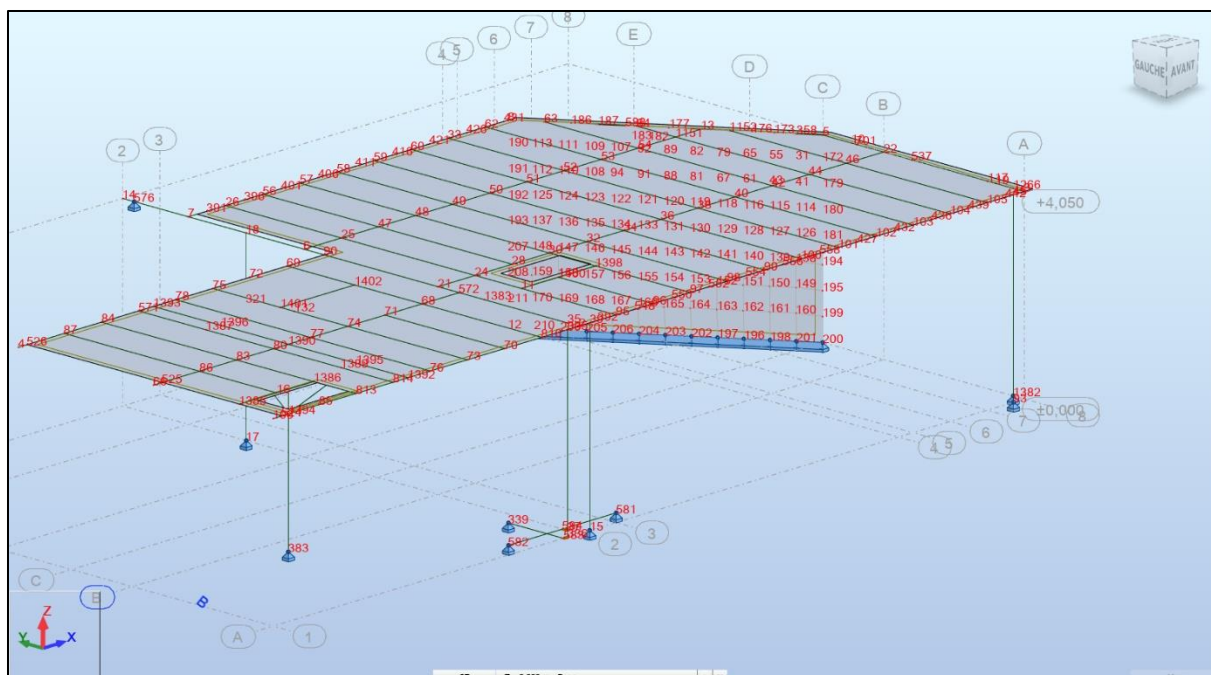


Figure 4-3 : Nœuds

Les poutres sont relâchées autour des axes locaux y et z soit des degrés de liberté bbblll, où « b » signifie bloqué et « l » libre.

Les portiques sont sur appuis rotulés (rotations libres et translations bloquées), dont les degrés de liberté sont bbblll, où « b » signifie bloqué et « l » libre.

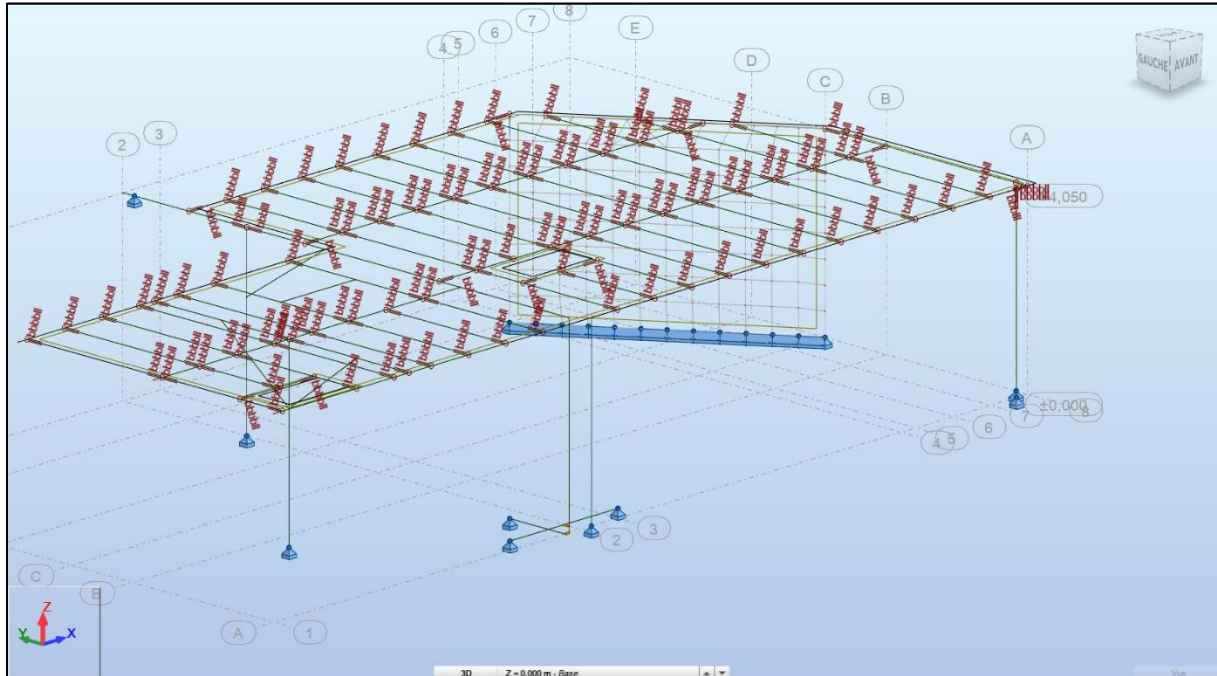


Figure 4-4 : Appuis et relâchements

4.3. CHARGEMENTS

4.3.1. CHARGES PERMANENTES

4.3.1.1. CAS DE CHARGE 1 – POIDS PROPRE

Le poids propre de la dalle est automatique généré par ROBOT [9] à partir du volume des éléments structuraux et de leur poids volumique ; cette charge est majorée de 5% pour les assemblages.

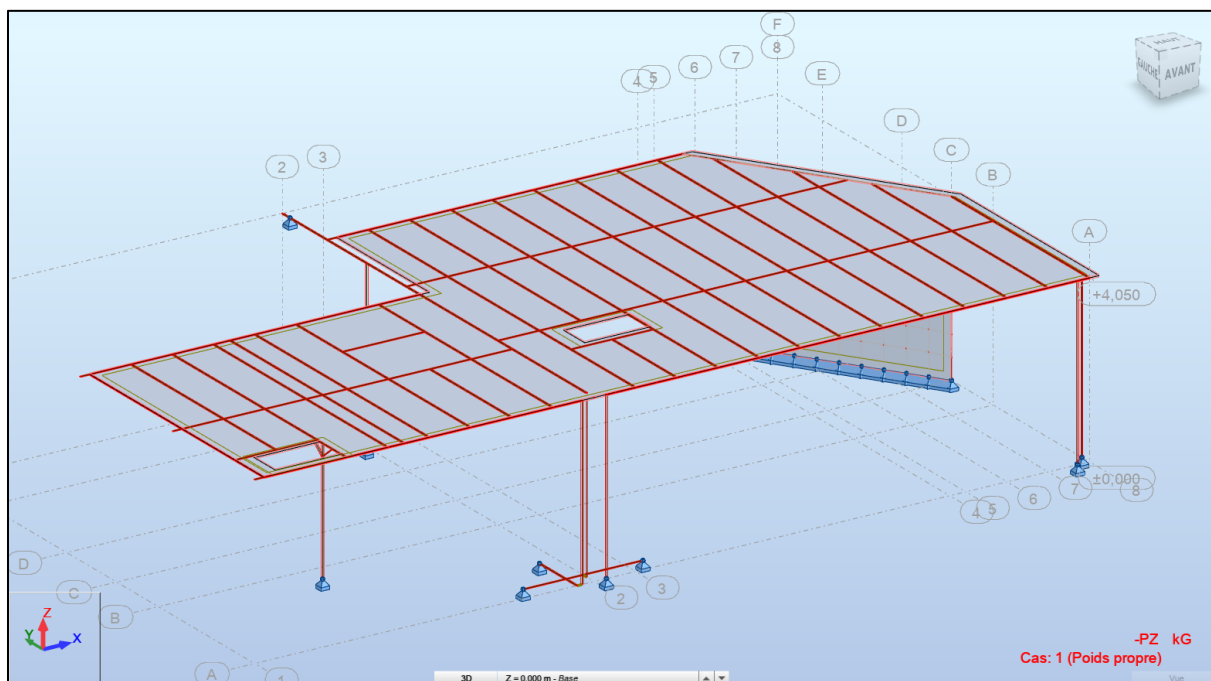


Figure 4-5 : Poids Propre

4.3.1.2. CAS DE CHARGE 2 – SURCHARGE PLANCHER

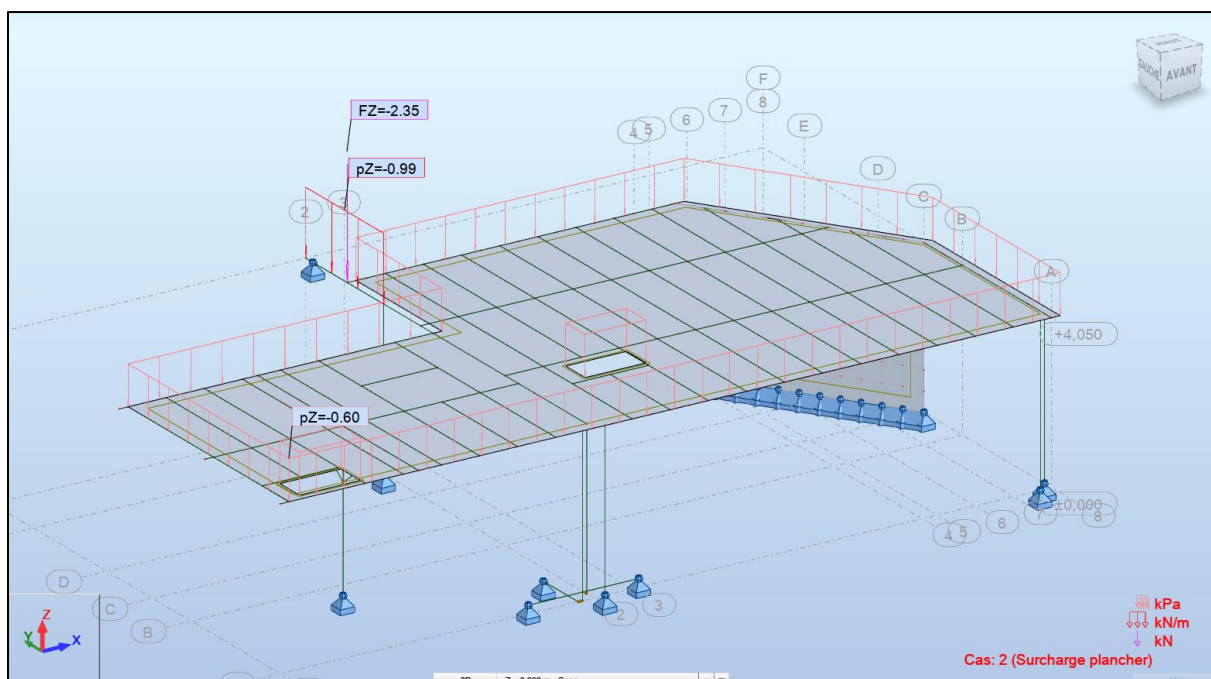


Figure 4-6 : Surcharge plancher

- La charge du réseau existant de 60 kg/m^2 ou de $0,6 \text{ kN/m}^2$.
- La valeur $FZ = -2,35 \text{ kN}$ correspond au poids d'un IPE 160 non modélisé de la zone 1.

4.3.2. COMBINAISONS DES CHARGES

Les combinaisons ELU et ELS des cas de charge, telles que générées par le logiciel, sont listées ci-dessous :

Combinaison	Nom	Cas	Coef.	Cas	Coef.
3 (C)	ELU/1=1*1.35 + 2*1.35	1	1,35	2	1,35
5 (C)	ELS:CAR/1=1*1,00 + 2*1.00	1	1	2	1
6 (C)	ELS:FRE/2=1*1.00 + 2*1.00	1	1	2	1
7 (C)	ELS:QPR/3=1*1.00 + 2*1.00	1	1	2	1

Tableau 4-1 : Combinaisons des chargements

4.4. JUSTIFICATION DES OUVRAGES

4.4.1. CHARPENTE METALLIQUE

Les caractéristiques de la charpente sont extraites de la note [8].

Les ratios des profilés sont indiqués en ANNEXE 2.

4.4.2. LONGRINES

Les longrines reposeront sur des massifs supportés par un ou plusieurs micropieux. Le nombre de micropieux sera défini en fonction des charges induites par la charpente. Pour ne pas impacter les ouvrages existants, l'arase supérieure des massifs de longrines se situera au-dessus de l'arase supérieure du massif de poteau en béton armé existant, qui est à 1 m de profondeur. Les longrines auront une hauteur maximale de 80 cm, et les futurs massifs devront être suffisamment éloignés du massif existant pour éviter toute interaction.

Géométrie :

Caractéristique de la section									
Géométrie									
h	0,5	m		f_{ck}	30	MPa	f_{yk}	500	Mpa
b_w	0,3	m		γ_c	1,5		γ_s	1,15	
d	0,45	m		f_{cd}	20,0	Mpa	f_{yd}	434,8	Mpa
c	0,05	m		f_{ctm}	2,9	Mpa			

Vérification de $A_{s,min}$:

Vérification de $A_{s,min}$		
A_{smin} Eurocode		
Max(A_{smin}) =	2,04	cm ²
= $0,26 \cdot (f_{ctm}/f_{yk}) \cdot b_w \cdot d$	2,04	cm ²
> $0,0013 \cdot b_w \cdot d$	1,76	cm ²

Calcul du ferrailage théorique retenu sur le logiciel :

Barre/Position [m]	Ferrailage théorique supérieur (My) [cm2]	Armatures supérieures - disposition (My)	Ferrailage théorique inférieur (My) [cm2]	Armatures inférieures - disposition (My)	Arm. transversale - type/disposition
259	0	-	2,99	3f12	2f6 12*24.0
260	2,88	3f12	1,02	2f12	2f6 6*24.0

Ferrailage retenu :

- Longitudinale (inf et sup) : 3 HA 12 ;
- Transversale (Cadres) : 2 HA 6, e = 24 cm.

4.5. AJOUT DE MICROPIEUX

D'après le rapport géotechnique G2 AVP n°14093, la charge admissible d'un micropieu type II de diamètre 200 à l'ELU est de 120,1 kN.

Le tableau ci-dessous donne le nombre de micropieux de 20cm de diamètre à une profondeur de 5m à mettre en dessous des nouvelles longrines suivant les réactions F_z à l'ELU.

