ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 1, January 2018

Flexural Strength Evaluation of Composite Deck System Analytically Base on International Standard and Parametric Variation

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Abstract: **-- The work presented in this paper is concerned with the evaluation of the flexural strength of composite deck system analytically base on international standard and parametric variation. The research work includes a study on core base analysis of metal deck composite slab for the flexural capacity and limiting geometrical and material parameters under full bond. Estimation and comparison of flexural resistance as per European, British and American Code of practice using developed MS excel tool. Study on parametric variation such as different materials, profile sheet thickness and slab thickness. Analytical approaches considering the bond properties from no bond to full bond cases. This study gives the guidelines to the users in India, for flexural capacity of the composite deck as per Indian scenario. The guidelines will be useful for users in India, in absence of Indian code of practice for a composite deck design. The developed MS Excel programs will be useful for the design of deck slab.**

Keywords**: Deck Sheet, Metal Deck Slab, Shear Bond, Flexural Strength, Fire Rating.**

I. INTRODUCTION

Composite slabs consist of profiled steel deck with reinforced concrete topping. The decking not only acts as a permanent formwork to the concrete, but also provides sufficient shear bond with the concrete and acts compositely. In recent years, the composite slabs are preferred due to light weight, low cost construction and ability to defend the natural disasters. The sheeting takes on different roles during different stages in construction. Prior to casting the concrete serves as a platform for the workmen and their equipment. During casting of concrete, the sheeting acts as formwork. After the concrete has hardened and the two components have become a composite system, the sheeting serves as reinforcement. The flexural members are quite sensitive to the shear stress transfer between the two material components. The embossment pattern has a very marked influence [1]. To develop composite action between materials, the steel deck must be able to resist horizontal shear and prevent vertical separation of concrete and steel deck. The ultimate interlocking capacity expression based on end-slip of the shear span is developed based on moment balancing technique and concluded that the expression is linear for all data used. The compressive strength of concrete does not apparently effect on ultimate interlocking load carrying capacity [2]. The behaviour of composite steel-concrete structures with external profiled reinforcement is directly dependent on the deformability and contact strength between materials [3]. The interaction forces between steel and concrete are always located just on embossment ends. Steeper the embossment faces are, the larger slip resistance but too steep embossment leads to failure. Open rib sheet profile have higher the strength than dovetailed design. For the few degree variation of slope of embossment causes larger variation of shear resistance [4].

In the present work the design of metal deck composite slab is carried out using American Standard, British Standard and Euro Standard. The variation of parameters like thickness of deck sheet, compressive strength of concrete & overall slab depths is carried out.

II. METHODOLOGY

The comparative analysis for flexural capacity considering full interaction case between deck sheet and concrete is done as per European Standard EN 1994-1-1:2004, American Steel Deck Institute-ANSI: 2011, British Standard BS-5950: Part-IV:1994, and Indian Standard. The comparison is done with different codes and thickness variation for profile configuration as shown in Figure 1.

Thickness of Deck Sheet Variation Effect on Moment Resistance Capacity: -

The stress block in European and British Standard assume rectangular in shape and for Indian standards partly parabolic and partly rectangular shape is used. American Standard follows the cracked section and uncrack moment of inertia and

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simple bending theory to calculate the flexural capacity of the deck slab.

Other properties such as overall depth of deck 150 mm, grade of concrete 25 MPa and grade of steel 340 MPa are considered.

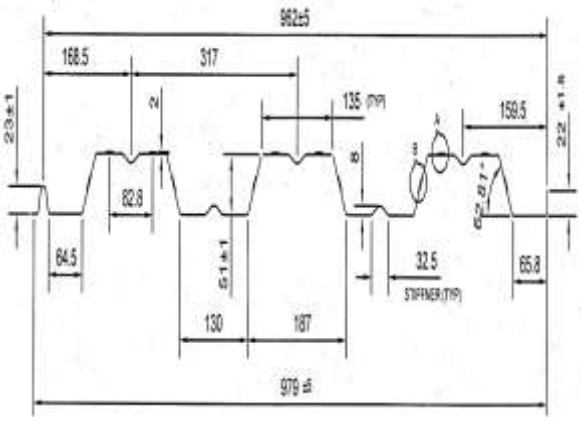

Figure 1 MarSun 51 Deck Sheet Profile

Thickness of Metal Deck Slab Variation Effect on Moment Resistance Capacity-

The comparison is done with different codes and thickness variation for deck slab depth. Other properties such as thickness of deck sheet 0.8 mm, grade of concrete 25 MPa and grade of steel 340 MPa are considered.

