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A Parametric Study Of A Concrete Composite Deck

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Abstract — Steel concrete composite deck is a quick and affordable structural method that is employed all over the world. In recent times, India has also become more aware of the tactics. A lean cold-formed steel sheet that can be shaped into any required shape makes up the profile deck. Changing the geometrical shape and strength of material characteristics of the steel concrete deck allows for a critical analysis to be done in this article. Its impact on the placement of the N-A and flexural resistance is examined. Another significant issue with decks is their ductile behavior. In order to assure ductile behavior of composite deck, authors present the limitation assessment of N-A for frequently used steel grades for profile deck. For an open trough type profile deck, the article takes into account differences in concrete thickness, yield strength of the material, and concrete cylinder strength. According to Eurocode EN-1994, N-A depth and MOR calculations are conducted assuming a complete connection between steel and concrete. The findings reveal that changing geometrical and material factors significantly affect flexural capacity and N-A placement.

Keywords—Composite slab; Profile deck; Parametric study; Cold form steel.

I. INTRODUCTION

Concrete is cast over cold-formed, profiled steel sheets in a steel concrete composite floor deck. Cold-formed steel sheet with a thickness of between 0.9 mm and 1.3 mm into a reiterating design of similar ribs creates the steel deck. The composite system is created by pouring lightweight or regular weight concrete onto the deck sheet.

The deck sheets serve as both a tensile reinforcement and a stay-in-place (SIP) formwork for concrete slabs. The profiled decking, shrinkage reinforcement, shear connectors, and temperature reinforcement are all parts of composite floors with profiled decking. The edges of the decks are often supported by steel section beams. Studs that have been welded together or any other local connection makes up the connection between the profiled deck slab and the steel beam. It is required to create an entire composite action between the steel deck and the concrete in order to prevent vertical separation and to withstand horizontal shear at the steel-concrete interface. Either embossments are offered for this purpose or the profile is fashioned into a dovetail form. The resistance of the deck changes along with its profile. In this study, the N-A depth and MOR are estimated for a certain trapezoidal profile form while taking into account variations in other factors.

II. ANALYSIS AND SPECIFICATIONS

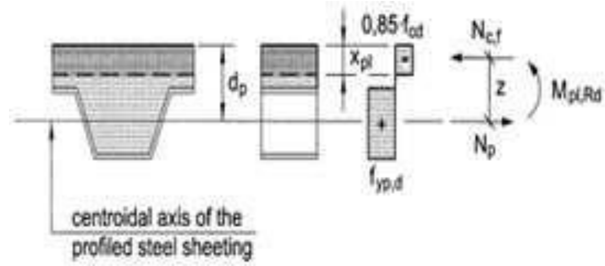
Geometrical and material parameters are taken into account in accordance with Section 9 of the Eurocode EN1994-1-1 (2004). According to Euro code EN1994-1-1, the total depth of composite slab (h) must be at least 80 mm. A minimum of 40 mm of concrete must be present above the flat surface of the sheeting's ribs. The sheet's yield strength must be between 230 N/mm^2 and 450 N/mm^2. Steel sheet and concrete have material factors of safety of 1.1 and 1.5

respectively.

A. Analysis Based on MOR

Complete shear connection may be achieved by embossment or by re-entrant form, is assumed in the analysis. In the event of a complete shear connection, the N-A often rests in the concrete. The stress distribution illustrated in Fig. 1 corresponds to the bending resistance with the N-A lying above the sheet.