Réaction F_z (kN)	Micropieu type 2	
	Diamètre (m)	Nombre de micropieux
≤ 120	0,2	1
entre 120 et 240	0,2	2
entre 240 et 360	0,2	3
entre 360 et 480	0,2	4
entre 480 et 600	0,2	5

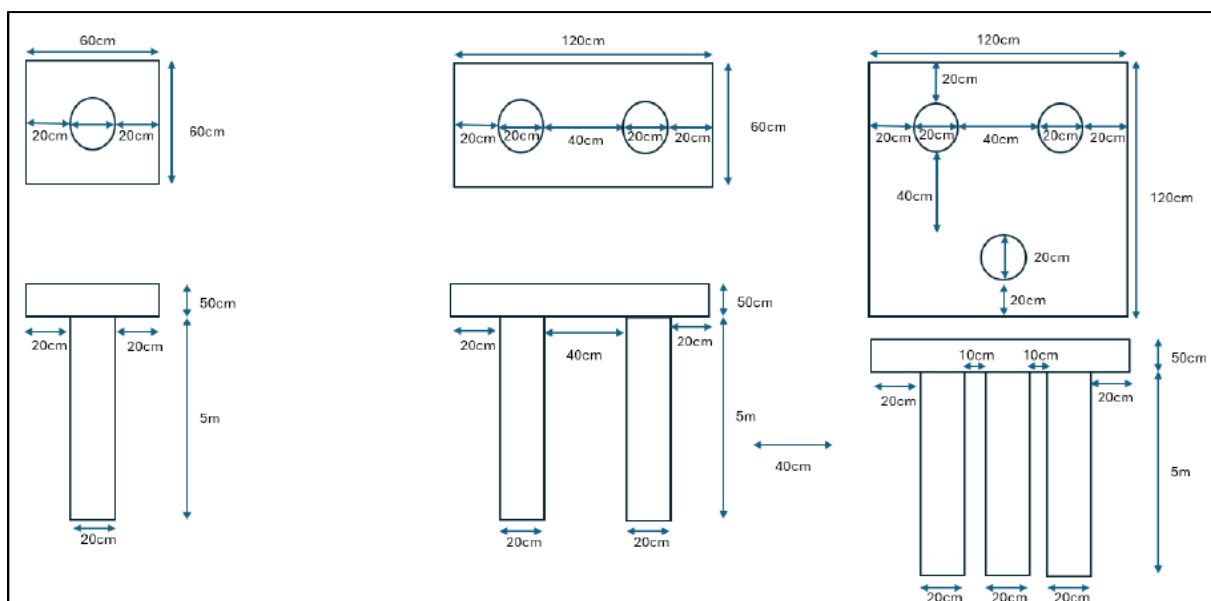


Figure 4-7 : Dimensions des groupes de pieux

En se référant au tableau des réactions de pied de poteau (ci-dessous), et constatant que toutes les réactions sont inférieures à 120 kN, un micropieu unique est attribué à chaque poteau.

Poteau	Nœud sur modèle	Réaction d'appui modèle (Fz kN)	Nombre de micropieux à mettre
P1	383	78,7	1
P2	17	60,75	1
P3	339	-2,26	1
P4	581	30,11	1
P5	582	35,39	1

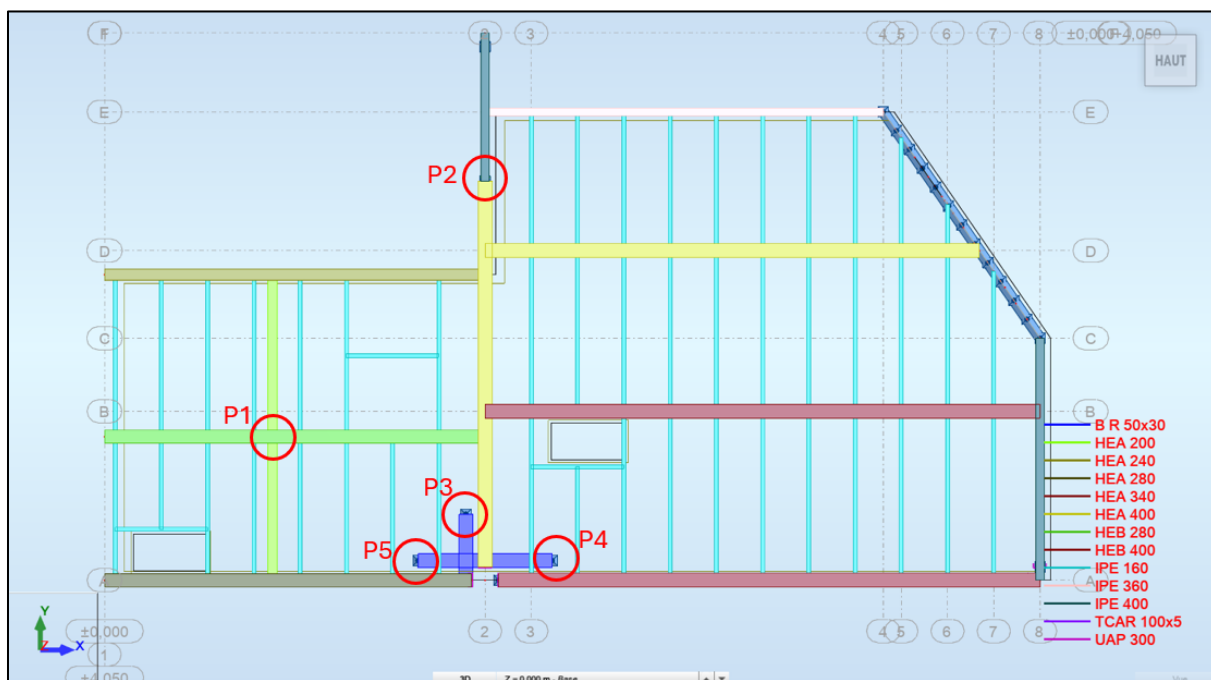


Figure 4-8 : Représentation de l'emplacement des micropieux prévus

5. CONCLUSION

Cette note de calcul confirme la capacité portante des longrines de 0,5 m de hauteur et 0,3 m de largeur.

- Les barres du modèle sont présentées en ANNEXE 1.
- Les ratios des profilés sont indiqués en ANNEXE 2.
- La vérification des profilés est détaillée en ANNEXE 3.

Conformément à la descente de charges détaillée dans la note, les armatures requises pour les longrines ($h = 0,5$ m ; $l = 0,3$ m), décrites au (§4.4.2), sont :

- Longitudinale (inf et sup) : 3 HA 12 ;
- Transversale (Cadres) : 2 HA6, $e = 24$ cm.

Le système de fondation global spécifié au (§4.5) est présenté ci-après :

- Un micropieu du type 2 de diamètre 0,2 m sera placé sous chaque longrine.

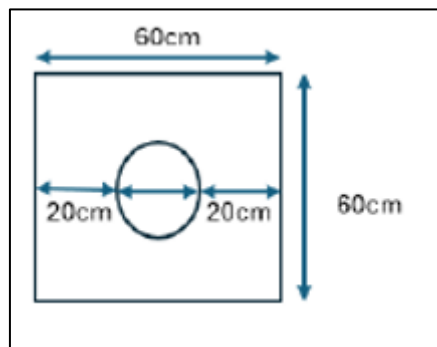


Figure 5-1 : Système de fondation global – Extrait de (Figure 4-7)

ANNEXE 1 Barres du modèle

Barre	Nœud 1	Noeud2	Section	Matériau	Gamma (deg)	Type de barre	Élément de construction
1	90	321	TCAR 100x5	ACIER E24	0	Bracon	Barre
2	39	3	HEA 340	ACIER E24	0	Poutres	Poutre
3	95	24	IPE 160	ACIER E24	0	Solives	Poutre
6	335	336	UAP 300	ACIER E24	-90	Poteaux U	Poteau
8	106	335	HEA 280	ACIER E24	0	Poutres	Poutre
9	3	5	IPE 400	ACIER E24	0	Poutres	Poutre
10	6	13	HEA 400	ACIER E24	0	Poutres	Poutre
11	8	7	IPE 360	ACIER E24	0	Poutres	Poutre
13	1385	1386	IPE 160	ACIER	0	Solives	Poutre
14	39	15	UAP 300	ACIER E24	90	Poteaux U	Poteau
15	11	1398	IPE 160	ACIER E24	0	Solives	Poutre
16	16	86	IPE 160	ACIER E24	0	Solives	Poutre
17	21	22	HEB 400	ACIER E24	0	Poutres	Poutre
18	35	37	UAP 300	ACIER E24	0	Poteaux U	Poteau
19	18	14	IPE 400	ACIER E24	0	Poutres	Poutre
20	25	26	IPE 160	ACIER E24	0	Solives	Poutre
21	45	93	UAP 300	ACIER E24	-90	Poteaux U	Poteau
25	24	25	IPE 160	ACIER E24	0	Solives	Poutre
32	28	47	IPE 160	ACIER E24	0	Solives	Poutre
33	96	1400	IPE 160	ACIER E24	0	Solives	Poutre
34	30	48	IPE 160	ACIER E24	0	Solives	Poutre
35	97	30	IPE 160	ACIER E24	0	Solives	Poutre
36	32	49	IPE 160	ACIER E24	0	Solives	Poutre
37	98	32	IPE 160	ACIER E24	0	Solives	Poutre
38	34	50	IPE 160	ACIER E24	0	Solives	Poutre
39	99	34	IPE 160	ACIER E24	0	Solives	Poutre
40	47	56	IPE 160	ACIER E24	0	Solives	Poutre
41	48	57	IPE 160	ACIER E24	0	Solives	Poutre
42	49	58	IPE 160	ACIER E24	0	Solives	Poutre
43	50	59	IPE 160	ACIER E24	0	Solives	Poutre
44	36	51	IPE 160	ACIER E24	0	Solives	Poutre
45	52	33	IPE 160	ACIER E24	0	Solives	Poutre
46	53	62	IPE 160	ACIER E24	0	Solives	Poutre
47	54	63	IPE 160	ACIER E24	0	Solives	Poutre
48	100	36	IPE 160	ACIER E24	0	Solives	Poutre
49	38	52	IPE 160	ACIER E24	0	Solives	Poutre
50	101	38	IPE 160	ACIER E24	0	Solives	Poutre
51	816	68	IPE 160	ACIER E24	0	Solives	Poutre
52	68	69	IPE 160	ACIER E24	0	Solives	Poutre
53	70	71	IPE 160	ACIER E24	0	Solives	Poutre

55	73	74	IPE 160	ACIER E24	0	Solives	Poutre
56	74	75	IPE 160	ACIER E24	0	Solives	Poutre
57	76	77	IPE 160	ACIER E24	0	Solives	Poutre
59	1392	1390	HEA 200	ACIER E24	0	Poutres 257 et 59	Poutre
61	813	83	IPE 160	ACIER E24	0	Solives	Poutre
62	83	84	IPE 160	ACIER E24	0	Solives	Poutre
64	86	87	IPE 160	ACIER E24	0	Solives	Poutre
65	40	53	IPE 160	ACIER E24	0	Solives	Poutre
67	17	18	HEA 200	ACIER E24	90	Poteau HEA 200	Poteau
69	102	40	IPE 160	ACIER E24	0	Solives	Poutre
73	4	90	HEA 240	ACIER E24	0	Poutres	Poutre
76	103	42	IPE 160	ACIER E24	0	Solives	Poutre
78	104	44	IPE 160	ACIER E24	0	Solives	Poutre
80	105	46	IPE 160	ACIER E24	0	Solives	Poutre
97	1390	383	HEA 200	ACIER E24	90	Poteau HEA 200	Poteau
188	524	525	IPE 160	ACIER E24	0	Solives	Poutre
189	525	526	IPE 160	ACIER E24	0	Solives	Poutre
237	51	60	IPE 160	ACIER E24	0	Solives	Poutre
241	572	66	HEB 280	ACIER E24	0	Poutres	Poutre
257	1390	1393	HEA 200	ACIER E24	0	Poutres 257 et 59	Poutre
259	582	581	B R 50x30	BETON30	0	Poutre BA Flexion	Poutre
260	583	339	B R 50x30	BETON30	0	Poutre BA Flexion	Poutre
261	77	78	IPE 160	ACIER E24	0	Solives	Poutre
262	44	1151	IPE 160	ACIER E24	0	Solives	Poutre
263	46	1152	IPE 160	ACIER E24	0	Solives	Poutre
264	42	54	IPE 160	ACIER E24	0	Solives	Poutre
265	1151	64	IPE 160	ACIER E24	0	Solives	Poutre
266	1266	1382	UAP 300	ACIER E24	0	Poteaux U	Poteau
268	35	18	HEA 400	ACIER E24	0	Poutres 268	Poutre
269	1394	1396	TCAR 100x5	ACIER E24	0	Bracon	Barre
270	1394	1395	TCAR 100x5	ACIER E24	0	Bracon	Barre
271	80	571	IPE 160	ACIER E24	0	Solives	Poutre
272	814	80	IPE 160	ACIER E24	0	Solives	Poutre
276	1401	1402	IPE 160	ACIER E24	0	Poutres	Poutre

