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Lateral Load Distribution in Composite Beam-Slab Bridges

Répartition latérale des charges dans les ponts mixtes acier-béton

Querverteilung der Verkehrslast bei Verbundbrücken

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1. INTRODUCTION

Field tests and analytical studies on simple-span beam slab bridges with prestressed concrete I-beams have indicated that the lateral distribution of the design loads are different from that assumed by the specifications (Ref. 3,4). The reported pilot study was undertaken to assess the reliability of the specifications on the lateral load distribution and finite element modeling of simple span beam-slab bridges with reinforced concrete deck and steel girders (Ref. 2).

2. LATERAL LOAD DISTRIBUTION

The standard practice in the design of the bridge beams of a beam-slab superstructure for the live loads is through the use of "Load Distribution Factors" (Ref. 5). The distribution factor is defined as the fraction of the wheel load applied to the longitudinal beam. In composite bridges, the distribution factor for an interior beam is taken as S/5.5, where S is the beam spacing in feet. For the exterior beam the distribution factor is the reaction of the wheel loads obtained by assuming the deck slab to act as a simple span beam between the exterior beam and the first interior beam. This approach simplifies the design process; however, since the lateral load distribution is considered to be the function only of the spacing of the beams, a more detailed study was needed to verify the validity of the design process.

3. TEST STRUCTURE

The test structures considered in the study are the AASHO Test Bridges designated as 2B and 3B which were field tested and reported in detail in Reference 4. The bridges have a span of 50', a width of 15' with three steel I-beams spaced at 5'-0" on centers. Bridges 2B and 3B are identical except for the difference in beam sizes; W18 x 50 for Bridge 2B and W18 x 60 for Bridge 3B (Fig. 1). The steel beams have cover plates and are connected to the bridge deck by channel shear connectors. The test vehicle was a two axle truck with 6.8 kips front and 14.3 kips drive axle loads. The axle loads were spaced at 64 in. The terms exterior and interior in the figure and table follow the terminology of Reference 4; from a designer's standpoint, they correspond to exterior beams, and the center to interior beams.

4. COMPARISON OF ANALYTICAL WITH FIELD TEST RESULTS

Verification of the finite element solution, Fig. 1, can be made by comparing the moments carried by the beams and the beam moment percentages from the analysis and the field test results. For this comparison, the truck is placed directly over the interior beam. It can be seen from Table 1 that the analytical results are in agreement with the test results for both structures. The analytical results in general gave a slightly larger percent of the load carried by interior beams and a larger total moment compared to the test values. This suggests a slight loss of composite action.

5. EFFECT OF COMPOSITE AND NON-COMPOSITE CONSTRUCTION

The effect of composite versus non-composite construction can be seen in Table 1. The structures designated non-composite were analyzed by neglecting any composite interaction between the beams and the slabs. The results show a decrease in the total moment carried by the beams and consequently an increase in the total moment carried by the slabs. There is, however, practically no change in the distribution of the moments carried by the beams.

6. DESIGN AND ANALYTIC DISTRIBUTION FACTORS

The analytic distribution factors for a beam were determined by positioning the vehicle load across the section of the bridge such that the maximum moment response is obtained for that beam. Figure 2 illustrates the schematic comparison of the design and the analytic results both for composite and non-composite cases. It can be seen that the design values overestimate the center beam moment but underestimate the interior and exterior beam moments. In view of current construction practices, it can be assumed that actual bridges are closer to full composite than full non-composite. This in turn, in view of Fig. 2, indicates that present specifications do not reflect the actual bridge behavior.

7. REFERENCES

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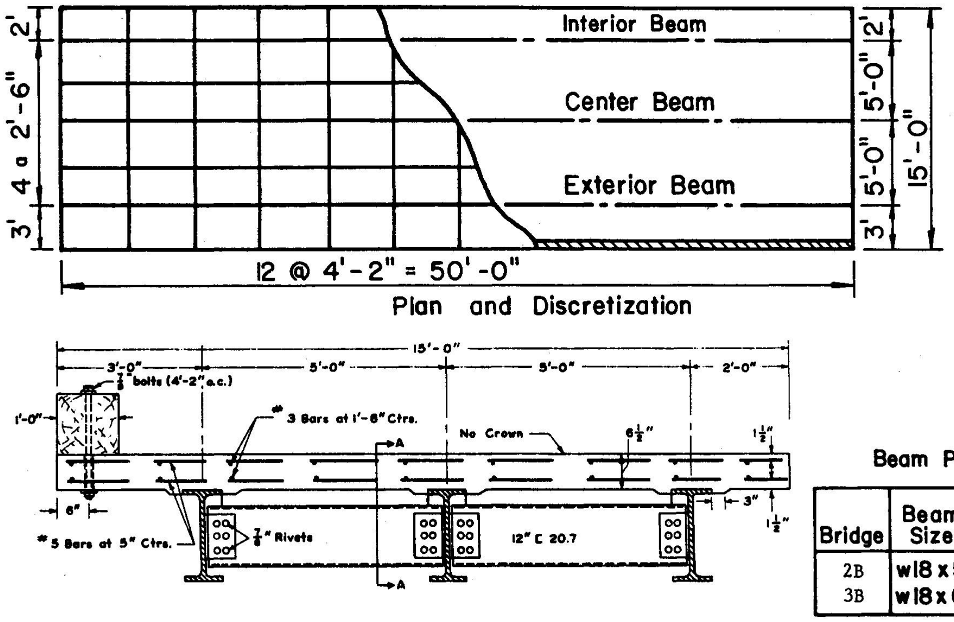
TABLE 1 MOMENT PERCENTAGES

