Further Studies on Composite Beams with Formed Steel Deck

Etudes complémentaires sur des poutres mixtes à platelage métallique

Weitere Untersuchungen über Verbundträger mit Stahlblechdecken

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After publication of our paper in the Preliminary Report, Tenth Congress IABSE (1), additional tests were undertaken on composite beams with 3 in. (76 mm) formed steel deck with a w/h ratio equal or greater than 2.0 In addition, it was desirable to provide further experimental data on shear connectors with an increased embedment length above the rib. In the study reported in Ref. 1, most stud shear connectors were embedded 1½ in. (38 mm) above the rib (H - h). In the additional beam tests, all connectors were embedded 2 in. (50.8 mm) above the rib in order to optimize the shear connector resistance. The rib geometry provided w/h ratios of 2 and 2.42.

As a result of the additional beam tests, the shear connector resistance was re-evaluated and a slight modification suggested by Lim (2) was introduced into Eq. 2 of the preliminary report. It was found that replacing the coefficient 0.6 with $0.85/\sqrt{N}$ provided a better fit to the test data with single connectors in a rib, as well as providing for more than two connectors in a rib. This results in the expression:

$$Q_{rib} = \frac{0.85}{\sqrt{N}} \cdot \frac{H - h}{h} \cdot \frac{w}{h} \cdot Q_{sol} \leq Q_{sol} \qquad (1)$$

where N = number of shear connectors placed in a rib. The parameters w, h and H were defined previously (w = average rib width, h = height of rib, H = height of stud shear connector) and Q_{sol} is the connector strength in a solid slab.

Figure 1 shows the 56 beam tests results summarized in Fig. 4 of Ref. 1 as well as 19 additional beam tests including one test with three connectors per rib. The plot shows that Eq. 1 provides a good estimate of flexural capacity for 1, 2 or 3 connectors in a rib. Pushoff tests summarized in Ref. 3 indicate the same type of change in connector capacity with varying numbers of shear connectors in a rib. Equation 1 provides the same connector capacity as Eq. 2 in the preliminary report when two connectors are placed in a rib. For a single connector a higher capacity results which approaches the solid slab value for longer embeddment lengths.

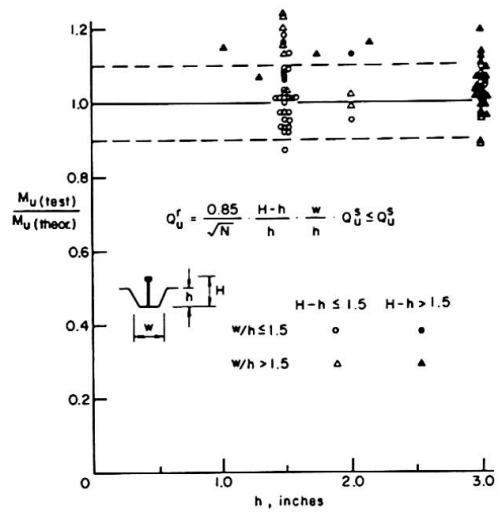

Fig. 1

In the Preliminary Report, Eq. 4 was incorrectly shown. It was intended to be expressed as:

$$I_{eff} = I_s + \sqrt{\frac{V'h}{Vh}} (I_{tr} - I_s) \quad (2)$$

The shear connection ratio was missing its exponent in the Preliminary Report.

All additional tests verified the applicability of Eqs. 1 and 2 to composite beams with formed steel deck, including deck with larger w/h ratios.

REFERENCES

1. Grant, J. A., Fisher, J. W. and Slutter, R. G., High Strength Steel Composite Beams with Formed Steel Deck, Preliminary Report, Tenth Congress, IABSE, Tokyo, 1976.
2. Lim, L. C., Private Correspondence, April 28, 1976.
3. Iyengar, S. H. and Zils, J. J., Composite Floor System for Sears Tower, AISC Engineering Journal, American Institute of Steel Construction, Vol. 10, No. 3, 1973.

SUMMARY

Additional tests on composite beams with formed steel deck verified that the w/h ratio could be extended beyond 2. A modification to the expression developed for shear connection capacity was found to provide for differing numbers of shear connectors installed in a rib.

RESUME

Des essais complémentaires sur des poutres mixtes avec platelage métallique ont montré que le rapport w/h (largeur de la nervure/hauteur de la nervure) peut être étendu au-delà de 2. Une modification de l'expression développée pour la résistance des connecteurs a permis de tenir compte du nombre de connecteurs par nervure.

ZUSAMMENFASSUNG

Zusätzliche Versuche an Verbundträgern mit Stahlblechdecken zeigten, dass das w/h Verhältnis (Rippenbreite/Rippenhöhe) über 2 hinaus vergrössert werden darf. Eine Erweiterung des Ausdruckes für die Dübeltragfähigkeit, die die Anzahl der Dübel pro Rippe berücksichtigt, ist gefunden worden.