ANNEXE 2 Ratios des profilés

Pièce	Profil	Matériau	Lay	Laz	Ratio	Cas	Ratio(uy)	Cas (uy)	Ratio(uz)	Cas (uz)	Ratio(vx)	Cas (vx)	Ratio(vy)	Cas (vy)
1 Barre_1	TCAR 100x5	ACIER E24	62.78	62.78	0.10	3 ELU/1+1*1.55 + 2*	-	-	-	-	-	-	-	-
2	HEA 340	ACIER E24	81.26	156.82	0.11	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.14	5 ELS:CAR/1+1*1.15	-	-	-	-
3	HEA 160	ACIER E24	55.49	197.94	0.08	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.07	5 ELS:CAR/1+1*1.15	-	-	-	-
6 Poteaux_14	UAP 300	ACIER E24	34.29	130.72	0.05	3 ELU/1+1*1.55 + 2*	-	-	-	-	0.08	2 Surcharge planch	0.00	1 Poids propre
8	HEA 280	ACIER E24	66.92	113.39	0.07	3 ELU/1+1*1.55 + 2*	0.01	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
9	HEA 400	ACIER E24	31.60	132.40	0.19	3 ELU/1+1*1.55 + 2*	0.05	5 ELS:CAR/1+1*1.15	0.06	5 ELS:CAR/1+1*1.15	-	-	-	-
10	HEA 400	ACIER E24	63.49	145.65	0.12	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.12	5 ELS:CAR/1+1*1.15	-	-	-	-
11	HEA 360	ACIER E24	57.57	227.31	0.03	1 Poids propre	0.00	2 Surcharge planch	0.08	5 ELS:CAR/1+1*1.15	-	-	-	-
13 Solives_13	HEA 160	ACIER	30.40	108.46	0.02	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.01	5 ELS:CAR/1+1*1.15	-	-	-	-
14 Poteaux_14	UAP 300	ACIER E24	34.29	130.72	0.17	3 ELU/1+1*1.55 + 2*	-	-	-	-	0.10	1 Poids propre	0.00	2 Surcharge planch
15 Solives_15	HEA 160	ACIER E24	30.40	108.46	0.03	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.01	5 ELS:CAR/1+1*1.15	-	-	-	-
16	HEA 160	ACIER E24	30.40	108.46	0.02	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.01	5 ELS:CAR/1+1*1.15	-	-	-	-
17	HEB 400	ACIER E24	70.27	162.25	0.14	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.16	5 ELS:CAR/1+1*1.15	-	-	-	-
18 Poteaux_14	UAP 300	ACIER E24	34.29	130.72	0.24	3 ELU/1+1*1.55 + 2*	-	-	-	-	0.03	2 Surcharge planch	0.00	5 ELS:CAR/1+1*1.15
19	HEA 400	ACIER E24	19.34	81.01	0.04	3 ELU/1+1*1.55 + 2*	0.02	2 Surcharge planch	0.01	5 ELS:CAR/1+1*1.15	-	-	-	-
20 Solives_20	HEA 160	ACIER E24	45.61	162.69	0.05	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.04	5 ELS:CAR/1+1*1.15	-	-	-	-
21 Poteaux_U_21	UAP 300	ACIER E24	34.29	130.72	0.14	3 ELU/1+1*1.55 + 2*	-	-	-	-	0.10	1 Poids propre	0.12	2 Surcharge planch
25	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
32	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
33 Solives_33	HEA 160	ACIER E24	37.25	132.87	0.03	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.02	5 ELS:CAR/1+1*1.15	-	-	-	-
34	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
35 Solives_35	HEA 160	ACIER E24	55.49	197.94	0.08	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.07	5 ELS:CAR/1+1*1.15	-	-	-	-
36	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
37 Solives_37	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	1 Poids propre	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
38	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
39 Solives_39	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
40 Solives_40	HEA 160	ACIER E24	45.61	162.69	0.04	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
41 Solives_41	HEA 160	ACIER E24	45.61	162.69	0.04	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
42 Solives_42	HEA 160	ACIER E24	45.61	162.69	0.04	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
43 Solives_43	HEA 160	ACIER E24	45.61	162.69	0.04	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
44	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
45 Solives_45	HEA 160	ACIER E24	45.61	162.69	0.04	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
46 Solives_46	HEA 160	ACIER E24	45.61	162.69	0.04	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
47 Solives_47	HEA 160	ACIER E24	37.05	132.18	0.02	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.01	5 ELS:CAR/1+1*1.15	-	-	-	-
48 Solives_48	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
49	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
50 Solives_50	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
51 Solives_51	HEA 160	ACIER E24	47.13	168.12	0.04	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
52 Solives_52	HEA 160	ACIER E24	53.21	189.81	0.08	3 ELU/1+1*1.55 + 2*	0.01	5 ELS:CAR/1+1*1.15	0.07	5 ELS:CAR/1+1*1.15	-	-	-	-
53 Solives_53	HEA 160	ACIER E24	47.13	168.12	0.04	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
55	HEA 160	ACIER E24	47.13	168.12	0.04	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
56	HEA 160	ACIER E24	53.21	189.81	0.08	3 ELU/1+1*1.55 + 2*	0.01	5 ELS:CAR/1+1*1.15	0.07	5 ELS:CAR/1+1*1.15	-	-	-	-
57 Solives_57	HEA 160	ACIER E24	47.13	168.12	0.04	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
59	HEA 200	ACIER E24	37.43	62.24	0.25	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.11	5 ELS:CAR/1+1*1.15	-	-	-	-
61 Solives_61	HEA 160	ACIER E24	47.13	168.12	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.04	5 ELS:CAR/1+1*1.15	-	-	-	-
62 Solives_62	HEA 160	ACIER E24	53.21	189.81	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
64 Solives_64	HEA 160	ACIER E24	53.21	189.81	0.05	3 ELU/1+1*1.55 + 2*	0.00	5 ELS:CAR/1+1*1.15	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
65	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
67 Poteau HEA 2	HEA 200	ACIER E24	34.23	81.31	0.27	3 ELU/1+1*1.55 + 2*	-	-	-	-	0.21	2 Surcharge planch	0.00	5 ELS:CAR/1+1*1.15
69 Solives_69	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
73	HEA 240	ACIER E24	81.88	137.10	0.12	3 ELU/1+1*1.55 + 2*	0.02	5 ELS:CAR/1+1*1.15	0.07	5 ELS:CAR/1+1*1.15	-	-	-	-
76 Solives_76	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
78 Solives_78	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
80 Solives_80	HEA 160	ACIER E24	55.49	197.94	0.06	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
97 Poteau HEA 2	HEA 200	ACIER E24	34.23	81.31	0.15	3 ELU/1+1*1.55 + 2*	-	-	-	-	0.05	5 ELS:CAR/1+1*1.15	0.24	2 Surcharge planch
188 Solives_188	HEA 160	ACIER E24	47.13	168.12	0.04	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
189 Solives_189	HEA 160	ACIER E24	53.21	189.81	0.03	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
237 Solives_237	HEA 160	ACIER E24	45.61	162.69	0.04	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
241 Poutres_241	HEB 280	ACIER E24	67.95	116.16	0.11	3 ELU/1+1*1.55 + 2*	0.02	5 ELS:CAR/1+1*1.15	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
257 Poutres_257	HEA 200	ACIER E24	42.26	70.27	0.34	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.17	5 ELS:CAR/1+1*1.15	-	-	-	-
261 Solives_261	HEA 160	ACIER E24	53.21	189.81	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.04	5 ELS:CAR/1+1*1.15	-	-	-	-
262 Solives_262	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
263 Solives_263	HEA 160	ACIER E24	45.95	163.91	0.04	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.03	5 ELS:CAR/1+1*1.15	-	-	-	-
264	HEA 160	ACIER E24	52.75	188.18	0.05	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.05	5 ELS:CAR/1+1*1.15	-	-	-	-
265 Solives_265	HEA 160	ACIER E24	15.13	53.96	0.02	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.00	5 ELS:CAR/1+1*1.15	-	-	-	-
266 Poteaux_U_2	UAP 300	ACIER E24	34.29	130.72	0.02	3 ELU/1+1*1.55 + 2*	-	-	-	-	0.09	1 Poids propre	0.12	2 Surcharge planch
268 268	HEA 400	ACIER E24	49.44	113.43	0.17	3 ELU/1+1*1.55 + 2*	0.01	2 Surcharge planch	0.11	5 ELS:CAR/1+1*1.15	-	-	-	-
269	TCAR 100x5	ACIER E24	57.11	57.11	0.15	3 ELU/1+1*1.55 + 2*	-	-	-	-	-	-	-	-
270	TCAR 100x5	ACIER E24	57.11	57.11	0.13	3 ELU/1+1*1.55 + 2*	-	-	-	-	-	-	-	-
271 Solives_271	HEA 160	ACIER E24	53.21	189.81	0.04	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.04	5 ELS:CAR/1+1*1.15	-	-	-	-
272 Solives_272	HEA 160	ACIER E24	47.13	168.12	0.03	3 ELU/1+1*1.55 + 2*	0.00	2 Surcharge planch	0.02	5 ELS:CAR/1+1*1.15	-	-	-	-

ANNEXE 3 Vérification des profilés

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 1 Barre_1 **POINT:** 1 **COORDONNEE:** $x = 0.00$ $L = 0.000$ m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: TCAR 100x5

$h = 10.0$ cm $gM0 = 1.00$ $gM1 = 1.00$

$b = 10.0$ cm $A_y = 9.44$ cm² $A_z = 9.44$ cm² $A_x = 18.88$ cm²

$t_w = 0.5$ cm $I_y = 282.80$ cm⁴ $I_z = 282.80$ cm⁴ $I_x = 438.80$ cm⁴

$t_f = 0.5$ cm $W_{ply} = 67.75$ cm³ $W_{plz} = 67.75$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 23.61$ kN $M_{y,Ed} = 0.87$ kN*m $M_{z,Ed} = -1.53$ kN*m $V_{y,Ed} = -0.52$ kN

$N_{c,Rd} = 443.68 \text{ kN}$ $M_{y,pl,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 124.03 \text{ kN}$

$N_{b,Rd} = 443.68 \text{ kN}$ $M_{y,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.70 \text{ kN}$

$MN_{y,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 124.03 \text{ kN}$

$T_{t,Ed} = -0.39 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.05 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.05 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.10 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{1.67} + (M_{z,Ed}/MN_{z,Rd})^{1.67} = 0.03 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$V_{z,Ed}/V_{z,T,Rd} = 0.01 < 1.00$ (6.2.6-7)

$\tau_{xy,Ed}/(\tau_{xy}/(\sqrt{3} \cdot gM_0)) = 0.03 < 1.00$ (6.2.6)

$\tau_{xz,Ed}/(\tau_{xz}/(\sqrt{3} \cdot gM_0)) = 0.03 < 1.00$ (6.2.6)

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 2 **POINT:** 3 **COORDONNEE:** $x = 0.50 L = 5.872 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \text{ (1+2)} \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 340

$h = 33.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 30.0 \text{ cm}$ $A_y = 110.39 \text{ cm}^2$ $A_z = 44.95 \text{ cm}^2$ $A_x = 133.47 \text{ cm}^2$

$t_w = 0.9 \text{ cm}$ $I_y = 27693.10 \text{ cm}^4$ $I_z = 7436.00 \text{ cm}^4$ $I_x = 127.71 \text{ cm}^4$

$t_f = 1.7 \text{ cm}$ $W_{ply} = 1850.48 \text{ cm}^3$ $W_{plz} = 755.95 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.63 \text{ kN}$ $M_{y,Ed} = 46.36 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.18 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = 0.09 \text{ kN}$

$N_{c,Rd} = 3136.55 \text{ kN}$ $M_{y,Ed,max} = 46.69 \text{ kN} \cdot \text{m}$ $M_{z,Ed,max} = 0.97 \text{ kN} \cdot \text{m}$
 $V_{y,c,Rd} = 1497.67 \text{ kN}$

$N_{b,Rd} = 832.28 \text{ kN}$ $M_{y,c,Rd} = 434.86 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 177.65 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -2.08 \text{ kN}$

$MN_{y,Rd} = 434.86 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 177.65 \text{ kN}\cdot\text{m}$ $V_{z,c,Rd} = 609.84 \text{ kN}$

$M_{b,Rd} = 434.86 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 25044.99 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 1.00$

$L_{cr,upp} = 1.000 \text{ m}$ $\lambda_{m,LT} = 0.13$ $f_{i,LT} = 0.48$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 11.705 \text{ m}$ $\lambda_{m,y} = 0.87$ $L_z = 11.705 \text{ m}$ $\lambda_{m,z} = 1.67$

$L_{cr,y} = 11.705 \text{ m}$ $X_y = 0.68$ $L_{cr,z} = 11.705 \text{ m}$ $X_z = 0.27$

$\lambda_{m,y} = 81.26$ $k_{yy} = 1.00$ $\lambda_{m,z} = 156.82$ $k_{yz} = 0.70$

flambement par torsion:

flambement en flexion-torsion

Courbe,T=c $\alpha_{T,c} = 0.49$ Courbe,TF=c $\alpha_{T,c} = 0.49$

$L_t = 11.705 \text{ m}$ $f_{i,T} = 0.96$ $N_{cr,y} = 4189.36 \text{ kN}$ $f_{i,TF} = 1.04$

$N_{cr,T} = 4969.25 \text{ kN}$ $X_T = 0.67$ $N_{cr,TF} = 4189.36 \text{ kN}$ $X_{TF} = 0.62$

$\lambda_{m,T} = 0.79$ $N_{b,T,Rd} = 2087.76 \text{ kN}$ $\lambda_{m,TF} = 0.87$ $N_{b,TF,Rd} = 1948.76 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/M_{N,y,Rd} = 0.11 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 81.26 < \lambda_{max} = 210.00 \quad \lambda_{z} = 156.82 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{t,Rd}, N_{TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.11 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/\gamma_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/\gamma_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/\gamma_{M1}) = 0.11 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/\gamma_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/\gamma_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/\gamma_{M1}) = 0.06 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y,max} = L/200.00 = 5.9 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.8 \text{ cm} < u_{z,max} = L/200.00 = 5.9 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 3 POINT: 6 COORDONNEE: $x = 0.56 L = 2.042 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.04 \text{ kN}$ $M_{y,Ed} = 2.32 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.00 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 186.28 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = 0.04 \text{ kN}$

$MN_{,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 131.01 \text{ kN}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.08 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 6 Poteaux_14 POINT: 7 COORDONNEE: $x = 1.00$ L = 4.050 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: UAP 300

$h=30.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=10.0 \text{ cm}$ $A_y=36.14 \text{ cm}^2$ $A_z=30.64 \text{ cm}^2$ $A_x=58.56 \text{ cm}^2$

$t_w=0.9 \text{ cm}$ $I_y=8170.18 \text{ cm}^4$ $I_z=562.07 \text{ cm}^4$ $I_x=38.46 \text{ cm}^4$

$t_f=1.6 \text{ cm}$ $W_{ey}=544.68 \text{ cm}^3$ $W_{ez}=79.88 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 4.44 \text{ kN}$ $M_{y,Ed} = 3.21 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 0.06 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.07 \text{ kN}$

$N_{c,Rd} = 1376.13 \text{ kN}$ $M_{y,Ed,max} = 3.21 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = 0.35 \text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 489.55 \text{ kN}$

$$N_{b,Rd} = 484.69 \text{ kN} \quad M_{y,c,Rd} = 128.00 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 18.77 \text{ kN}\cdot\text{m} \quad V_{z,Ed} = 0.79 \text{ kN}$$

$$V_{z,T,Rd} = 415.31 \text{ kN}$$

$$M_{b,Rd} = 87.04 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.01 \text{ kN}\cdot\text{m}$$

Classe de la section = 3



PARAMETRES DE DEVERSEMENT:

$$z = 0.00 \quad M_{cr} = 308.25 \text{ kN}\cdot\text{m} \quad \text{Courbe, LT - dXLT} = 0.68$$

$$L_{cr,upp} = 4.050 \text{ m} \quad \lambda_{m,LT} = 0.64 \quad f_{i,LT} = 0.88$$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 4.050 \text{ m} \quad \lambda_{m,y} = 0.37 \quad L_z = 4.050 \text{ m} \quad \lambda_{m,z} = 1.39$$

$$L_{cr,y} = 4.050 \text{ m} \quad X_y = 0.92 \quad L_{cr,z} = 4.050 \text{ m} \quad X_z = 0.35$$

$$\lambda_{my} = 34.29 \quad k_{zy} = 1.00 \quad \lambda_{mz} = 130.72 \quad k_{zz} = 1.00$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} + M_{y,Ed}/M_{y,c,Rd} + M_{z,Ed}/M_{z,c,Rd} = 0.03 < 1.00 \quad (6.2.1(7))$$

$$\sqrt{(\sigma_{x,Ed})^2 + 3 \cdot (\tau_{xy,Ed})^2} / (f_y / g_{M0}) = 0.03 < 1.00 \quad (6.2.1.(5))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{my} = 34.29 < \lambda_{max} = 210.00 \quad \lambda_{mz} = 130.72 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.04 < 1.00 \quad (6.3.2.1.(1))$$

$$\frac{N_{Ed}}{X_y \cdot N_{Rk/gM1}} + \frac{k_{yy} \cdot M_{y,Ed,max}}{X_{LT} \cdot M_{y,Rk/gM1}} + \frac{k_{yz} \cdot M_{z,Ed,max}}{M_{z,Rk/gM1}} = 0.05 < 1.00 \quad (6.3.3.(4))$$

$$\frac{N_{Ed}}{X_z \cdot N_{Rk/gM1}} + \frac{k_{zy} \cdot M_{y,Ed,max}}{X_{LT} \cdot M_{y,Rk/gM1}} + \frac{k_{zz} \cdot M_{z,Ed,max}}{M_{z,Rk/gM1}} = 0.05 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 0.2 \text{ cm} < v_{x \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$v_y = 0.0 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 1 Poids propre

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 8 **POINT:** 7 **COORDONNEE:** $x = 0.46 L = 3.630 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$