Bridge		Σ Beam Moment / Truck Moment	Beam Moment/ Σ Beam Moment		
			Interior	Center	Exterior
2B	FIELD TEST (Ref. 4)	89.30	34.0	32.0	34.0
	Finite Element (composite)	93.57	32.6	34.2	33.2
	Finite Element (non-composite)	82.13	33.2	33.8	33.0
3B	FIELD TEST (Ref. 4)	92.10	33.8	33.4	29.2
	Finite Element (composite)	94.59	32.7	34.3	33.0
	Finite Element (non-composite)	83.85	33.2	33.8	33.0



Beam Properties

Bridge	Beam Size	I_x (In^4) w/Coverplate
2B	W18 x 50	1040
3B	W18 x 60	1176

Fig. 1 Test Bridge; Left Beam = Exterior Beam, Right Beam = Interior Beam (Ref. 4)

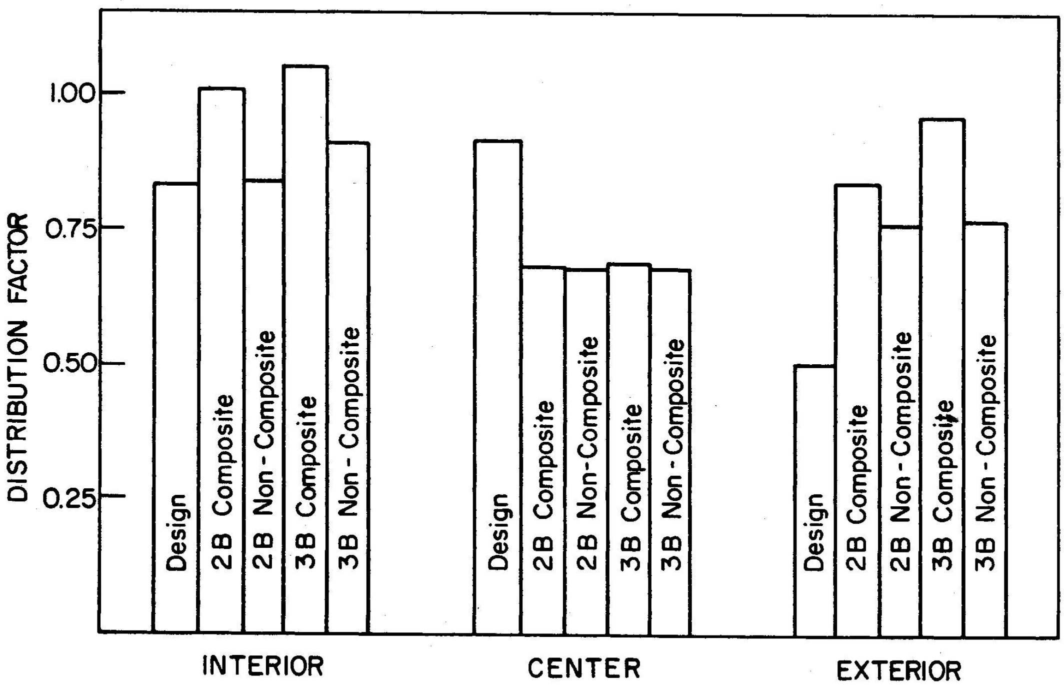


Fig. 2 Distribution Factors, Design vs. Finite Element Analysis

SUMMARY

This paper presents the lateral load distribution for two composite bridges. The finite element method was used to analyze the bridges and to determine load distribution factors. The results were shown to agree with the field test results.

RESUME

Les auteurs étudient la répartition latérale des charges dans deux ponts à poutres mixtes. Les coefficients de répartition sont déterminés à l'aide d'une méthode aux éléments finis. Ces résultats théoriques sont en bon accord avec ceux donnés par des essais.

ZUSAMMENFASSUNG

Die Querverteilungslinien für zwei Verbundbalkenbrücken wurden mit Hilfe der Methode der finiten Elemente bestimmt. Die theoretischen Ergebnisse stimmen mit denjenigen aus Versuchen befriedigend überein.