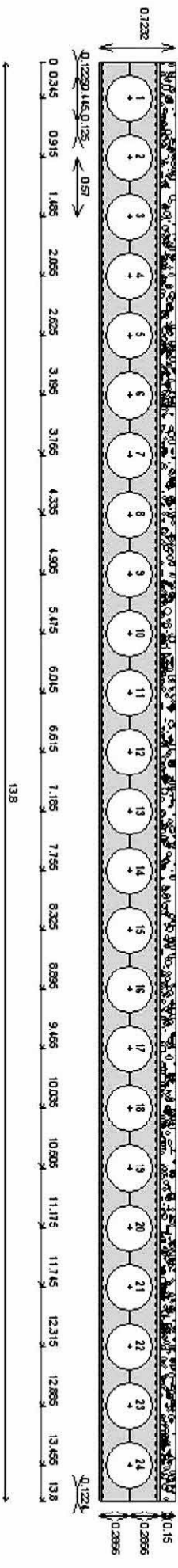




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DATA

COMPOSITE BEAM

Partial safety factors

γ_{M0} = 1.10 γ_c = 1.50
 γ_{M1} = 1.10 γ_{vs} = 1.25
 γ_{Mw} = 1.25

Span length : L = 13.800 m

Total number of openings : n = 24
 Opening diameter : a₀ = 445.0 mm
 Width of intermediate posts : w = 125.0 mm
 Distance between opening axes (a₀ + w) : p = 570.0 mm
 Width of the left end post : w_o = 122.5 mm
 Width of the right end post : w_e = 122.5 mm
 Total depth of the steel section : H_t = 573.2 mm

Total weight of the steel beam : p = 23.18 kN (1.680 kN/m)
 Total paint surface : S = 28.17 m²
 Paint surface (without the upper face) : S' = 23.03 m²

Massiveness : M = 99.70 m⁻¹
 Massiveness (without the upper face) : M' = 85.30 m⁻¹

Available width on the left : L₁ = 3.000 m
 Available width on the right : L₂ = 3.000 m

Upper chord :

(Base profile)

W 360x370x179 - S235

f_y = 225 N/mm²
 h = 368.0 mm
 b_f = 373.0 mm
 t_f = 23.9 mm
 t_w = 15.0 mm
 r = 15.0 mm
 r_b = 8.0 mm

Lower chord :

(Base profile)

W 360x370x179 - S235

f_y = 225 N/mm²
 h = 368.0 mm
 b_f = 373.0 mm
 t_f = 23.9 mm
 t_w = 15.0 mm
 r = 15.0 mm
 r_b = 8.0 mm

Gross section

Area : A = 259.03 cm²
 Position of the centroid : z_G = 286.60 mm
 Inertia /yy : I_y = 154001 cm⁴
 Inertia /zz : I_z = 20687.6 cm⁴

Net section

Area : A_{net} = 192.28 cm²
 Position of the centroid : z_{G.net} = 286.60 mm
 Inertia /yy : I_{y.net} = 142986 cm⁴
 Inertia /zz : I_{z.net} = 20675.1 cm⁴

Properties of the concrete slab : plain slab

Slab thickness : E = 150 mm

Max effective width on the left : L₁ = 3.000 m
 Max effective width on the right : L₂ = 3.000 m

Effective width : L_{eff} = 3.450 m

Concrete C25/30 f_{ck} = 25.00 N/mm²
 Concrete density = 2400 kg/m³ f_{ctm} = 2.565 N/mm²
 Concrete shrinkage = 300.10⁻⁶ E_{cm} = 30472 N/mm²

Modular ratios Long term : C_{Eq} = 20.68 Short term : C_{Eq} = 6.89

Connector HILTI X-HVB 140 h = 141.0 mm P_{Rd} = 30 kN



Project name : Wandee group (Thailand)

Project reference :

Beam reference : Cellular beam

(One should verify that the HILTI specifications for the use and installation of the connectors are respected.)

Connector arrangement e = 250.0 mm (on 3 rows) (n = 165)

Construction stage : No propping - verification of the steel beam in construction phase

- Weight of the steel beam (g) : 1.680 kN/m
- Weight of the slab (g) : 3.530 kN/m² (21.180 kN/m)
- Construction load (Q_c) : 0.750 kN/m² (4.500 kN/m)

The beam is laterally restrained, continuous support all along the beam.