MATERIAU:ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: HEA 280** $h=27.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=28.0 \text{ cm}$ $A_y=81.58 \text{ cm}^2$ $A_z=31.74 \text{ cm}^2$ $A_x=97.26 \text{ cm}^2$ $tw=0.8 \text{ cm}$ $I_y=13673.30 \text{ cm}^4$ $I_z=4762.64 \text{ cm}^4$ $I_x=62.37 \text{ cm}^4$ $tf=1.3 \text{ cm}$ $W_{ply}=1112.22 \text{ cm}^3$ $W_{plz}=518.13 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES: $M_{y,Ed} = -15.23 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -1.84 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 4.96 \text{ kN}$ $M_{y,pl,Rd} = 261.37 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 121.76 \text{ kN}\cdot\text{m}$ $V_{y,c,Rd} = 1106.86 \text{ kN}$ $M_{y,c,Rd} = 261.37 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 121.76 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -8.48 \text{ kN}$ $V_{z,c,Rd} = 430.64 \text{ kN}$ Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:

en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$M_{z,Ed}/M_{z,c,Rd} = 0.02 < 1.00 \quad (6.2.5.(1))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.02 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.02 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$M_{y,Ed}/(XLT \cdot M_{y,Rk}/gM1) + M_{z,Ed}/(M_{z,Rk}/gM1) = 0.07 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES

Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 4.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 4.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00


Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 9 **POINT:** 7 **COORDONNEE:** x = 0.70 L = 3.650 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 400

$h=40.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=18.0 \text{ cm}$ $A_y=55.99 \text{ cm}^2$ $A_z=42.69 \text{ cm}^2$ $A_x=84.46 \text{ cm}^2$

$t_w=0.9 \text{ cm}$ $I_y=23128.40 \text{ cm}^4$ $I_z=1317.82 \text{ cm}^4$ $I_x=51.33 \text{ cm}^4$

$t_f=1.4 \text{ cm}$ $W_{ply}=1307.15 \text{ cm}^3$ $W_{plz}=229.00 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 1.00 \text{ kN}$ $M_{y,Ed} = 43.25 \text{ kN*m}$ $M_{z,Ed} = 2.29 \text{ kN*m}$ $V_{y,Ed} = -0.63 \text{ kN}$

$N_{c,Rd} = 1984.81 \text{ kN}$ $M_{y,Ed,max} = 43.25 \text{ kN*m}$ $M_{z,Ed,max} = 2.29 \text{ kN*m}$
 $V_{y,c,Rd} = 759.71 \text{ kN}$

$N_{b,Rd} = 749.39 \text{ kN}$ $M_{y,c,Rd} = 307.18 \text{ kN*m}$ $M_{z,c,Rd} = 53.82 \text{ kN*m}$ $V_{z,Ed} = 6.50 \text{ kN}$

$MN_{y,Rd} = 307.18 \text{ kN*m}$ $MN_{z,Rd} = 53.82 \text{ kN*m}$ $V_{z,c,Rd} = 579.22 \text{ kN}$

$Mb_{,Rd} = 266.39 \text{ kN*m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 769.32 \text{ kN*m}$ Courbe,LT - $X_{LT} = 0.83$

$L_{cr,upp}=3.360 \text{ m}$ $Lam_{LT} = 0.63$ $f_{i,LT} = 0.77$ $X_{LT,mod} = 0.87$

PARAMETRES DE FLAMBEMENT:


 en y:
 
 en z:

$L_y = 5.230 \text{ m}$ $\text{Lam}_y = 0.34$ $L_z = 5.230 \text{ m}$ $\text{Lam}_z = 1.41$

$\text{Lcr},y = 5.230 \text{ m}$ $X_y = 0.97$ $\text{Lcr},z = 5.230 \text{ m}$ $X_z = 0.38$

$\text{Lam}_y = 31.60$ $k_{yy} = 1.00$ $\text{Lam}_z = 132.40$ $k_{yz} = 0.73$

flambement par torsion: flambement en flexion-torsion

Courbe,T=b $\alpha_{T,b} = 0.34$ Courbe,TF=b $\alpha_{TF,b} = 0.34$

$L_t = 5.230 \text{ m}$ $f_{i,T} = 0.98$ $N_{cr,y} = 17525.13 \text{ kN}$ $f_{i,TF} = 0.58$

$N_{cr,T} = 2720.77 \text{ kN}$ $X_T = 0.69$ $N_{cr,TF} = 17525.13 \text{ kN}$ $X_{TF} = 0.95$

$\text{Lam}_T = 0.85$ $N_{b,T,Rd} = 1370.58 \text{ kN}$ $\text{Lam}_{TF} = 0.34$ $N_{b,TF,Rd} = 1886.66 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/M_{N,y,Rd} = 0.14 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/M_{N,z,Rd} = 0.04 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.06 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00$ (6.2.6.(1))

$V_{z,Ed}/V_{z,c,Rd} = 0.01 < 1.00$ (6.2.6.(1))

Contrôle de la stabilité globale de la barre:

$\text{Lam}_{b,y} = 31.60 < \text{Lam}_{b,max} = 210.00$ $\text{Lam}_{b,z} = 132.40 < \text{Lam}_{b,max} = 210.00$ STABLE

$N_{Ed}/\text{Min}(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00$ (6.3.1)

$M_{y,Ed,max}/M_{b,Rd} = 0.16 < 1.00$ (6.3.2.1.(1))

$N_{Ed}/(X_y \cdot N_{Rk}/\gamma_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/\gamma_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/\gamma_{M1}) = 0.19 < 1.00$ (6.3.3.(4))

$$\frac{N_{Ed}}{(X_z \cdot N_{Rk/gM1})} + \frac{k_{zy} \cdot M_{y,Ed,max}}{(X_{LT} \cdot M_{y,Rk/gM1})} + \frac{k_{zz} \cdot M_{z,Ed,max}}{(M_{z,Rk/gM1})} = 0.13 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.1 \text{ cm} < u_{y \text{ max}} = L/200.00 = 2.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.2 \text{ cm} < u_{z \text{ max}} = L/200.00 = 2.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 10 **POINT:** 1 **COORDONNEE:** x = 0.47 L = 5.000 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 400

$h=39.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=30.0 \text{ cm}$ $A_y=126.20 \text{ cm}^2$ $A_z=57.33 \text{ cm}^2$ $A_x=158.98 \text{ cm}^2$

$t_w=1.1 \text{ cm}$ $I_y=45069.40 \text{ cm}^4$ $I_z=8563.83 \text{ cm}^4$ $I_x=189.76 \text{ cm}^4$

$t_f=1.9 \text{ cm}$ $W_{ply}=2561.80 \text{ cm}^3$ $W_{plz}=872.86 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 3.68 \text{ kN}$ $M_{y,Ed} = 71.77 \text{ kN}^*\text{m}$ $M_{z,Ed} = -0.16 \text{ kN}^*\text{m}$ $V_{y,Ed} = 0.02 \text{ kN}$

$N_{c,Rd} = 3736.03 \text{ kN}$ $M_{y,Ed,max} = 71.77 \text{ kN}^*\text{m}$ $M_{z,Ed,max} = -0.57 \text{ kN}^*\text{m}$
 $V_{y,T,Rd} = 1710.87 \text{ kN}$

$N_{b,Rd} = 1211.09 \text{ kN}$ $M_{y,c,Rd} = 602.02 \text{ kN}^*\text{m}$ $M_{z,c,Rd} = 205.12 \text{ kN}^*\text{m}$
 $V_{z,Ed} = -0.06 \text{ kN}$

$MN_{y,Rd} = 602.02 \text{ kN}^*\text{m}$ $MN_{z,Rd} = 205.12 \text{ kN}^*\text{m}$ $V_{z,T,Rd} = 777.48 \text{ kN}$

$Mb_{,Rd} = 602.02 \text{ kN}^*\text{m}$ $Tt_{,Ed} = 0.03 \text{ kN}^*\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 33422.41 \text{ kN}^*\text{m}$ Courbe,LT - $XLT = 1.00$

$L_{cr,upp}=1.000 \text{ m}$ $Lam_{LT} = 0.13$ $f_{i,LT} = 0.48$ $XLT,mod = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 10.690 \text{ m}$ $Lam_y = 0.68$ $L_z = 10.690 \text{ m}$ $Lam_z = 1.55$

$L_{cr,y} = 10.690 \text{ m}$ $X_y = 0.86$ $L_{cr,z} = 10.690 \text{ m}$ $X_z = 0.32$

Lamy = 63.49 kyy = 1.00 Lamz = 145.65 kyz = 0.70

flambement par torsion: flambement en flexion-torsion

Courbe,T=b alfa,T=0.34 Courbe,TF=b alfa,TF=0.34

Lt=10.690 m fi,T=0.90 Ncr,y=8174.58 kN fi,TF=0.81

Ncr,T=6127.51 kN X,T=0.74 Ncr,TF=8174.58 kN X,TF=0.80

Lam_T=0.78 Nb,T,Rd=2750.46 kN Lam_TF=0.68 Nb,TF,Rd=2977.86 kN

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.12 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3}) \cdot gM0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3}) \cdot gM0) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 63.49 < \lambda_{max} = 210.00 \quad \lambda_{z} = 145.65 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.12 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.12 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.07 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 5.3 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.7 \text{ cm} < u_z \text{ max} = L/200.00 = 5.3 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces**FAMILLE:****PIECE:** 11 **POINT:** 4 **COORDONNEE:** $x = 0.51 L = 4.360 \text{ m}$ **CHARGEMENTS:****Cas de charge décisif:** 1 Poids propre**MATERIAU:****ACIER E24** $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 360**

h=36.0 cm gM0=1.00 gM1=1.00

b=17.0 cm Ay=48.84 cm² Az=35.14 cm² Ax=72.73 cm²

tw=0.8 cm Iy=16265.60 cm⁴ Iz=1043.45 cm⁴ Ix=37.49 cm⁴

tf=1.3 cm Wply=1019.15 cm³ Wplz=191.10 cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

N,Ed = 0.17 kN My,Ed = 7.70 kN*m Mz,Ed = -0.01 kN*m Vy,Ed = -0.00 kN

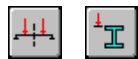
Nc,Rd = 1709.16 kN My,Ed,max = 7.70 kN*m Mz,Ed,max = 0.02 kN*m
Vy,T,Rd = 662.63 kN

Nb,Rd = 253.40 kN My,c,Rd = 239.50 kN*m Mz,c,Rd = 44.91 kN*m Vz,Ed = 0.01 kN

MN,y,Rd = 239.50 kN*m MN,z,Rd = 44.91 kN*m Vz,T,Rd = 476.72 kN

Mb,Rd = 239.50 kN*m Tt,Ed = -0.00 kN*m

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

z = 1.00 Mcr = 3842.21 kN*m Courbe,LT - XLT = 1.00

Lcr,upp=1.000 m Lam_LT = 0.25 fi,LT = 0.53 XLT,mod = 1.00

PARAMETRES DE FLAMBEMENT:



en y:



en z:

Ly = 8.610 m Lam_y = 0.61 Lz = 8.610 m Lam_z = 2.42

Lcr,y = 8.610 m Xy = 0.88 Lcr,z = 8.610 m Xz = 0.15

Lamy = 57.57 kyy = 1.00 Lamz = 227.31 kyz = 0.69

flambement par torsion:

flambement en flexion-torsion

Courbe,T=b alfa,T=0.34 Courbe,TF=b alfa,TF=0.34

Lt=8.610 m fi,T=1.16 Ncr,y=4547.61 kN fi,TF=0.76

$$N_{cr,T}=1641.97 \text{ kN} \quad X_{T,T}=0.58 \quad N_{cr,TF}=4547.61 \text{ kN} \quad X_{TF,T}=0.83$$

$$L_{am_T}=1.02 \quad N_{b,T,Rd}=998.53 \text{ kN} \quad L_{am_TF}=0.61 \quad N_{b,TF,Rd}=1419.38 \text{ kN}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\tau_{xy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\tau_{xz}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 57.57 < \lambda_{max} = 210.00 \quad \lambda_{z} = 227.31 > \lambda_{max} = 210.00 \quad \text{INSTABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.03 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/g_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.03 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/g_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.02 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y,max} = L/200.00 = 4.3 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.4 \text{ cm} < u_{z,max} = L/200.00 = 4.3 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil instable !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 13 Solives_13 **POINT:** 7 **COORDONNEE:** $x = 0.50 L = 1.000 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$M_{y,Ed} = 0.62 \text{ kN}\cdot\text{m} \quad M_{z,Ed} = -0.00 \text{ kN}\cdot\text{m} \quad V_{y,Ed} = 0.00 \text{ kN}$$

$$M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m} \quad V_{y,T,Rd} = 186.27 \text{ kN}$$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m} \quad V_{z,Ed} = 0.51 \text{ kN}$$

$$V_{z,T,Rd} = 131.00 \text{ kN}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:



en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$M_{y,Ed}/M_{y,c,Rd} = 0.02 < 1.00 \quad (6.2.5.(1))$$

$$M_{z,Ed}/M_{z,c,Rd} = 0.00 < 1.00 \quad (6.2.5.(1))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{y,t,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{y,tz,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPÈRE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 14 Poteaux_14 **POINT:** 6 **COORDONNEE:** x = 0.83 L = 3.375 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: UAP 300

h=30.0 cm $gM0=1.00$ $gM1=1.00$

$b=10.0 \text{ cm}$ $A_y=36.14 \text{ cm}^2$ $A_z=30.64 \text{ cm}^2$ $A_x=58.56 \text{ cm}^2$
 $tw=0.9 \text{ cm}$ $I_y=8170.18 \text{ cm}^4$ $I_z=562.07 \text{ cm}^4$ $I_x=38.46 \text{ cm}^4$
 $tf=1.6 \text{ cm}$ $W_{ely}=544.68 \text{ cm}^3$ $W_{elz}=79.88 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 19.93 \text{ kN}$ $M_{z,Ed} = -0.42 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.63 \text{ kN}$
 $N_{c,Rd} = 1376.13 \text{ kN}$ $M_{z,Ed,max} = -2.55 \text{ kN}\cdot\text{m}$ $V_{y,c,Rd} = 490.32 \text{ kN}$
 $N_{b,Rd} = 484.69 \text{ kN}$ $M_{z,c,Rd} = 18.77 \text{ kN}\cdot\text{m}$

Classe de la section = 3



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 4.050 \text{ m}$ $\lambda_{m,y} = 0.37$ $L_z = 4.050 \text{ m}$ $\lambda_{m,z} = 1.39$
 $L_{cr,y} = 4.050 \text{ m}$ $X_y = 0.92$ $L_{cr,z} = 4.050 \text{ m}$ $X_z = 0.35$
 $\lambda_{my} = 34.29$ $k_{yz} = 1.00$ $\lambda_{mz} = 130.72$ $k_{zz} = 0.98$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$M_{z,Ed}/M_{z,c,Rd} = 0.02 < 1.00 \quad (6.2.5.(1))$$

$$N_{Ed}/N_{c,Rd} + M_{z,Ed}/M_{z,c,Rd} = 0.04 < 1.00 \quad (6.2.1(7))$$

$$\sqrt{(\sigma_{x,Ed})^2 + 3(\tau_{y,Ed})^2}/(f_y/\gamma_{M0}) = 0.03 < 1.00 \quad (6.2.1.(5))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{m,y} = 34.29 < \lambda_{m,max} = 210.00 \quad \lambda_{m,z} = 130.72 < \lambda_{m,max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.15 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.17 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 0.3 \text{ cm} < v_{x \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 1 Poids propre

$$v_y = 0.0 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 15 Solives_15 **POINT:** 1 **COORDONNEE:** x = 0.50 L = 1.000 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.00 \text{ kN}$ $M_{y,Ed} = 0.74 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.00 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 186.28 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.63 \text{ kN}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 131.01 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\tau_{xy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\tau_{xz}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 16 POINT: 4 COORDONNEE: $x = 0.50 L = 1.000 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.00 \text{ kN}$ $M_{y,Ed} = 0.51 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.02 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3})gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3})gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:
PIECE: 17 **POINT:** 7 **COORDONNEE:** $x = 0.50 \text{ L} = 6.000 \text{ m}$
CHARGEMENTS:
Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$
MATERIAU:
ACIER E24 $f_y = 235.00 \text{ MPa}$