Fig. 1 - Stress Distribution for N-A Above the Sheet



According to Eurocode, "Concrete's ultimate stress in compression is 0.85(fck)cy/yc , where (fck)cy is the material's typical cylinder compression strength". Let us use this in below equations.

$$T = A_{pe} * fyp / Y_{ap} \quad (1)$$

$$C = b *x* 0.85(f_{ek})_{ey} / Y_e \quad (2)$$

Design resistance moment of the section is

$$M_{Rd} = Tz \quad (3)$$

Where lever arm z is

$$z = d_p - 0.5x \quad (4)$$

B.Analysis of Balanced Depth of N-A

The ductile behavior of the steel concrete composite deck must be guaranteed. The Euro code EN1994-1-1 does not provide any criterion for a slab's ductile or brittle behavior except from experiment. Here, the proposed balanced depth of N-A value is used to analytically check the under-reinforced section and prevent brittle failure. For a profile deck made of a regularly used steel grade, x/d is determined. An analogy is shown using the strain diagram of a single reinforced R.C.C. section. For the purpose computing the strain value for steel, the safety factor for profile decks is taken to be 1.1. The x/d values for various steel grades are shown in Table 1

Grade of Steel 'f_{yp}' inN/mm^2	**N-A (x/d) in mm**
230	0.552
250	0.536
310	0.515
350	0.501
450	0.476

Table 1 Depth of N-A Proposed for Balanced Section

III. MOR AND DEPTH OF N-A

Calculating the MOR and the depth of the N-A takes into account the trapezoidal form of the profile. For a specific situation, different grades of steel, concrete, and deck depth are used. Also highlighted is the N-A's depth restriction. The trapezoidal profile sheet's geometry is seen in Fig. 2. When determining the size of the deck, embossments are overlooked. The sheet has a 1434 mm^2 surface area, and its

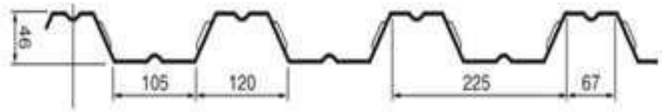


Fig. 2 – Trapezoidal Type Profile Sheet

A. For Cylindrical Strength of concrete 30 N/mm^2, Steel grade of sheet 250 N/mm^2, and Design Thickness 1.18mm

Fig. 3 Shows, the analysis done for MOR and depth of N-A for the section. Fig. 3 displays the values of MOR and the depth of N-A for variations in overall depth and with the material properties. Even if the total depth varies from 90mm to 120mm, the depth of N-A does not change. But, the N-A's balanced depth rises by 33.33%..

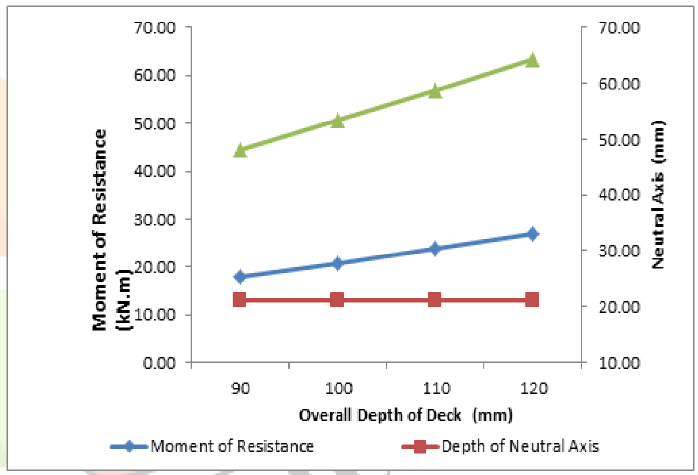


Fig. 3 - Variation as per Change in Overall Depth

effective depth, 110 mm overall, is 90.14 mm.

B. For Grade of Sheet 250 N/mm^2, Overall Depth 120 mm, and Design thickness 1.18 mm

Fig. 4 Shows the values of the MOR and the depth of the N-A for varying concrete strengths. And further geometrical requirements are Overall Depth of 120 mm, Steel Sheet Grade of 250 N/mm^2, and Design Thickness of 1.18 mm. On changing, the strength of concrete raised from 30 N/mm2 to 45 N/mm^2, the N-A's balanced depth remains the identical, but the N-A's actual depth decreases by 39.5%.

