

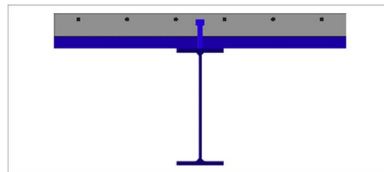


BEAM

DESIGN OF COMPOSITE BEAM AND SLAB SECTIONS
FOR SAGGING AND HOGGING MOMENTS
DESIGN | X01

Summary

The beam module allows you to design a composite section for flexure. Composite construction methods are becoming more popular globally due to the rapid construction potential and efficient use of materials. The module forms part of the PROKON structural analysis and design suit together with the three other composite design modules.



What makes this module special?

- Design a section for sagging and hogging moments and for shear
- Various deck layouts are supported
- Design checks indicate which failure mode governs
- Detailed equations

Detailed Description

A composite beam is usually a combination of a steel I-beam and a concrete slab cast on top. Shear connectors are welded to the top flange of the steel beam to ensure that the composite action is possible. Composite construction reduces the construction timeline because the contractors don't have to wait for concrete beams to reach the required 28-day strength before removing formwork. With good planning, formwork can be avoided entirely, which allows for massive savings. The composite beam section design module allows you to design a composite section for flexure and shear. The module considers the case of sagging as well as hogging moments.

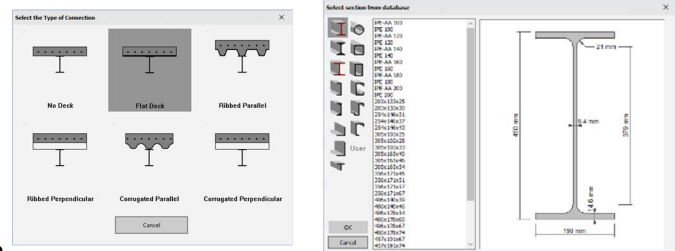


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Various deck layouts are possible:

1. No deck
2. Flat deck
3. Ribbed parallel to beam
4. Ribbed perpendicular to beam
5. Corrugated parallel to beam
6. Corrugated perpendicular to beam



The module reads sections from the **PROKON® Section Database** which contains the steel sections used in most countries.

Theory used in this module

The module calculates the sagging and hogging resistance of composite beam sections according to rigid-plastic theory in Section 6 of EN 1994-1-1:2004 (Eurocode 4). It can evaluate both full shear connection and partial shear connection designs using plastic theory.

The module verifies that the section is either a Class 1 or a Class 2 section as required for rigid-plastic theory design. It accounts for longitudinal reinforcement in compression (if present) for sagging resistance with the assumption that such reinforcement is fully anchored.

To calculate the plastic bending resistance of the section, the module determines the plastic neutral axis (PNA) location of the section. It does this by balancing the contributing horizontal forces (based on plastic stresses) in the composite cross-section.

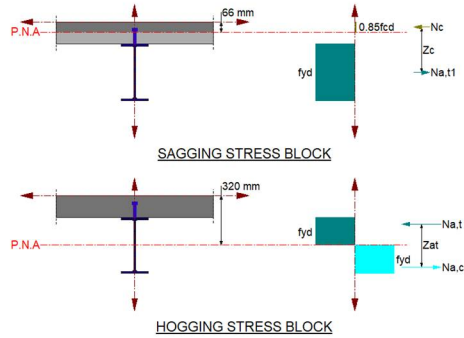
In the shear connection calculations, the module checks headed studs for adherence to the ductility requirements for steel sections with equal flanges. It also checks resistance to vertical shear.



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SUMMARY			
SAGGING RESISTANCE			
Composite Section			
Compression			
Concrete	Nc	-2582.346 kN	33.1 mm
Reinforcing	Ns,c	0 kN	0 mm
Steel section	Ns,c1	0 kN	140 mm
Tension			
Steel section	Na,t1	2582.346 kN	320 mm
Plastic Neutral Axis	PNA		66.3 mm
Steel Section			
Compression			
Steel Section	Na,c2	0 kN	140 mm
Tension			
Steel Section	Na,t2	0 kN	320 mm
Plastic Neutral Axis	PNA: Steel		123 mm
Resistance moment	Mpl,Rd	740.766 kNm	
HOGGING RESISTANCE			
Compression			
Steel section	Na,c	-1291.173 kN	460.1 mm
Tension			
Reinforcing	Ns,t	0 kN	0 mm
Steel section	Na,t	1291.173 kN	178.9 mm
Plastic Neutral Axis	PNA		320 mm
Resistance moment	Mpl,Rd	-361.871 kNm	
Shear Connectors			
Stud Resistance	PRd	73.7 kN	
Resistance 1	PRd,1	81.7 kN	
Resistance 2	PRd,2	73.7 kN	
Number of connectors	n	31	
Degree of connection	PSC	100 %	
VERTICAL SHEAR RESISTANCE			
Design shear area	A _{sv}	3515 mm ²	
Resistance force	Vpl,Rd	720.435 kN	



#	Check	Result	Note
1	Sagging Converged	Pass	S _{fit} = 0 kN
2	Hogging Converged	Pass	S _{fit} = 0 kN
3	Cross-section class for sagging	Pass	The cross-section for sagging moments is class 1.
4	Cross-section class for hogging	Pass	The cross-section for hogging moments is class 1.
5	Shear Connector Length	Pass	Not less than 4 times the diameter.
6	Shear Connector Diameter	Pass	Not less than 16 mm and not greater than 25 mm.
7	Degree of Shear Connection	Pass	$\eta_s = 1.0 \Rightarrow \eta_{s, min} = 0.5$
8	Structural steel grade	Pass	The structural steel grade is less than S420.



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Supported Codes

Design Codes

- AISC 360 – 16 (LRFD)
- Eurocode 4 – 2004
- SANS 10162-1:2011