PARAMETRES DE LA SECTION: HEB 400
 $h=40.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=30.0 \text{ cm}$ $A_y=157.55 \text{ cm}^2$ $A_z=69.98 \text{ cm}^2$ $A_x=197.78 \text{ cm}^2$
 $t_w=1.4 \text{ cm}$ $I_y=57680.50 \text{ cm}^4$ $I_z=10819.00 \text{ cm}^4$ $I_x=357.00 \text{ cm}^4$
 $t_f=2.4 \text{ cm}$ $W_{ply}=3231.74 \text{ cm}^3$ $W_{plz}=1104.04 \text{ cm}^3$
EFFORTS INTERNES ET RESISTANCES ULTIMES:
 $N_{,Ed} = -2.08 \text{ kN}$ $M_{y,Ed} = 103.77 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.22 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.03 \text{ kN}$
 $N_{t,Rd} = 4647.83 \text{ kN}$ $M_{y,pl,Rd} = 759.46 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 259.45 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 2136.34 \text{ kN}$
 $M_{y,c,Rd} = 759.46 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 259.45 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = 1.96 \text{ kN}$
 $MN_{,y,Rd} = 759.46 \text{ kN}\cdot\text{m}$ $MN_{,z,Rd} = 259.45 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 949.16 \text{ kN}$
 $Mb,Rd = 759.46 \text{ kN}\cdot\text{m}$ $Tt,Ed = -0.03 \text{ kN}\cdot\text{m}$

Classe de la section = 1


PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 43404.77 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 1.00$
 $L_{cr,upp}=1.000 \text{ m}$ $\lambda_{m_LT} = 0.13$ $f_{t,LT} = 0.48$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:

 en y:  en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))
 $M_{y,Ed}/M_{N,y,Rd} = 0.14 < 1.00$ (6.2.9.1.(2))
 $M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))
 $(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.02 < 1.00$ (6.2.9.1.(6))
 $V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)
 $V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)
 $\tau_{ty,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00$ (6.2.6)
 $\tau_{tz,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00$ (6.2.6)

Contrôle de la stabilité globale de la barre:

$M_{y,Ed}/M_{b,Rd} = 0.14 < 1.00$ (6.3.2.1.(1))

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 6.0 \text{ cm}$ Vérifié

Cas de charge décisif: 2 Surcharge plancher

$u_z = 0.9 \text{ cm} < u_{z \text{ max}} = L/200.00 = 6.0 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 18 Poteaux_14 **POINT:** 7 **COORDONNEE:** x = 1.00 L = 4.050 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: UAP 300

h=30.0 cm $g_{M0}=1.00$ $g_{M1}=1.00$

b=10.0 cm $A_y=36.14$ cm² $A_z=30.64$ cm² $A_x=58.56$ cm²

tw=0.9 cm $I_y=8170.18$ cm⁴ $I_z=562.07$ cm⁴ $I_x=38.46$ cm⁴

tf=1.6 cm $W_{ely}=544.68$ cm³ $W_{elz}=79.88$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 36.24 \text{ kN}$ $M_{y,Ed} = -2.38 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 1.01 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.89 \text{ kN}$
 $N_{c,Rd} = 1376.13 \text{ kN}$ $M_{y,Ed,max} = -2.38 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -2.59 \text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 489.94 \text{ kN}$
 $N_{b,Rd} = 484.69 \text{ kN}$ $M_{y,c,Rd} = 128.00 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 18.77 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.61 \text{ kN}$
 $V_{z,T,Rd} = 415.51 \text{ kN}$
 $M_{b,Rd} = 87.69 \text{ kN}\cdot\text{m}$ $T_{t,Ed} = 0.01 \text{ kN}\cdot\text{m}$
 Classe de la section = 3



PARAMETRES DE DEVERSEMENT:

$z = 0.00$ $M_{cr} = 315.59 \text{ kN}\cdot\text{m}$ Courbe,LT - dXLT = 0.69
 $L_{cr,low} = 4.050 \text{ m}$ $\lambda_{m,LT} = 0.64$ $f_{l,LT} = 0.87$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 4.050 \text{ m}$ $\lambda_{m,y} = 0.37$ $L_z = 4.050 \text{ m}$ $\lambda_{m,z} = 1.39$
 $L_{cr,y} = 4.050 \text{ m}$ $X_y = 0.92$ $L_{cr,z} = 4.050 \text{ m}$ $X_z = 0.35$
 $\lambda_{m,y} = 34.29$ $k_{zy} = 0.99$ $\lambda_{m,z} = 130.72$ $k_{zz} = 0.97$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} + M_{y,Ed}/M_{y,c,Rd} + M_{z,Ed}/M_{z,c,Rd} = 0.07 < 1.00$ (6.2.1(7))

$\sqrt{\text{Sig}_{x,Ed}^2 + 3 \cdot (\text{Tau}_{ty,Ed})^2} / (f_y / g_{M0}) = 0.07 < 1.00$ (6.2.1.(5))

$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$\text{Tau}_{ty,Ed} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00$ (6.2.6)

$\text{Tau}_{tz,Ed} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00$ (6.2.6)

Contrôle de la stabilité globale de la barre:

$\Lambda_{y,y} = 34.29 < \Lambda_{y,max} = 210.00$ $\Lambda_{y,z} = 130.72 < \Lambda_{y,max} = 210.00$ STABLE

$M_{y,Ed,max}/M_{b,Rd} = 0.03 < 1.00$ (6.3.2.1.(1))

$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.19 < 1.00$ (6.3.3.(4))

$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.24 < 1.00$ (6.3.3.(4))

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$v_x = 0.1 \text{ cm} < v_{x,max} = L/150.00 = 2.7 \text{ cm}$ Vérifié

Cas de charge décisif: 2 Surcharge plancher

$v_y = 0.0 \text{ cm} < v_{y,max} = L/150.00 = 2.7 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 19 **POINT:** 1 **COORDONNEE:** $x = 0.47 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 400

$h=40.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=18.0 \text{ cm}$ $A_y=55.99 \text{ cm}^2$ $A_z=42.69 \text{ cm}^2$ $A_x=84.46 \text{ cm}^2$

$t_w=0.9 \text{ cm}$ $I_y=23128.40 \text{ cm}^4$ $I_z=1317.82 \text{ cm}^4$ $I_x=51.33 \text{ cm}^4$

$t_f=1.4 \text{ cm}$ $W_{ply}=1307.15 \text{ cm}^3$ $W_{plz}=229.00 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -4.28 \text{ kN}$ $M_{y,Ed} = 11.59 \text{ kN*m}$ $M_{z,Ed} = -1.66 \text{ kN*m}$ $V_{y,Ed} = -1.18 \text{ kN}$

$N_{t,Rd} = 1984.81 \text{ kN}$ $M_{y,pl,Rd} = 307.18 \text{ kN*m}$ $M_{z,pl,Rd} = 53.82 \text{ kN*m}$
 $V_{y,c,Rd} = 759.71 \text{ kN}$

$M_{y,c,Rd} = 307.18 \text{ kN*m}$ $M_{z,c,Rd} = 53.82 \text{ kN*m}$ $V_{z,Ed} = -6.74 \text{ kN}$

$MN_{y,Rd} = 307.18 \text{ kN*m}$ $MN_{z,Rd} = 53.82 \text{ kN*m}$ $V_{z,c,Rd} = 579.22 \text{ kN}$

$Mb,Rd = 304.88 \text{ kN*m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 2995.87 \text{ kN*m}$ Courbe,LT - $X_{LT} = 0.97$

$L_{cr,upp}=1.700 \text{ m}$ $\lambda_{m_LT} = 0.32$ $f_{i,LT} = 0.57$ $X_{LT,mod} = 0.99$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.03 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.01 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$M_{y,Ed}/M_{b,Rd} = 0.04 < 1.00 \quad (6.3.2.1.(1))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 20 Solives_20 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.07 \text{ kN}$ $M_{y,Ed} = 1.40 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$MN_{,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 21 Poteaux U_21 **POINT:** 7 **COORDONNEE:** $x = 1.00$ $L = 4.050$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \text{ (1+2)} \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: UAP 300

$h = 30.0$ cm $gM0 = 1.00$ $gM1 = 1.00$

$b = 10.0$ cm $A_y = 36.14$ cm² $A_z = 30.64$ cm² $A_x = 58.56$ cm²

$t_w = 0.9$ cm $I_y = 8170.18$ cm⁴ $I_z = 562.07$ cm⁴ $I_x = 38.46$ cm⁴

$t_f = 1.6$ cm $W_{ply} = 639.34$ cm³ $W_{plz} = 144.83$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 67.20$ kN

$N_{c,Rd} = 1376.13$ kN

$N_{b,Rd} = 484.69 \text{ kN}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 4.050 \text{ m}$ $\lambda_{m,y} = 0.37$ $L_z = 4.050 \text{ m}$ $\lambda_{m,z} = 1.39$

$L_{cr,y} = 4.050 \text{ m}$ $X_y = 0.92$ $L_{cr,z} = 4.050 \text{ m}$ $X_z = 0.35$

$\lambda_{m,y} = 34.29$ $\lambda_{m,z} = 130.72$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.05 < 1.00$ (6.2.4.(1))

Contrôle de la stabilité globale de la barre:

$\lambda_{m,y} = 34.29 < \lambda_{m,max} = 210.00$ $\lambda_{m,z} = 130.72 < \lambda_{m,max} = 210.00$ STABLE

$N_{Ed}/N_{b,Rd} = 0.14 < 1.00$ (6.3.1.1.(1))

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$v_x = 0.3 \text{ cm} < v_{x,max} = L/150.00 = 2.7 \text{ cm}$ Vérifié

Cas de charge décisif: 1 Poids propre

$v_y = 0.3 \text{ cm} < v_{y,max} = L/150.00 = 2.7 \text{ cm}$ Vérifié

Cas de charge décisif: 2 Surcharge plancher

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 25 **POINT:** 4 **COORDONNEE:** $x = 0.50$ $L = 1.735$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h=16.0$ cm $gM0=1.00$ $gM1=1.00$

$b=8.2$ cm $A_y=13.73$ cm² $A_z=9.66$ cm² $A_x=20.09$ cm²

$t_w=0.5$ cm $I_y=869.29$ cm⁴ $I_z=68.31$ cm⁴ $I_x=3.62$ cm⁴

$t_f=0.7$ cm $W_{ply}=123.86$ cm³ $W_{plz}=26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = -0.08 \text{ kN} \quad M_{y,Ed} = 1.56 \text{ kN}\cdot\text{m}$$

$$N_{t,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$V_{z,Ed} = 0.01 \text{ kN}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$V_{z,T,Rd} = 130.98 \text{ kN}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(\sigma_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(\sigma_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 32 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = 0.02 \text{ kN} \quad M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$$

$$N_{c,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{y,t,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{y,tz,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.7 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 33 Poutres_33 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.225 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.00 \text{ kN}$ $M_{y,Ed} = 0.77 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$N_{,Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.03 < 1.00$ (6.2.5.(1))

$\tau_{y,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00$ (6.2.6)

$\tau_{z,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES


Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

Déplacements (REPERE GLOBAL): Non analysé
Profil correct !!!
CALCUL DES STRUCTURES ACIER
NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:
PIECE: 34 **POINT:** 4 **COORDONNEE:** $x = 0.50 \text{ L} = 1.735 \text{ m}$
CHARGEMENTS:
Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:
ACIER E24 $f_y = 235.00 \text{ MPa}$

PARAMETRES DE LA SECTION: IPE 160

h=16.0 cm gM0=1.00 gM1=1.00

b=8.2 cm Ay=13.73 cm² Az=9.66 cm² Ax=20.09 cm²

tw=0.5 cm Iy=869.29 cm⁴ Iz=68.31 cm⁴ Ix=3.62 cm⁴

tf=0.7 cm Wply=123.86 cm³ Wplz=26.10 cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

N_{Ed} = 0.02 kN M_{y,Ed} = 1.55 kN*m

N_{c,Rd} = 472.12 kN M_{y,pl,Rd} = 29.11 kN*m

N_{b,Rd} = 472.12 kN M_{y,c,Rd} = 29.11 kN*m

M_{N,y,Rd} = 29.11 kN*m

T_{t,Ed} = 0.00 kN*m

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

N_{Ed}/N_{c,Rd} = 0.00 < 1.00 (6.2.4.(1))

M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 (6.2.5.(1))

Tau_{ty,Ed}/(f_y/(sqrt(3)*gM0)) = 0.00 < 1.00 (6.2.6)

Tau_{tz,Ed}/(f_y/(sqrt(3)*gM0)) = 0.00 < 1.00 (6.2.6)

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 35 Solives_35 **POINT:** 6 **COORDONNEE:** x = 0.56 L = 2.042 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.02\text{ kN}$ $M_{y,Ed} = 2.18\text{ kN}\cdot\text{m}$ $M_{z,Ed} = 0.00\text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.00\text{ kN}$

$N_{c,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 186.27\text{ kN}$

$N_{b,Rd} = 472.12\text{ kN}$ $M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{z,Ed} = 0.01\text{ kN}$

$MN_{y,Rd} = 29.11\text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 131.00\text{ kN}$

$T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.08 < 1.00$ (6.2.9.1.(2))

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3})\sigma_{y,Rd}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3})\sigma_{x,Rd}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 36 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.735 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.01 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{u,ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{u,tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 37 Solives_37 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.825 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.00 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3})\sigma_{y,Rd}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3})\sigma_{x,Rd}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 1 Poids propre

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:
PIECE: 38 **POINT:** 4 **COORDONNEE:** $x = 0.50 \text{ L} = 1.735 \text{ m}$
CHARGEMENTS:
Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$
MATERIAU:
ACIER E24 $f_y = 235.00 \text{ MPa}$

PARAMETRES DE LA SECTION: IPE 160
 $h=16.0 \text{ cm}$ $g_{M0}=1.00$ $g_{M1}=1.00$
 $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$
 $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$
 $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$
EFFORTS INTERNES ET RESISTANCES ULTIMES:
 $N_{,Ed} = -0.02 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN*m}$
 $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN*m}$
 $M_{y,c,Rd} = 29.11 \text{ kN*m}$
 $M_{N,y,Rd} = 29.11 \text{ kN*m}$
 $T_{t,Ed} = 0.00 \text{ kN*m}$

Classe de la section = 1


PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{y,tz,Ed}/(f_y/(\sqrt{3})gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{y,tz,Ed}/(f_y/(\sqrt{3})gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 39 Solives_39 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.02 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{y,Ed}/(\tau_{y,Rd}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{z,Ed}/(\tau_{z,Rd}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 40 Solives_40 **POINT:** 4 **COORDONNEE:** $x = 0.50$ $L = 1.500$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \text{ (1+2)} \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0$ cm $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2$ cm $A_y = 13.73$ cm² $A_z = 9.66$ cm² $A_x = 20.09$ cm²