Permanent load case (G) Reactions at supports : R_o = 157.73 kN
 R_e = 157.73 kN

Surface loads q = 3.530 kN/m²

Distributed loads

x_o = 0.000 m q_o = 1.680 kN/m x_e = 13.800 m q_e = 1.680 kN/m

Variable load case nr 1 (Q1) Reactions at supports : R_o = 82.80 kN
 R_e = 82.80 kN

Surface loads q = 2.000 kN/m²

No load defined for this case

ULS Combination at construction stage : 1.35 g + 1.50 Q_c

Ultimate Limit State Combinations
 1.35 G + 1.50 Q1
 1.35 G + 1.50 Q2
 1.35 G + 1.35 Q1 + 1.35 Q2
 1.00 G + 1.50 Q1
 1.00 G + 1.50 Q2
 1.00 G + 1.35 Q1 + 1.35 Q2

Serviceability Limit State Combinations 1.00 G + 1.00 Q1

Note : the calculation method applies to steel rolled profiles only.



RESULTS OF THE VERIFICATIONS

Construction stage

The web slenderness is such that the shear buckling check is not required : $d / t_w < 69 \epsilon$

Moment resistance in an opening section : $M_{Rd} = 1071.699 \text{ kN.m}$

ULS Combination at construction stage : 1.35 g + 1.50 Qc

SUMMARY OF THE CRITERIA (Construction stage)

Resistance to axial force Open.12 :	$\Gamma_{N,max} = 0.834$	< 1 Satisfactory
Resistance to shear force Open.1 :	$\Gamma_{V,max} = 0.846$	< 1 Satisfactory
Resistance to bending moment Open.1 :	$\Gamma_{M,max} = 0.701$	< 1 Satisfactory
Axial force-shear force interaction Open.12 :	$\Gamma_{NV,max} = 0.834$	< 1 Satisfactory
Moment-axial force interaction Open.18 :	$\Gamma_{MN,max} = 0.946$	< 1 Satisfactory
Moment-shear force interaction Open.1 :	$\Gamma_{MV,max} = 0.704$	< 1 Satisfactory
Moment-axial force-shear force interaction Open.18 :	$\Gamma_{MNV,max} = 0.987$	< 1 Satisfactory
Resistance to longitudinal shear :	$\Gamma_{Vh,max} = 1.114$	> 1 Not satisfactory
Resistance to buckling of the posts :	$\Gamma_{b,max} = 1.337$	> 1 Not satisfactory
Section Resistance in the post :	$\Gamma_{R,max} = 0.732$	< 1 Satisfactory
Minimal throat thickness :	$a_{min} = 4.7 \text{ mm}$	

THE BEAM IS NOT SUFFICIENT FOR THE APPLIED LOADS
(Construction stage)

Maximal deflection in construction phase (g) : $v = 44.0 \text{ mm (L/313)}$



RESULTS OF THE VERIFICATIONS

Composite action stage

Verification of the degree of connection

Minimal degree of connection = 0.664

ULS Combination : : ULS 01 1.35 G + 1.50 Q1

Degree of connection = 0.641 < 0.664 -> PLASTIC CALCULATION IS NOT POSSIBLE.

ULS Combination : : ULS 02 1.35 G + 1.50 Q2

Degree of connection = 0.641 < 0.664 -> PLASTIC CALCULATION IS NOT POSSIBLE.

ULS Combination : : ULS 03 1.35 G + 1.35 Q1 + 1.35 Q2

Degree of connection = 0.641 < 0.664 -> PLASTIC CALCULATION IS NOT POSSIBLE.

ULS Combination : : ULS 04 1.00 G + 1.50 Q1

Degree of connection = 0.641 < 0.664 -> PLASTIC CALCULATION IS NOT POSSIBLE.

ULS Combination : : ULS 05 1.00 G + 1.50 Q2

Degree of connection = 0.641 < 0.664 -> PLASTIC CALCULATION IS NOT POSSIBLE.

ULS Combination : : ULS 06 1.00 G + 1.35 Q1 + 1.35 Q2

Degree of connection = 0.641 < 0.664 -> PLASTIC CALCULATION IS NOT POSSIBLE.

INCREASE THE DEGREE OF CONNECTION APPROX. 4%

Calculation of the deflections at Serviceability Limit States

Maximal deflection in construction phase (g) :

$v = 44.0 \text{ mm} = L / 313$

Load case : Q1

$v = 11.7 \text{ mm} = L / 1179$

Deflection due to concrete shrinkage (M = 289.989 kN.m)

$v = 12.8 \text{ mm} = L / 1076$

The user has to check whether the deflections are acceptable according to the project requirements, and to consider a precambering if necessary.