Grade of Concrete Variation Effect on Moment Resistance Capacity

The moment resistance capacity of metal deck slab is based on the position of the neutral axis position of slab hence grade of concrete directly affects the capacity of slab. Other properties of deck slab like sheet thickness 0.8mm, yield strength of deck material 340MPa and overall deck slab depth considered for analysis is 150mm.

Thickness of Deck Sheet Variation Effect on Shear Bond Resistance

The Empirical parameters assumed for the longitudinal shear resistance of the deck slab using deck sheet for British Standard mr=163.26, kr=0.0312 and for European Standard mr=172.45, kr=0.249. the deck sheet profile is shown in Figure 1

The other properties such as overall depth of deck slab is 150 mm, grade of concrete 25 MPa and grade of deck sheet 340 MPa are considered.

Fire resistance capacity

At the time of fire, strength of material is reducing with time. To increase the fire resistance capacity of deck slab, the extra reinforcement is required to insert in deck slab. European Standard considered the contribution of deck sheet in fire resistance capacity of slab up-to deck sheets yield strength gets null. The British Standard does not consider the contribution of deck sheet in fire resistance capacity of deck slab. The properties such as overall depth of deck slab is 150 mm, grade of concrete 25 MPa and grade of deck sheet 340 MPa are considered. The reinforcing bar of 415MPa grade for fire resistance is considered at 30mm above the deck bottom.

III. RESULT ANALYSIS

The result analysis is made for the moment resistance capacity of deck slab with parametric variation as fallows;

Thickness of Deck Sheet Variation Effect on Moment Resistance Capacity The results of flexural capacity using four International standards versus thickness of a profile deck sheet are summarized as per Figure 2.

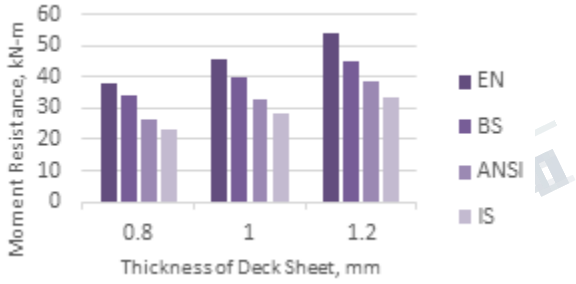

Figure 2 Thickness of Deck Sheet Variation Effect on Moment Resistance Capacity

Thickness of Metal Deck Slab Variation Effect on Moment Resistance Capacity-

The results of flexural capacity using four International standards versus thickness of a deck profile are summarized as per Figure 3.

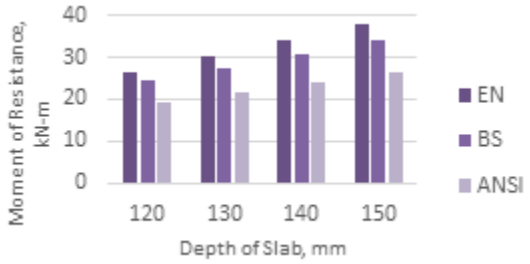

Figure 3 Thickness of Slab Variation Effect on Moment Resistance Capacity

Grade of Concrete Variation Effect on Moment Resistance Capacity

The results of flexural capacity using four International standards versus thickness of a deck profile are summarized as per Figure 4.

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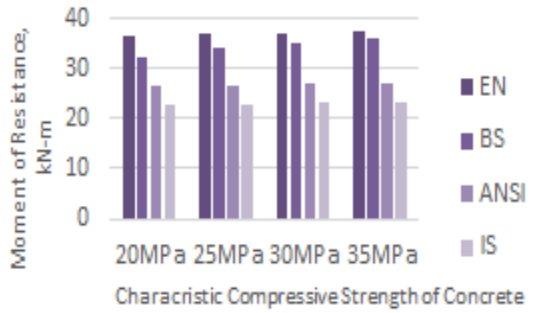

Figure 4 Grade of Concrete Variation Effect on Moment Resistance Capacity

Thickness of Deck Sheet Variation Effect on Shear Bond Resistance

The results of Shear Bond Resistance factors using two different international standards versus thickness of a profile deck sheet are summarized as per Figure 5.