$t_w = 0.5$ cm $I_y = 869.29$ cm⁴ $I_z = 68.31$ cm⁴ $I_x = 3.62$ cm⁴

$t_f = 0.7$ cm $W_{ply} = 123.86$ cm³ $W_{plz} = 26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.04$ kN $M_{y,Ed} = 1.16$ kN*m

$N_{c,Rd} = 472.12$ kN $M_{y,pl,Rd} = 29.11$ kN*m

$N_{b,Rd} = 472.12$ kN $M_{y,c,Rd} = 29.11$ kN*m

$M_{N,y,Rd} = 29.11$ kN*m

$T_{t,Ed} = 0.00$ kN*m

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 41 Solives_41 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.00 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$MN_{,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3}) \cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3}) \cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 42 Solives_42 POINT: 4 COORDONNEE: $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.00 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 43 Solives_43 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \text{ (1+2)} \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.00 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 44 **POINT:** 4 **COORDONNEE:** $x = 0.50$ $L = 1.735$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h=16.0$ cm $gM0=1.00$ $gM1=1.00$

$b=8.2$ cm $A_y=13.73$ cm² $A_z=9.66$ cm² $A_x=20.09$ cm²

$t_w=0.5$ cm $I_y=869.29$ cm⁴ $I_z=68.31$ cm⁴ $I_x=3.62$ cm⁴

$t_f=0.7$ cm $W_{ply}=123.86$ cm³ $W_{plz}=26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = -0.10 \text{ kN} \quad M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$$

$$N_{t,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 45 Solives_45 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = -0.45 \text{ kN} \quad M_{y,Ed} = 1.16 \text{ kN}\cdot\text{m}$$

$$N_{t,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

en y:



en z:

PARAMETRES DE FLAMBEMENT:**FORMULES DE VERIFICATION:****Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{y,t,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{z,t,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$uz = 0.0 \text{ cm} < uz_{\text{max}} = L/200.00 = 1.5 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 46 Solives_46 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.99 \text{ kN}$ $M_{y,Ed} = 1.15 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.00 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 130.99 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:



en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00$ (6.2.5.(1))

$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$\tau_{y,Ed}/(\tau_{fy}/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00$ (6.2.6)

$\tau_{z,Ed}/(\tau_{fy}/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 47 Solives_47 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.219 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$$h=16.0 \text{ cm} \quad gM0=1.00 \quad gM1=1.00$$

$$b=8.2 \text{ cm} \quad A_y=13.73 \text{ cm}^2 \quad A_z=9.66 \text{ cm}^2 \quad A_x=20.09 \text{ cm}^2$$

$$t_w=0.5 \text{ cm} \quad I_y=869.29 \text{ cm}^4 \quad I_z=68.31 \text{ cm}^4 \quad I_x=3.62 \text{ cm}^4$$

$$t_f=0.7 \text{ cm} \quad W_{ply}=123.86 \text{ cm}^3 \quad W_{plz}=26.10 \text{ cm}^3$$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = 2.15 \text{ kN} \quad M_{y,Ed} = 0.70 \text{ kN}\cdot\text{m}$$

$$N_{c,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad V_{z,Ed} = -0.04 \text{ kN}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad V_{z,T,Rd} = 130.74 \text{ kN}$$

$$T_{t,Ed} = -0.01 \text{ kN}\cdot\text{m}$$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:

en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.02 < 1.00 \quad (6.2.5.(1))$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(\tau_{fy}/(\sqrt{3}\cdot gM0)) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(\tau_{fy}/(\sqrt{3}\cdot gM0)) = 0.01 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.2 \text{ cm}$ Vérifié

Cas de charge décisif: 2 Surcharge plancher

$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.2 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 48 Solives_48 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160** $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$ $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$ $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = -0.05 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN}\cdot\text{m}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:** $N_{,Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1)) $M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00$ (6.2.5.(1))

$$\tau_{xy}, \tau_{yz}, \tau_{zx} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xy}, \tau_{yz}, \tau_{zx} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 49 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.735 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$ $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$ $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{Ed} = -0.02 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:*Contrôle de la résistance de la section:*

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 50 Solives_50 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.825 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.07 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN}^*\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}^*\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}^*\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}^*\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}^*\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:



en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 51 Solives_51 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.550 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -3.45 \text{ kN}$ $M_{y,Ed} = 1.24 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$V_{z,Ed} = -0.01 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$V_{z,T,Rd} = 130.98 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{a,ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{a,tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:

PIECE: 52 Solives_52 POINT: 1 COORDONNEE: $x = 0.50 L = 1.750 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 1.56 \text{ kN}$ $M_{y,Ed} = 2.39 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.11 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.06 \text{ kN}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 185.90 \text{ kN}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.11 \text{ kN}$

$MN_{,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 130.83 \text{ kN}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.08 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.02 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3})\cdot gM0) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3})\cdot gM0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 53 Solives_53 POINT: 4 COORDONNEE: $x = 0.50 L = 1.550 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 3.49 \text{ kN}$ $M_{y,Ed} = 1.24 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.01 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 55 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.550 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.29 \text{ kN}$ $M_{y,Ed} = 1.24 \text{ kN}\cdot\text{m}$

$$N_{c,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1=1}\cdot 1.15 + 2\cdot 1.00 \quad (1+2)\cdot 1.00$$

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1=1}\cdot 1.15 + 2\cdot 1.00 \quad (1+2)\cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 56 **POINT:** 7 **COORDONNEE:** $x = 0.50$ $L = 1.750$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h=16.0$ cm $gM0=1.00$ $gM1=1.00$

$b=8.2$ cm $A_y=13.73$ cm² $A_z=9.66$ cm² $A_x=20.09$ cm²

$t_w=0.5$ cm $I_y=869.29$ cm⁴ $I_z=68.31$ cm⁴ $I_x=3.62$ cm⁴

$t_f=0.7$ cm $W_{ply}=123.86$ cm³ $W_{plz}=26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = 0.82 \text{ kN} \quad M_{y,Ed} = 2.39 \text{ kN}\cdot\text{m} \quad M_{z,Ed} = 0.11 \text{ kN}\cdot\text{m} \quad V_{y,Ed} = -0.06 \text{ kN}$$

$$N_{c,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m} \quad V_{y,T,Rd} = 185.90 \text{ kN}$$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m} \quad V_{z,Ed} = 0.11 \text{ kN}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m} \quad V_{z,T,Rd} = 130.83 \text{ kN}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.08 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.02 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 57 Solives_57 **POINT:** 4 **COORDONNEE:** $x = 0.50 \quad L = 1.550 \text{ m}$

CHARGEMENTS:

$$\text{Cas de charge décisif: } 3 \text{ ELU/1} = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -3.95 \text{ kN}$ $M_{y,Ed} = 1.04 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{t,Rd} = 0.01 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00$ (6.2.5.(1))

$\tau_{y,Ed}/(f_y/(\sqrt{3})gM0) = 0.00 < 1.00$ (6.2.6)

$\tau_{z,Ed}/(f_y/(\sqrt{3})gM0) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 59 **POINT:** 7 **COORDONNEE:** $x = 0.44 L = 1.350 \text{ m}$

CHARGEMENTS:**Cas de charge décisif:** 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:**ACIER E24** $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 200

$h=19.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=20.0 \text{ cm}$ $A_y=45.12 \text{ cm}^2$ $A_z=18.08 \text{ cm}^2$ $A_x=53.83 \text{ cm}^2$
 $t_w=0.7 \text{ cm}$ $I_y=3692.16 \text{ cm}^4$ $I_z=1335.51 \text{ cm}^4$ $I_x=21.09 \text{ cm}^4$
 $t_f=1.0 \text{ cm}$ $W_{ply}=429.48 \text{ cm}^3$ $W_{plz}=203.82 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 7.78 \text{ kN}$ $M_{y,Ed} = -24.47 \text{ kN}^*\text{m}$ $M_{z,Ed} = 0.10 \text{ kN}^*\text{m}$ $V_{y,Ed} = -0.07 \text{ kN}$
 $N_{c,Rd} = 1265.01 \text{ kN}$ $M_{y,Ed,max} = -24.47 \text{ kN}^*\text{m}$ $M_{z,Ed,max} = 0.10 \text{ kN}^*\text{m}$
 $V_{y,T,Rd} = 611.75 \text{ kN}$
 $N_{b,Rd} = 945.75 \text{ kN}$ $M_{y,c,Rd} = 100.93 \text{ kN}^*\text{m}$ $M_{z,c,Rd} = 47.90 \text{ kN}^*\text{m}$ $V_{z,Ed} = -18.79 \text{ kN}$
 $M_{N,y,Rd} = 100.93 \text{ kN}^*\text{m}$ $M_{N,z,Rd} = 47.90 \text{ kN}^*\text{m}$ $V_{z,T,Rd} = 245.19 \text{ kN}$
 $M_{b,Rd} = 100.93 \text{ kN}^*\text{m}$ $T_{t,Ed} = -0.01 \text{ kN}^*\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 2391.05 \text{ kN}^*\text{m}$ Courbe,LT - $X_{LT} = 1.00$
 $L_{cr,low}=1.350 \text{ m}$ $L_{am_LT} = 0.21$ $f_{t,LT} = 0.50$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 3.100 \text{ m}$ $L_{am_y} = 0.40$ $L_z = 3.100 \text{ m}$ $L_{am_z} = 0.66$
 $L_{cr,y} = 3.100 \text{ m}$ $X_y = 0.93$ $L_{cr,z} = 3.100 \text{ m}$ $X_z = 0.75$
 $L_{am_y} = 37.43$ $k_{yy} = 1.00$ $L_{am_z} = 62.24$ $k_{yz} = 0.70$

flambement par torsion:

flambement en flexion-torsion

Courbe,T=c alfa,T=0.49 Courbe,TF=c alfa,TF=0.49

Lt=1.350 m fi,T=0.56 Ncr,y=7962.99 kN fi,TF=0.63

Ncr,T=14995.50 kN X,T=0.95 Ncr,TF=7962.99 kN X,TF=0.90

Lam_T=0.29 Nb,T,Rd=1206.84 kN Lam_TF=0.40 Nb,TF,Rd=1136.07 kN

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.01 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.24 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.06 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.08 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 37.43 < \lambda_{max} = 210.00 \quad \lambda_{z} = 62.24 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.01 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.24 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/g_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.25 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/g_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.14 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$u_z = 0.2 \text{ cm} < u_z \text{ max} = L/200.00 = 1.6 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 61 Solives_61 **POINT:** 2 **COORDONNEE:** $x = 0.46 L = 1.433 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.24 \text{ kN}$ $M_{y,Ed} = 1.59 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$V_{z,Ed} = -0.09 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$V_{z,T,Rd} = 131.01 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00$ (6.2.5.(1))

$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$\tau_{Ed}/(\tau_{fy}/(\sqrt{3})gM0)) = 0.00 < 1.00$ (6.2.6)

$\tau_{Ed}/(\tau_{fy}/(\sqrt{3})gM0)) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 62 Solives_62 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.750 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.26\text{ kN}$ $M_{y,Ed} = 1.58\text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$

$M_{N,y,Rd} = 29.11\text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$N_{,Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00$ (6.2.5.(1))

$\tau_{y,Ed}/(f_y/(\sqrt{3})gM0) = 0.01 < 1.00$ (6.2.6)

$\tau_{z,Ed}/(f_y/(\sqrt{3})gM0) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 64 Solives_64 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.750 m

CHARGEMENTS:**Cas de charge décisif:** 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:**ACIER E24** $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.18\text{ kN}$ $M_{y,Ed} = 1.58\text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12\text{ kN}$ $M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$

$MN_{,y,Rd} = 29.11\text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00$ (6.2.5.(1))

$\tau_{u,ty,Ed}/(f_y/(\sqrt{3})\cdot gM0) = 0.01 < 1.00$ (6.2.6)

$\tau_{u,tz,Ed}/(f_y/(\sqrt{3})\cdot gM0) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 65 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$$h=16.0 \text{ cm} \quad gM0=1.00 \quad gM1=1.00$$

$$b=8.2 \text{ cm} \quad A_y=13.73 \text{ cm}^2 \quad A_z=9.66 \text{ cm}^2 \quad A_x=20.09 \text{ cm}^2$$

$$t_w=0.5 \text{ cm} \quad I_y=869.29 \text{ cm}^4 \quad I_z=68.31 \text{ cm}^4 \quad I_x=3.62 \text{ cm}^4$$

$$t_f=0.7 \text{ cm} \quad W_{ply}=123.86 \text{ cm}^3 \quad W_{plz}=26.10 \text{ cm}^3$$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{,Ed} = 0.90 \text{ kN} \quad M_{y,Ed} = 1.55 \text{ kN}^*\text{m}$$

$$N_{c,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}^*\text{m}$$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}^*\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}^*\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}^*\text{m}$$

$$\text{Classe de la section} = 1$$



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{,Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy}, \tau_{yz}, E_d / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xy}, \tau_{yz}, E_d / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 67 Poteau HEA 200_67 **POINT:** 2 **COORDONNEE:** x = 0.11 L = 0.450 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: HEA 200** $h=19.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=20.0 \text{ cm}$ $A_y=45.12 \text{ cm}^2$ $A_z=18.08 \text{ cm}^2$ $A_x=53.83 \text{ cm}^2$ $t_w=0.7 \text{ cm}$ $I_y=3692.16 \text{ cm}^4$ $I_z=1335.51 \text{ cm}^4$ $I_x=21.09 \text{ cm}^4$ $t_f=1.0 \text{ cm}$ $W_{ply}=429.48 \text{ cm}^3$ $W_{plz}=203.82 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{Ed} = 60.49 \text{ kN}$ $M_{y,Ed} = 3.04 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.13 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.29 \text{ kN}$ $N_{c,Rd} = 1265.01 \text{ kN}$ $M_{y,Ed,max} = 18.21 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -0.78 \text{ kN}\cdot\text{m}$
 $V_{y,c,Rd} = 612.18 \text{ kN}$ $N_{b,Rd} = 785.54 \text{ kN}$ $M_{y,c,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = 6.75 \text{ kN}$ $MN_{y,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,c,Rd} = 245.30 \text{ kN}$ $Mb_{Rd} = 89.93 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:** $z = 0.00$ $M_{cr} = 256.53 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 0.87$ $L_{cr,upp}=4.050 \text{ m}$ $\lambda_{m_LT} = 0.63$ $f_{i,LT} = 0.75$ $X_{LT,mod} = 0.89$ **PARAMETRES DE FLAMBEMENT:**

en y:



en z:

