

STEEL DECKS WITH OUTWARDS STIFFENERS

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Sources



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1.INTRODUCTION



Due to its many construction advantages steel decking is frequently used in steel-framed construction for both roofs and floors, in residential, commercial and industrial buildings, as well for new constructions as for refurbishments.

1. INTRODUCTION

In order to increase the shear connection between the steel and the concrete, the upper flange of steel decks often contain outwards stiffener.



ComFlor® 80 from TataSteel steel deck

2. STATE OF THE ART PRE-GRISPE <u>Composite stage (steel + concrete)</u>:

Steel sheeting with outwards stiffeners are within the scope of the European standard EN 1994-1-1 for the design of composite structures (steel and concrete).

<u>Construction stage</u>:

The sheeting used as shuttering has to support the fresh concrete weight and the construction loads. No existing study allows to calculate the moment resistance and stiffness of steel profile with outwards stiffeners.

2. STATE OF THE ART PRE-GRISPE

<u>Construction stage</u>:

 To design a steel sheeting according to the European Standard EN 1993-1-3 (dealing with design rules for cold-formed members and sheeting), first, effective section properties must be calculated, next, resistance must be determined with the effective
cross-section.

In the calculation according to EN 1993-1-3 it is assumed that the flange stiffeners are oriented inwardly of the section, i.e. downwards in the case of the upper flange (figures below).

2. STATE OF THE ART PRE-GRISPE Construction stage:

- But the EN 1993-1-3 does not cover profiled sheeting with outwards stiffeners.
- Therefore the only option for manufacturers to design these products is to carry out tests according to EN 1993-1-3, which is expensive and time consuming.

2. STATE OF THE ART PRE-GRISPE

<u>Issue identified by the GRISPE project</u>:

EN 1994-1-1 specifies that steel sheeting should be designed in accordance with EN 1993-1-3, but EN 1993-1-3 does not provide any information about the design and verification of profiles with outwards stiffeners.





2. STATE OF THE ART PRE-GRISPE

GRISPE objectives and methodology:

The main objectives were to provide technical data and a calculation method for steel decks with outwards stiffeners. Despite their growing importance in the construction industry in Europe, no calculation method is included in the current version of Eurocode EN 1993-1-3.

The missing data were determined by testing.

Based on the tests analysis a calculation method was developed and validated

An amendment was proposed to CEN TC 250/SC3/WG3 EN 1993-1-3 The project has received financial support from the European Community (RFCS programme) under grant agreement No 754092

3. TESTING

Aim of the testing:

To determine the <u>moment resistance</u> and the effective flexion <u>stiffness</u> (inertia moment) of a profile with outwards stiffeners

Testing configuration:

← Global behaviour in positive flexion was tested according to EN 1002 1 2 Annov A



3. TESTING

Single span test results:

- Determination of the <u>moment resistance</u> and of the effective flexion <u>stiffness</u> (inertia moment)
- Failure mode: buckling of the upper flange



Test set-up



Failure mode

4. DESIGN AND CALCULATION

The moment resistance and the inertia moment were also determined by calculation where the calculation of the effective section modulus W_{eff} was based on an effective cross-section with a stress σ_1 in the upper flange and in the upper outwards stiffener and σ_2 in the bottom flange



Depending on the distance z_G the yield stress is reached in the upper or lower flange.

If the yield stress is reached in the lower flange then $\sigma_2 = f_{yb}$ and $\sigma_1 < f_{yb}$ If the yield stress is reached in the upper flange then $\sigma_1 = f_{yb}$ amedroiset host refieived financial support from the European Community (RFCS programme) under grant agreement No 754092

4. DESIGN AND CALCULATION Results:

The moment resistance determined by calculation with the effective section modulus $W_{\rm eff}$ defined in this way is compared to the moment resistance determined by testing

The comparison confirms that the definition of the effective section modulus W_{eff} based on an effective cross-section with:

- stress σ_1 in the upper flange and in outwards stiffener
- stress σ_2 in the bottom flange

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5. PROPOSAL OF AMENDMENT <u>Taking into account the intermediate outwards stiffener</u> in the sheeting flange: Proposed change

Add a new clause in the section 5.5.3.3: (12) For intermediate stiffeners facing outwards of sheeting flanges used for composite slabs, the calculations should be performed by taking the stress in the stiffener as equal to the stress in the flange.

6. EXCEL SHEET

An excel file was developed to provide a reliable design procedure in order to encourage and facilitate the use of steel decks with outwards stiffeners:

The overall aim was to achieve simple, clear, easy to understand and easy to use excel sheets. The excel file was validated by the comparison of the calculation results with all the tests which have been carried out. Moreover the calculation methods have been made available to a number of industry users to verify their fitness for purpose.

6. EXCEL SHEET

Calculation of span moment resistance for a profile with outwards stiffener in the upper flange and two stiffeners in the lower flange



7. CONCLUSION

The design by calculation methods of steel decks with outwards stiffeners presented here, were checked and validated by an extensive test programme performed within the GRISPE project.

An Excel sheet including this method was developed for calculation of moment resistance of profile with outwards stiffener

These design by calculation method was proposed for amendment on EN 1993-1-3 within CEN/TC250 Subcommittee 3 (SC3) "Steel Structures".



Thank you for your attention