Estimation of the natural frequency

Mass assumed to be concentrated Mass assumed to be distributed

G + 0.00 Q1 : 3.3 Hz	G + 0.00 Q1 : 3.8 Hz
G + 0.10 Q1 : 3.3 Hz	G + 0.10 Q1 : 3.7 Hz
G + 0.20 Q1 : 3.2 Hz	G + 0.20 Q1 : 3.6 Hz
G + 0.30 Q1 : 3.1 Hz	G + 0.30 Q1 : 3.5 Hz
G + 0.40 Q1 : 3.0 Hz	G + 0.40 Q1 : 3.5 Hz
G + 0.50 Q1 : 3.0 Hz	G + 0.50 Q1 : 3.4 Hz



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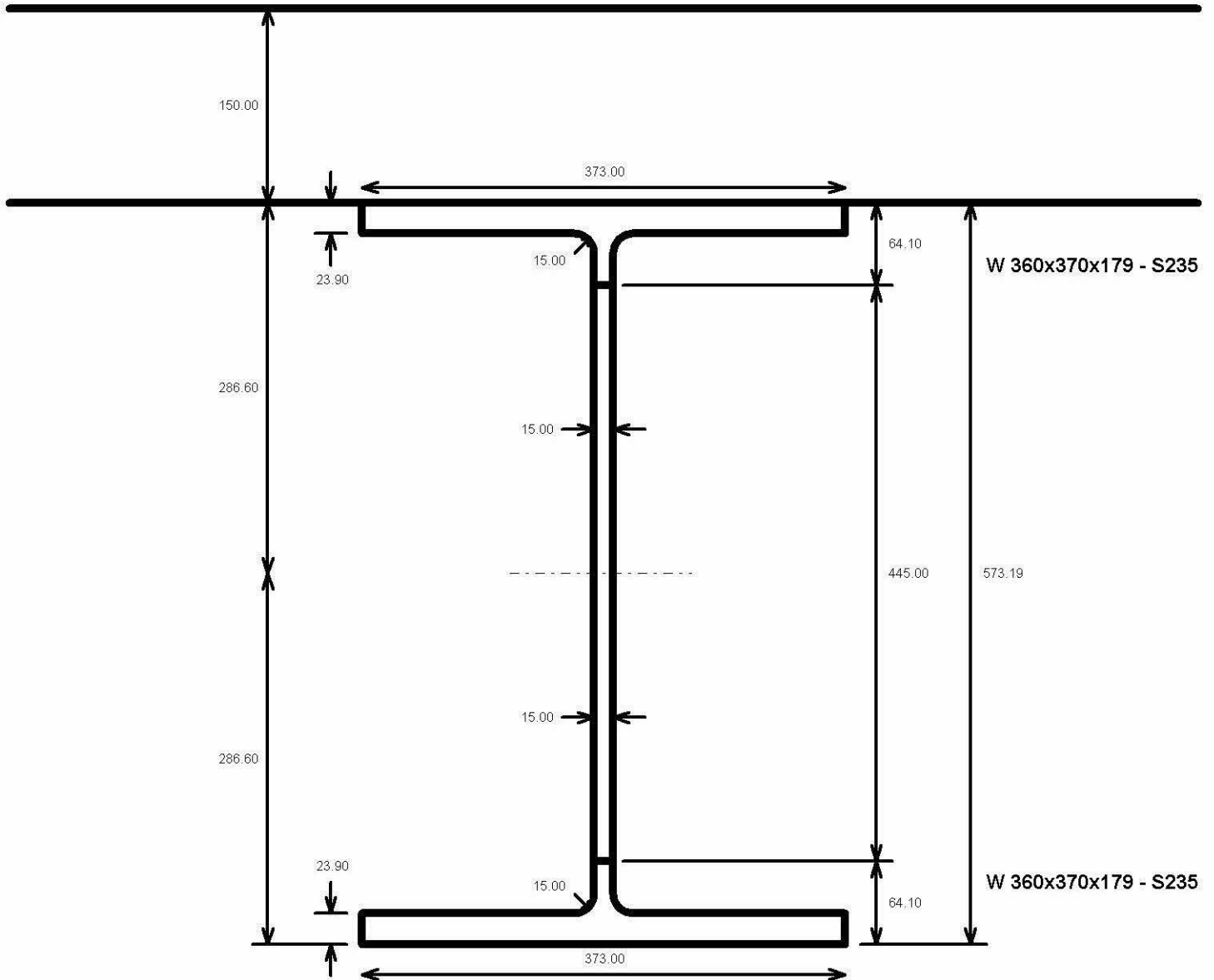
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Project name : Wandee group (Thailand)

Project reference :

Beam reference : Cellular beam

Number of openings = 24 - Diameter = 445 mm - Distance between axes = 570 mm





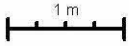
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