 $L_y = 4.050 \text{ m}$ $\lambda_{m_y} = 0.36$ $L_z = 4.050 \text{ m}$ $\lambda_{m_z} = 0.87$

$$\begin{aligned} L_{cr,y} &= 2.835 \text{ m} & X_y &= 0.94 & L_{cr,z} &= 4.050 \text{ m} & X_z &= 0.62 \\ L_{amy} &= 34.23 & k_{yy} &= 1.03 & L_{amz} &= 81.31 & k_{yz} &= 0.77 \end{aligned}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.05 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.03 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 34.23 < \lambda_{max} = 210.00 \quad \lambda_{z} = 81.31 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.20 < 1.00 \quad (6.3.2.1.(1))$$

$$\frac{N_{Ed}/(X_y \cdot N_{Rk}/gM1)}{k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1)} + \frac{k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1)}{k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1)} = 0.27 < 1.00 \quad (6.3.3.(4))$$

$$\frac{N_{Ed}/(X_z \cdot N_{Rk}/gM1)}{k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1)} + \frac{k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1)}{k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1)} = 0.20 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 0.6 \text{ cm} < v_{x,max} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$v_y = 0.0 \text{ cm} < v_{y,max} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 69 Solives_69 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.41 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN}\cdot\text{m}$

$$N_{c,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 73 **POINT:** 7 **COORDONNEE:** $x = 1.00$ $L = 8.230$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: HEA 240

$h=23.0$ cm $gM0=1.00$ $gM1=1.00$

$b=24.0$ cm $A_y=64.54$ cm² $A_z=25.18$ cm² $A_x=76.84$ cm²

$t_w=0.8$ cm $I_y=7763.18$ cm⁴ $I_z=2768.81$ cm⁴ $I_x=41.74$ cm⁴

$t_f=1.2$ cm $W_{ply}=744.62$ cm³ $W_{plz}=351.69$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.07 \text{ kN}$ $M_{y,Ed} = -1.36 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -4.52 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 2.29 \text{ kN}$

$N_{c,Rd} = 1805.74 \text{ kN}$ $M_{y,Ed,max} = -14.81 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -4.52 \text{ kN}\cdot\text{m}$
 $V_{y,c,Rd} = 875.66 \text{ kN}$

$N_{b,Rd} = 592.08 \text{ kN}$ $M_{y,c,Rd} = 174.99 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 82.65 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -1.78 \text{ kN}$

$MN_{y,Rd} = 174.99 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 82.65 \text{ kN}\cdot\text{m}$ $V_{z,c,Rd} = 341.64 \text{ kN}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 8.230 \text{ m}$ $Lam_y = 0.87$ $L_z = 8.230 \text{ m}$ $Lam_z = 1.46$

$L_{cr,y} = 8.230 \text{ m}$ $X_y = 0.68$ $L_{cr,z} = 8.230 \text{ m}$ $X_z = 0.33$

$Lam_y = 81.88$ $k_{yy} = 1.00$ $Lam_z = 137.10$ $k_{yz} = 0.70$

flambement par torsion: flambement en flexion-torsion

Courbe,T=c $\alpha_{T,T}=0.49$ Courbe,TF=c $\alpha_{T,TF}=0.49$

$L_t=8.230 \text{ m}$ $f_{t,T}=0.92$ $N_{cr,y}=2375.52 \text{ kN}$ $f_{t,TF}=1.04$

$N_{cr,T}=3194.08 \text{ kN}$ $X_{T,T}=0.69$ $N_{cr,TF}=2375.52 \text{ kN}$ $X_{T,TF}=0.62$

$Lam_T=0.75$ $N_{b,T,Rd}=1250.21 \text{ kN}$ $Lam_{TF}=0.87$ $N_{b,TF,Rd}=1114.53 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.01 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.05 < 1.00$ (6.2.9.1.(2))

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.05 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.01 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 81.88 < \lambda_{max} = 210.00 \quad \lambda_{z} = 137.10 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{t,Rd}, N_{TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$N_{Ed}/(X_y \cdot N_{Rk}/\gamma_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/\gamma_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/\gamma_{M1}) = 0.12 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/\gamma_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/\gamma_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/\gamma_{M1}) = 0.10 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.1 \text{ cm} < u_{y,max} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.3 \text{ cm} < u_{z,max} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 76 Solives_76 **POINT:** 4 **COORDONNEE:** $x = 0.50 \text{ L} = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$


PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $g_{M0}=1.00$ $g_{M1}=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.38 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1


PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3}) \cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3}) \cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 78 Solives_78 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \text{ (1+2)} \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.62 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{y,Ed}/(\tau_{y,Rd}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{z,Ed}/(\tau_{z,Rd}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 80 Solives_80 **POINT:** 4 **COORDONNEE:** $x = 0.50$ $L = 1.825$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h=16.0$ cm $gM0=1.00$ $gM1=1.00$

$b=8.2$ cm $A_y=13.73$ cm² $A_z=9.66$ cm² $A_x=20.09$ cm²

$t_w=0.5$ cm $I_y=869.29$ cm⁴ $I_z=68.31$ cm⁴ $I_x=3.62$ cm⁴

$t_f=0.7$ cm $W_{ply}=123.86$ cm³ $W_{plz}=26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -1.14$ kN $M_{y,Ed} = 1.71$ kN*m

$N_{t,Rd} = 472.12$ kN $M_{y,pl,Rd} = 29.11$ kN*m

$M_{y,c,Rd} = 29.11$ kN*m

$M_{N,y,Rd} = 29.11$ kN*m

$T_{t,Ed} = 0.00$ kN*m

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{y,Ed}/(\tau_{y,Rd}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{z,Ed}/(\tau_{z,Rd}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 97 Poteau HEA 200_97 **POINT:** 6 **COORDONNEE:** $x = 0.89 L = 3.600$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: HEA 200

$h = 19.0$ cm $gM0 = 1.00$ $gM1 = 1.00$

$b = 20.0$ cm $A_y = 45.12$ cm² $A_z = 18.08$ cm² $A_x = 53.83$ cm²

$t_w = 0.7$ cm $I_y = 3692.16$ cm⁴ $I_z = 1335.51$ cm⁴ $I_x = 21.09$ cm⁴

$t_f = 1.0$ cm $W_{ply} = 429.48$ cm³ $W_{plz} = 203.82$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 78.43$ kN $M_{y,Ed} = -1.11$ kN*m $M_{z,Ed} = -0.05$ kN*m $V_{y,Ed} = -0.10$ kN

$N_{c,Rd} = 1265.01$ kN $M_{y,Ed,max} = -6.65$ kN*m $M_{z,Ed,max} = -0.46$ kN*m
 $V_{y,c,Rd} = 612.18$ kN

$N_{b,Rd} = 785.54$ kN $M_{y,c,Rd} = 100.93$ kN*m $M_{z,c,Rd} = 47.90$ kN*m $V_{z,Ed} = 2.46$ kN

$MN_{y,Rd} = 100.93$ kN*m $MN_{z,Rd} = 47.90$ kN*m $V_{z,c,Rd} = 245.30$ kN

$$M_{b,Rd} = 96.35 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$$z = 0.00 \quad M_{cr} = 404.33 \text{ kN}\cdot\text{m} \text{ Courbe,LT} - \quad X_{LT} = 0.92$$

$$L_{cr,low} = 4.050 \text{ m} \quad \lambda_{m,LT} = 0.50 \quad f_{i,LT} = 0.66 \quad X_{LT,mod} = 0.95$$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 4.050 \text{ m} \quad \lambda_{m,y} = 0.36 \quad L_z = 4.050 \text{ m} \quad \lambda_{m,z} = 0.87$$

$$L_{cr,y} = 2.835 \text{ m} \quad X_y = 0.94 \quad L_{cr,z} = 4.050 \text{ m} \quad X_z = 0.62$$

$$\lambda_{m,y} = 34.23 \quad k_{zy} = 0.54 \quad \lambda_{m,z} = 81.31 \quad k_{zz} = 1.00$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.06 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.01 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.01 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{m,y} = 34.23 < \lambda_{m,max} = 210.00 \quad \lambda_{m,z} = 81.31 < \lambda_{m,max} = 210.00 \quad \text{STABLE}$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.07 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.14 < 1.00 \quad (6.3.3.(4))$$

$$\frac{N_{Ed}}{(X_z \cdot N_{Rk/gM1})} + \frac{k_{zy} \cdot M_{y,Ed,max}}{(X_{LT} \cdot M_{y,Rk/gM1})} + \frac{k_{zz} \cdot M_{z,Ed,max}}{(M_{z,Rk/gM1})} = 0.15 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 0.1 \text{ cm} < v_{x \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$v_y = 0.6 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 188 Solives_188 **POINT:** 1 **COORDONNEE:** x = 0.35 L = 1.100 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$ $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$ $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = 0.13 \text{ kN}$ $M_{y,Ed} = 1.22 \text{ kN}\cdot\text{m}$ $N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = 0.02 \text{ kN}$ $M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 131.01 \text{ kN}$ $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:** $N_{,Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 189 Solives_189 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.750 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$ $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$ $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = 0.03 \text{ kN}$ $M_{y,Ed} = 0.96 \text{ kN}^*\text{m}$ $N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}^*\text{m}$ $N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}^*\text{m}$ $M_{N,y,Rd} = 29.11 \text{ kN}^*\text{m}$ $T_{t,Ed} = 0.00 \text{ kN}^*\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.03 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 237 Solives_237 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.500 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $g_{M0}=1.00$ $g_{M1}=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.04 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{u,ty,Ed}/(f_y/(\sqrt{3} \cdot gM0)) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{u,tz,Ed}/(f_y/(\sqrt{3} \cdot gM0)) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 241 Poutres_241 **POINT:** 7 **COORDONNEE:** x = 0.56 L = 4.600 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: HEB 280**

$h=28.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=28.0 \text{ cm}$ $A_y=110.78 \text{ cm}^2$ $A_z=41.09 \text{ cm}^2$ $A_x=131.36 \text{ cm}^2$

$t_w=1.1 \text{ cm}$ $I_y=19270.30 \text{ cm}^4$ $I_z=6594.52 \text{ cm}^4$ $I_x=144.25 \text{ cm}^4$

$t_f=1.8 \text{ cm}$ $W_{ply}=1534.43 \text{ cm}^3$ $W_{plz}=717.57 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.23 \text{ kN}$ $M_{y,Ed} = -30.72 \text{ kN*m}$ $M_{z,Ed} = -0.21 \text{ kN*m}$ $V_{y,Ed} = 1.50 \text{ kN}$

$N_{c,Rd} = 3086.96 \text{ kN}$ $M_{y,Ed,max} = -30.72 \text{ kN*m}$ $M_{z,Ed,max} = 6.53 \text{ kN*m}$
 $V_{y,T,Rd} = 1500.65 \text{ kN}$

$N_{b,Rd} = 1285.92 \text{ kN}$ $M_{y,c,Rd} = 360.59 \text{ kN*m}$ $M_{z,c,Rd} = 168.63 \text{ kN*m}$
 $V_{z,Ed} = -16.89 \text{ kN}$

$MN_{y,Rd} = 360.59 \text{ kN*m}$ $MN_{z,Rd} = 168.63 \text{ kN*m}$ $V_{z,T,Rd} = 556.98 \text{ kN}$

$T_{t,Ed} = -0.04 \text{ kN*m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 8.230 \text{ m} \quad \text{Lam}_y = 0.72 \quad L_z = 8.230 \text{ m} \quad \text{Lam}_z = 1.24$$

$$L_{cr,y} = 8.230 \text{ m} \quad X_y = 0.77 \quad L_{cr,z} = 8.230 \text{ m} \quad X_z = 0.42$$

$$\text{Lamy} = 67.95 \quad k_{yy} = 1.00 \quad \text{Lamz} = 116.16 \quad k_{yz} = 0.70$$

flambement par torsion:

flambement en flexion-torsion

$$\text{Courbe}, T=c \quad \alpha_{f,T}=0.49 \quad \text{Courbe}, TF=c \quad \alpha_{f,TF}=0.49$$

$$L_t=8.230 \text{ m} \quad f_{i,T}=0.81 \quad N_{cr,y}=5896.68 \text{ kN} \quad f_{i,TF}=0.89$$

$$N_{cr,T}=7675.92 \text{ kN} \quad X_{f,T}=0.76 \quad N_{cr,TF}=5896.68 \text{ kN} \quad X_{f,TF}=0.71$$

$$\text{Lam}_T=0.63 \quad N_{b,T,Rd}=2361.39 \text{ kN} \quad \text{Lam}_{TF}=0.72 \quad N_{b,TF,Rd}=2191.95 \text{ kN}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.09 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.03 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\tau_{xy}/(\sqrt{3} \cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\tau_{xz}/(\sqrt{3} \cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 67.95 < \lambda_{max} = 210.00 \quad \lambda_{z} = 116.16 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM_1) + k_{yy} \cdot M_{y,Ed,max}/(XLT \cdot M_{y,Rk}/gM_1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM_1) = 0.11 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM_1) + k_{zy} \cdot M_{y,Ed,max}/(XLT \cdot M_{y,Rk}/gM_1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM_1) = 0.08 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.1 \text{ cm} < u_y \text{ max} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.2 \text{ cm} < u_z \text{ max} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 257 Poutres 257 et 59_257 **POINT:** 2 **COORDONNEE:** x = 0.58 L = 2.042 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 200

$h=19.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=20.0 \text{ cm}$ $A_y=45.12 \text{ cm}^2$ $A_z=18.08 \text{ cm}^2$ $A_x=53.83 \text{ cm}^2$
 $t_w=0.7 \text{ cm}$ $I_y=3692.16 \text{ cm}^4$ $I_z=1335.51 \text{ cm}^4$ $I_x=21.09 \text{ cm}^4$
 $t_f=1.0 \text{ cm}$ $W_{ply}=429.48 \text{ cm}^3$ $W_{plz}=203.82 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 8.37 \text{ kN}$ $M_{y,Ed} = -27.23 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 0.08 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.06 \text{ kN}$
 $N_{c,Rd} = 1265.01 \text{ kN}$ $M_{y,Ed,max} = -32.93 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = 0.13 \text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 608.18 \text{ kN}$
 $N_{b,Rd} = 878.73 \text{ kN}$ $M_{y,c,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = 19.40 \text{ kN}$
 $MN_{y,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 244.27 \text{ kN}$
 $M_{b,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $T_{t,Ed} = 0.05 \text{ kN}\cdot\text{m}$
 Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 1617.98 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 1.00$
 $L_{cr,low}=1.750 \text{ m}$ $\lambda_{m_LT} = 0.25$ $f_{i,LT} = 0.52$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 3.500 \text{ m}$ $\lambda_{m_y} = 0.45$ $L_z = 3.500 \text{ m}$ $\lambda_{m_z} = 0.75$
 $L_{cr,y} = 3.500 \text{ m}$ $X_y = 0.91$ $L_{cr,z} = 3.500 \text{ m}$ $X_z = 0.69$
 $\lambda_{m_y} = 42.26$ $k_{yy} = 1.00$ $\lambda_{m_z} = 70.27$ $k_{yz} = 0.70$

flambement par torsion:

flambement en flexion-torsion

Courbe,T=c alfa,T=0.49 Courbe,TF=c alfa,TF=0.49

Lt=1.750 m fi,T=0.61 Ncr,y=6246.88 kN fi,TF=0.66

Ncr,T=9662.31 kN XT=0.92 Ncr,TF=6246.88 kN XT,TF=0.87

Lam_T=0.36 Nb,T,Rd=1160.43 kN Lam_TF=0.45 Nb,TF,Rd=1101.23 kN

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.01 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.27 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.07 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.08 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.02 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 42.26 < \lambda_{max} = 210.00 \quad \lambda_{z} = 70.27 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.01 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.33 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/g_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.34 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/g_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.18 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES


Flèches (REPERE LOCAL):