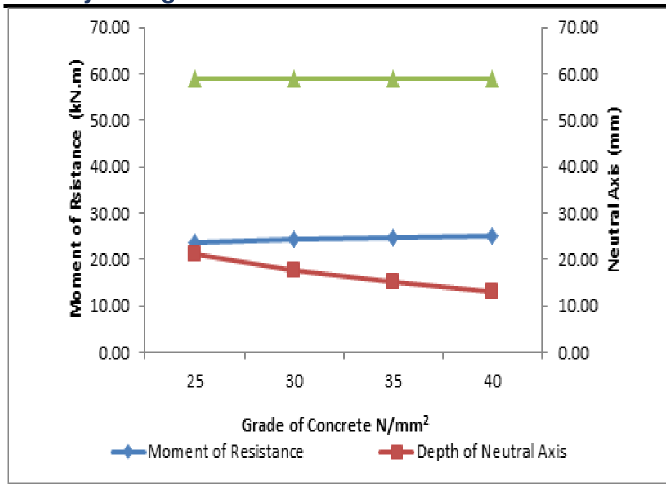


Fig. 4 - Concrete Strength Variation

C. For Concrete Strength 30 N/mm^2, Overall Depth120 mm, and Design thickness 1.18 mm

Fig. 5 displays the MOR and depth of the N-A for variations as per steel grade. Overall Depth 120 mm, Cylindrical Strength of Concrete 30 N/mm^2, and Design Thickness 1.18 mm are the additional geometrical requirements. The depth of N-A for the balanced section reduces by 14.36% when the steel grade is increased from 250 N/mm^2 to 450 N/mm^2, while the N-A's actual depth is almost doubled the value.

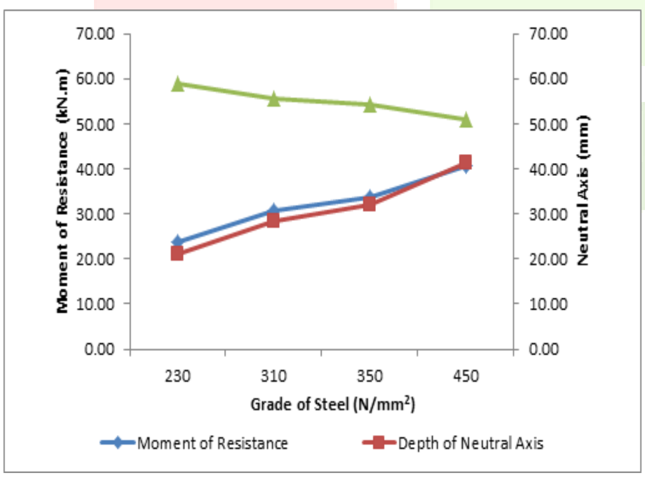


Fig. 5 - Variation as per Various Grade of Steel

IV. CONCLUSIONS

An open trough type deck floor of specified shape is analyzed for the depth of N-A and MOR. The MOR varies depending on the steel, concrete, and total depth of the deck. When the deck's total depth is raised from 90 mm to 120 mm, there is a 50.37% increase in the MOR. The MOR increases by 4.98% if the concrete grade is raised from 30 N/mm^2 to 45 N/mm^2. 250 N/mm^2 to 450 N/mm^2 of better quality steel result in a 70.75% increase in moment. The value of the MOR increases noticeably as steel quality increases. Thus, by adjusting the different parameters as illustrated, the ideal combination may be found for a given form of profile deck. Limiting values of N-A for frequently used steel grades are recommended when factor of safety is taken into account at 1.1. The N-A's depth must be verified by a limitation value to prevent brittle failure of the slab. The value of the real depth of the N-A grows dramatically with an increase in steel quality. Actual N-A for the deck under consideration is considerably lower than balanced section N-A. However, in order to reduce the amount of concrete in the tensile, the ideal N-A value may be further examined.

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