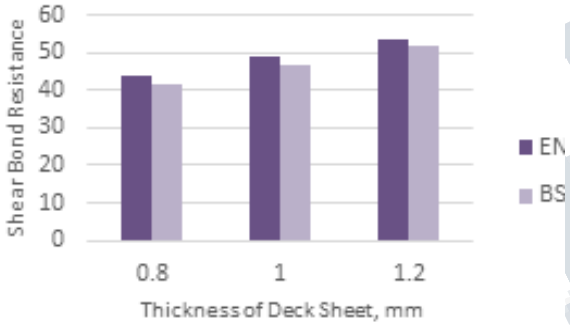

Figure 5 Thickness Variation Effect on Shear Bond Resistance

Fire resistance capacity

The results of Fire Resistance of deck slab for 60min fire using two different international standards versus thickness of a profile deck sheet are summarized in Figure 6.

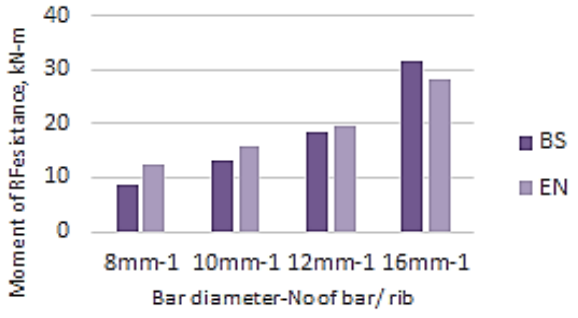

Figure 6 Moment of Resistance in Fire vs bar diameter effect

IV. CONCLUSION

Based on the code studies, generalized program tool is prepared to design composite metal deck slab in construction stage and Limit state stage with parametric variations. The developed program is compared with 'ComFlor' software. These studies are useful to design the metal deck formwork and composite metal deck slab.

Studies are carried out on existing international standards, considering full interaction between deck sheet and concrete. The following conclusions are drawn based the observations from studies;

1. Parametric study indicates that the moment of resistance of slab increases 17.21% and 13.45% with increase in thickness of deck sheet from 0.8mm to 1.0mm and 1.0mm to 1.2mm respectively.
2. The moment resistance capacity of metal deck slab is increases 11.85% and 10.60% with increase in overall depth of slab from 130mm to 140mm and 140mm to 150mm.
3. With increase in fire rating the bending resistance capacity decreases of composite metal deck slab hence fire reinforcements are required to insert at time construction for fire safety.
4. For the longitudinal shear strength of composite metal deck slab is based on the laboratory test result.
5. Up-to 3.5m clear span, the deck slab can be design and constructed without the intermediate props at construction stage.
6. The British Standard BS5950 gives more conservative result for flexure design as compared to European Standard EC4 and American Standard SDI.

REFRENCES

[1] S. Prasannan and L. Luttrell, "Strength formulations for composite slabs," Seventh International specialty conference on cold-formed steel structures, pp. 307-326, 1984.

[2] R. Schuster and W. Ling, "Mechanical interlocking capacity of composite slabs," International Specialty Conference on Cold-Formed Steel Structures, pp. 335-359, 1994.

[3] J. Valivonis, "Analysis of behaviour of contact between the profiled steel sheeting and the concrete," Journal of Civil Engineering and Management, vol. XII No. 3, pp. 187-194, 2010.

[4] M. Ferrer, F. Marimon and M. Crisinel, "Designing cold-formed steel sheets for composite slabs; An experimentally

validated FEM approach to slip failure mechanics," Thin-Walled Structures, vol. Vol. 44, pp. 1261-1271, 2006.

[5] EC4, "Design of composite steel and concrete structures - Part 1-1: General rules and rules for buildings," EUROPEAN STANDARD, 2004.

[6] British Standard, "BS5950- Part 4:Code of practice for design of composite slabs with profiled steel sheeting," 1994.

[7] American National Standard, C-2011 Standard for Composite Steel Floor Deck Slab, Steel Deck Institute, 2011.