$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm}$ Vérifié

Cas de charge décisif: 2 Surcharge plancher

$u_z = 0.3 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 261 Solives_261 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.750 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$
 $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$
 $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -3.65 \text{ kN}$ $M_{y,Ed} = 1.33 \text{ kN}\cdot\text{m}$
 $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$
 $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$
 $M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$
 $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$
Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$N_{,Ed}/N_{t,Rd} = 0.01 < 1.00$ (6.2.3.(1))
 $M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00$ (6.2.5.(1))
 $\tau_{y,t,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.01 < 1.00$ (6.2.6)
 $\tau_{z,t,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 262 Solives_262 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.735 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -1.41\text{ kN}$ $M_{y,Ed} = 1.54\text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$

$V_{z,Ed} = -0.00\text{ kN}$

$M_{N,y,Rd} = 29.11\text{ kN}\cdot\text{m}$

$V_{z,T,Rd} = 131.00\text{ kN}$

$T_{t,Ed} = -0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00$ (6.2.5.(1))

$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$\tau_{y,Ed}/(\tau_y/(\sqrt{3}\cdot gM0)) = 0.00 < 1.00$ (6.2.6)

$\tau_{z,Ed}/(\tau_z/(\sqrt{3}\cdot gM0)) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.7 \text{ cm}$ Vérifié

Cas de charge décisif: 2 Surcharge plancher

$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.7 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 263 Solives_263 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.511 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$$h=16.0 \text{ cm} \quad gM0=1.00 \quad gM1=1.00$$

$$b=8.2 \text{ cm} \quad Ay=13.73 \text{ cm}^2 \quad Az=9.66 \text{ cm}^2 \quad Ax=20.09 \text{ cm}^2$$

$$tw=0.5 \text{ cm} \quad Iy=869.29 \text{ cm}^4 \quad Iz=68.31 \text{ cm}^4 \quad Ix=3.62 \text{ cm}^4$$

$$tf=0.7 \text{ cm} \quad Wply=123.86 \text{ cm}^3 \quad Wplz=26.10 \text{ cm}^3$$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = -3.80 \text{ kN} \quad My_{Ed} = 1.10 \text{ kN} \cdot \text{m}$$

$$N_{t,Rd} = 472.12 \text{ kN} \quad My_{pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$$

$$My_{c,Rd} = 29.11 \text{ kN} \cdot \text{m} \quad Vz_{Ed} = -0.04 \text{ kN}$$

$$MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m} \quad Vz_{T,Rd} = 130.73 \text{ kN}$$

$$Tt_{Ed} = -0.01 \text{ kN} \cdot \text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$My_{Ed}/My_{c,Rd} = 0.04 < 1.00 \quad (6.2.5.(1))$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{u,ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{u,tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 264 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.735 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$


PARAMETRES DE LA SECTION: IPE 160
 $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$
 $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$
 $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:
 $N_{,Ed} = 1.52 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN}^*\text{m}$
 $N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}^*\text{m}$
 $N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}^*\text{m}$
 $M_{N,y,Rd} = 29.11 \text{ kN}^*\text{m}$
 $T_{t,Ed} = -0.00 \text{ kN}^*\text{m}$

Classe de la section = 1


PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:


en y:


en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.05 < 1.00 \quad (6.2.5.(1))$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 265 Solives_265 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 0.497 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 (1+2)*1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -1.54 \text{ kN}$ $M_{y,Ed} = 0.09 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$V_{z,Ed} = -0.01 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$

$V_{z,T,Rd} = 130.28 \text{ kN}$

$T_{t,Ed} = -0.01 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.5.(1))$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{a,ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.02 < 1.00 \quad (6.2.6)$$

$$\tau_{a,tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 0.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 0.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:

PIECE: 266 Poteaux U_21 POINT: 1 COORDONNEE: $x = 0.00$ $L = 0.000$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa

**PARAMETRES DE LA SECTION: UAP 300**

$h=30.0$ cm $gM0=1.00$ $gM1=1.00$

$b=10.0$ cm $A_y=36.14$ cm² $A_z=30.64$ cm² $A_x=58.56$ cm²

$t_w=0.9$ cm $I_y=8170.18$ cm⁴ $I_z=562.07$ cm⁴ $I_x=38.46$ cm⁴

$t_f=1.6$ cm $W_{ply}=639.34$ cm³ $W_{plz}=144.83$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -32.62$ kN

$N_{t,Rd} = 1376.13$ kN

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.02 < 1.00 \quad (6.2.3.(1))$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):** Non analysé**Déplacements (REPERE GLOBAL):**

$$v_x = 0.2 \text{ cm} < v_{x \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 1 Poids propre

$$v_y = 0.3 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 268 268 **POINT:** 2 **COORDONNEE:** $x = 0.35 L = 2.897 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1=1*1.55 + 2*1.35 \text{ (1+2)*1.35}$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 400

$h=39.0 \text{ cm}$ $g_{M0}=1.00$ $g_{M1}=1.00$

$b=30.0 \text{ cm}$ $A_y=126.20 \text{ cm}^2$ $A_z=57.33 \text{ cm}^2$ $A_x=158.98 \text{ cm}^2$

$t_w=1.1 \text{ cm}$ $I_y=45069.40 \text{ cm}^4$ $I_z=8563.83 \text{ cm}^4$ $I_x=189.76 \text{ cm}^4$

$t_f=1.9 \text{ cm}$ $W_{ply}=2561.80 \text{ cm}^3$ $W_{plz}=872.86 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.27 \text{ kN}$ $M_{y,Ed} = 84.00 \text{ kN*m}$ $M_{z,Ed} = -4.32 \text{ kN*m}$ $V_{y,Ed} = -0.71 \text{ kN}$

$N_{c,Rd} = 3736.03 \text{ kN}$ $M_{y,Ed,max} = 94.59 \text{ kN*m}$ $M_{z,Ed,max} = -4.32 \text{ kN*m}$
 $V_{y,T,Rd} = 1702.83 \text{ kN}$

$N_{b,Rd} = 1770.54 \text{ kN}$ $M_{y,c,Rd} = 602.02 \text{ kN*m}$ $M_{z,c,Rd} = 205.12 \text{ kN*m}$
 $V_{z,Ed} = 23.68 \text{ kN}$

$MN_{y,Rd} = 602.02 \text{ kN*m}$ $MN_{z,Rd} = 205.12 \text{ kN*m}$ $V_{z,T,Rd} = 775.36 \text{ kN}$

$Mb,Rd = 602.02 \text{ kN*m}$ $Tt,Ed = 0.19 \text{ kN*m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 116936.25 \text{ kN*m}$ Courbe,LT - $X_{LT} = 1.00$

$L_{cr,upp}=0.550 \text{ m}$ $\lambda_{m_LT} = 0.07$ $f_{i,LT} = 0.46$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 8.325 \text{ m} \quad \text{Lam}_y = 0.53 \quad L_z = 8.325 \text{ m} \quad \text{Lam}_z = 1.21$$

$$L_{cr,y} = 8.325 \text{ m} \quad X_y = 0.92 \quad L_{cr,z} = 8.325 \text{ m} \quad X_z = 0.47$$

$$\text{Lamy} = 49.44 \quad k_{yy} = 1.00 \quad \text{Lamz} = 113.43 \quad k_{yz} = 0.70$$

flambement par torsion:

flambement en flexion-torsion

$$\text{Courbe}, T=b \quad \alpha_{T,b}=0.34 \quad \text{Courbe}, TF=b \quad \alpha_{TF,b}=0.34$$

$$L_t=8.325 \text{ m} \quad f_{i,T}=0.85 \quad N_{cr,y}=13478.21 \text{ kN} \quad f_{i,TF}=0.69$$

$$N_{cr,T}=7155.42 \text{ kN} \quad X_{T,b}=0.77 \quad N_{cr,TF}=13478.21 \text{ kN} \quad X_{TF,b}=0.87$$

$$\text{Lam}_T=0.72 \quad N_{b,T,Rd}=2879.75 \text{ kN} \quad \text{Lam}_{TF}=0.53 \quad N_{b,TF,Rd}=3258.91 \text{ kN}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.14 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.04 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.03 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\tau_{xy}/(\sqrt{3} \cdot gM0)) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\tau_{xz}/(\sqrt{3} \cdot gM0)) = 0.01 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y,b} = 49.44 < \lambda_{b,max} = 210.00 \quad \lambda_{z,b} = 113.43 < \lambda_{b,max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.16 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(XLT \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.17 < 1.00 \quad (6.3.3.(4))$$

$$\frac{N_{Ed}}{(X_z \cdot N_{Rk/gM1})} + \frac{k_{zy} \cdot M_{y,Ed,max}}{(X_{LT} \cdot M_{y,Rk/gM1})} + \frac{k_{zz} \cdot M_{z,Ed,max}}{(M_{z,Rk/gM1})} = 0.10 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 4.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.5 \text{ cm} < u_{z \text{ max}} = L/200.00 = 4.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 269 **POINT:** 1 **COORDONNEE:** x = 0.00 L = 0.000 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: TCAR 100x5

$h=10.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=10.0 \text{ cm}$ $A_y=9.44 \text{ cm}^2$ $A_z=9.44 \text{ cm}^2$ $A_x=18.88 \text{ cm}^2$

$t_w=0.5 \text{ cm}$ $I_y=282.80 \text{ cm}^4$ $I_z=282.80 \text{ cm}^4$ $I_x=438.80 \text{ cm}^4$

$t_f=0.5 \text{ cm}$ $W_{ply}=67.75 \text{ cm}^3$ $W_{plz}=67.75 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 64.49 \text{ kN}$ $M_{y,Ed} = 0.56 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 0.24 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.13 \text{ kN}$

$N_{c,Rd} = 443.68 \text{ kN}$ $M_{y,pl,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 127.91 \text{ kN}$

$N_{b,Rd} = 443.68 \text{ kN}$ $M_{y,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -1.12 \text{ kN}$

$MN_{y,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 127.91 \text{ kN}$

$T_{t,Ed} = 0.02 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.15 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{1.70} + (M_{z,Ed}/M_{N,z,Rd})^{1.70} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.01 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 270 **POINT:** 7 **COORDONNEE:** x = 1.00 L = 2.210 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: TCAR 100x5

$$h=10.0 \text{ cm} \quad gM0=1.00 \quad gM1=1.00$$

$$b=10.0 \text{ cm} \quad Ay=9.44 \text{ cm}^2 \quad Az=9.44 \text{ cm}^2 \quad Ax=18.88 \text{ cm}^2$$

$$tw=0.5 \text{ cm} \quad Iy=282.80 \text{ cm}^4 \quad Iz=282.80 \text{ cm}^4 \quad Ix=438.80 \text{ cm}^4$$

$$tf=0.5 \text{ cm} \quad Wply=67.75 \text{ cm}^3 \quad Wplz=67.75 \text{ cm}^3$$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = 55.20 \text{ kN} \quad M_{y,Ed} = -2.03 \text{ kN}^*\text{m} \quad M_{z,Ed} = 0.00 \text{ kN}^*\text{m} \quad V_{y,Ed} = -0.13 \text{ kN}$$

$$N_{c,Rd} = 443.68 \text{ kN} \quad M_{y,pl,Rd} = 15.92 \text{ kN}^*\text{m} \quad M_{z,pl,Rd} = 15.92 \text{ kN}^*\text{m} \quad V_{y,T,Rd} = 128.02 \text{ kN}$$

$$N_{b,Rd} = 443.68 \text{ kN} \quad M_{y,c,Rd} = 15.92 \text{ kN}^*\text{m} \quad M_{z,c,Rd} = 15.92 \text{ kN}^*\text{m} \quad V_{z,Ed} = -1.56 \text{ kN}$$

$$M_{N,y,Rd} = 15.92 \text{ kN}^*\text{m} \quad M_{N,z,Rd} = 15.92 \text{ kN}^*\text{m} \quad V_{z,T,Rd} = 128.02 \text{ kN}$$

$$T_{t,Ed} = -0.01 \text{ kN}^*\text{m}$$

$$\text{Classe de la section} = 1$$



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.12 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.13 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{1.69} + (M_{z,Ed}/M_{N,z,Rd})^{1.69} = 0.03 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.01 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 271 Solives_271 **POINT:** 1 **COORDONNEE:** x = 0.50 L = 1.750 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -4.54\text{ kN}$ $M_{y,Ed} = 1.20\text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$

$V_{z,Ed} = -0.00\text{ kN}$

$M_{N,y,Rd} = 29.11\text{ kN}\cdot\text{m}$

$V_{z,T,Rd} = 130.79\text{ kN}$

$T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{t,Rd} = 0.01 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/M_{y,c,Rd} = 0.04 < 1.00$ (6.2.5.(1))

$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$\tau_{y,Ed}/(\tau_y/(\sqrt{3}\cdot gM0)) = 0.01 < 1.00$ (6.2.6)

$\tau_{z,Ed}/(\tau_z/(\sqrt{3}\cdot gM0)) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm}$ Vérifié

Cas de charge décisif: 2 Surcharge plancher

$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 272 Solives_272 **POINT:** 2 **COORDONNEE:** $x = 0.53 L = 1.642 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160** $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$ $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$ $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = -4.85 \text{ kN}$ $M_{y,Ed} = 0.94 \text{ kN}\cdot\text{m}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.07 \text{ kN}$ $MN_{,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 131.00 \text{ kN}$ $T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:** $N_{,Ed}/N_{t,Rd} = 0.01 < 1.00$ (6.2.3.(1)) $M_{y,Ed}/M_{y,c,Rd} = 0.03 < 1.00$ (6.2.5.(1))

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_{y,Ed}/(\sqrt{3} \cdot \sigma_{y,Rd})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_{x,Ed}/(\sqrt{3} \cdot \sigma_{x,Rd})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 2 Surcharge plancher

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 276 Poutres_276 **POINT:** 1 **COORDONNEE:** x = 0.00 L = 0.000 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.00 \text{ kN}$ $M_{y,Ed} = -0.00 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = 0.22 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = 0.22 \text{ kN}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,Ed,max} = 0.11 \text{ kN} \cdot \text{m}$ $M_{z,Ed,max} = 0.22 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 185.87 \text{ kN}$

$N_{b,Rd} = 237.56 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = 0.22 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{N,z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 130.81 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 2.000 \text{ m}$ $\lambda_{m,y} = 0.32$

$L_z = 2.000 \text{ m}$

$\lambda_{m,z} = 1.15$

$L_{cr,y} = 2.000 \text{ m}$ $X_y = 0.97$

$L_{cr,z} = 2.000 \text{ m}$

$X_z = 0.50$

$$Lamy = 30.40 \quad kzy = 0.52 \quad Lamz = 108.46 \quad kzz = 0.58$$

flambement par torsion: flambement en flexion-torsion

$$Courbe,T=b \quad \alpha,T=0.34 \quad Courbe,TF=b \quad \alpha,TF=0.34$$

$$Lt=2.000 \text{ m} \quad f_i,T=0.80 \quad N_{cr,y}=4504.26 \text{ kN} \quad f_i,TF=0.57$$

$$N_{cr,T}=1068.02 \text{ kN} \quad X,T=0.80 \quad N_{cr,TF}=4504.26 \text{ kN} \quad X,TF=0.96$$

$$Lam_T=0.66 \quad Nb,T,Rd=379.19 \text{ kN} \quad Lam_TF=0.32 \quad Nb,TF,Rd=451.03 \text{ kN}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.04 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3}) \cdot gM0) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3}) \cdot gM0) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 30.40 < \lambda_{max} = 210.00 \quad \lambda_{z} = 108.46 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.02 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.02 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.0 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.0 \text{ cm}$ Vérifié

Cas de charge décisif: 1 Poids propre



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!