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Wide Beam Shear Behavior with Diverse Types of Reinforcement. Paper by S. E. Mohammadyan-Yasouj, A. K. Marsono, R. Abdullah, and M. Moghadasi

Discussion by Eva O. L. Lantsoght

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The authors should be complimented on their study of different types of shear reinforcement for wide beams. The study of wide beams as well as slabs in one-way shear has only gained interest in the last few years, and additional experimental research is welcomed to deepen the understanding of this problem. The discusser invites the authors to elaborate on the following points, to facilitate the analysis of their experimental results:

1. Can you provide more details about the support? Was the specimen supported over the full width? What were the dimensions of the support? Did you use a mechanical hinge for the support? What was the support material and what was its stiffness?

2. The area through which the load is applied is a column stub with a width smaller than the full width of the specimen. Depending on the support conditions (hence the questions in Point 1), the width of the specimen might play a role,[31] and change the shear-carrying mechanism from the two-dimensional (2-D) behavior of beams to the three-dimensional (3-D) behavior seen in slabs under concentrated loads failing in one-way shear. Was there an effect of the reduced size of the load as compared to the full width of the beam in the experiments? What was the cracking pattern on the soffit of the specimens?

3. Could you provide a sketch and photograph of the test setup?

4. Why was the average specified concrete compressive strength f_c' = 29 MPa (4206 psi) smaller than the nominal specified strength of 30 MPa (4351 psi)? Was 30 MPa (4351 psi) a design value or average value? How many cylinders did you test, and what was the standard deviation on the results? What type of coarse aggregate was used (parent rock and source)? Did you calculate the capacity according to ACI 318-08[11] and Eurocode 2[12] based on f_c' = 29 MPa (4206 psi) (refer also to Point 11)?

5. The percentage of longitudinal flexural reinforcement that was used is rather high, with ρ_w = 1.4%. A higher percentage of flexural reinforcement is of course necessary to ensure that shear failure occurs in the experiment before flexural failure. For practical cases, a flexural failure before a shear failure is designed for. What was the effect of your rather high percentage of flexural reinforcement for comparison to practical cases, and your resulting recommendations for the shear reinforcement?

6. The authors state that "To consider the influence of the middepth horizontal shear bars on the shear capacity of the specimen, Eq. (3a) or (3b) can be used in this study." Where in Eq. (3a) or (3b) did you take the effect of the middepth bars into account?

7. When comparing the Eurocode provisions for shear to experimental results, the value of $C_{Rd,c}$ should not be taken as 0.18. A value of $C_{Rd,c}/\gamma_c$ = 0.18/1.5 = 0.12 corresponds to a characteristic value, but that does not immediately relate $C_{Rd,c}$ = 0.18 to average values. The most commonly used value for $C_{Rd,c}$ to compare to experiments is 0.15,[32] but more recent analyses[33] of an extended database of shear experiments[34] has led to a recommended value of $C_{Rd,c}$ = 0.1385.

8. Could you give more details about the finite element modeling, such as type of elements, material model, and basic assumptions?

9. There are different ways of defining the shear span: the shear span a is usually taken as the center-to-center distance between the load and the support, and the clear shear span a_v is usually taken as the face-to-face distance between the load and the support. Again, the geometry of the support is important here. However, assuming the width of the support as 0 m (until the width of the support is known), the shear span a would be 0.7 m (27.6 in.) and a/d = 3.33. Based on the clear shear span a_v = 0.55 m (21.7 in.), the ratio a_v/d becomes 2.6.

10. For a more complete comparison, the authors are encouraged to take into account the self-weight of the specimen and take this into account when defining the maximum load on the structure or the maximum sectional shear. The self-weight adds 9.2 kN (2.1 kip) to the total load.

11. How did the authors calculate $V_{Rd,c}$ and the resulting predicted maximum load according to the Eurocode of 379 kN (85 kip)? Could you please provide the calculation? Did you use an average or characteristic value for the concrete compressive strength?

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AUTHORS' CLOSURE

The authors would like to acknowledge the discussion and comments on the published work. The authors' response is presented in the following:

1. Each line support was contacted to the full width of the specimen by a roller with a diameter of 75 mm (3 in.) made by high-strength steel material.

2. The column size was a projection of a real column supporting a wide beam. To limit variables, the geometry of concrete parts in all specimens was similar and the only difference in the specimens was reinforcement arrangement. Because the loading was continued to clarify the cracks after ultimate failure of each specimen, there are no more details on the crack patterns on the soffit of the specimens.

3. The sketch of test setup was presented in Fig. 1(c) and a photograph of the test setup is shown in Fig. 8.

4. The ordered ready mixed concrete from the local supplier was Grade 30 and after compression tests on the 12 cylinders the average strength f_c' was 29 MPa (4.2 ksi). The standard deviation was 5.4 MPa (0.78 ksi). The calculated capacity according to ACI 318-08[11] and Eurocode 2[12] was based on f_c' = 29 MPa (4.2 ksi).

5. The main purpose of this high percentage of flexural reinforcement was to ensure shear failure before flexure failure. Because it was a first research on the application of independent bent-up bars in wide beams, the specimens were designed to limit variables and after providing a general understanding on the application of this type of shear reinforcement in this research, more studies for practical cases can be conducted.

6. To consider the influence of middepth horizontal shear reinforcement, the total area of this shear reinforcement was added to the area of longitudinal tensile reinforcement to calculate ρ_w in Eq. (3a) or (3b).

7. The authors agree with the discusser's opinion, but in the case of using the recommended value of $C_{Rd,c}$ = 0.1385, the value of total capacity of each specimen by Eurocode 2 in Table 3 becomes lesser and shows that this equation is conservative to predict the shear behavior of wide beams.

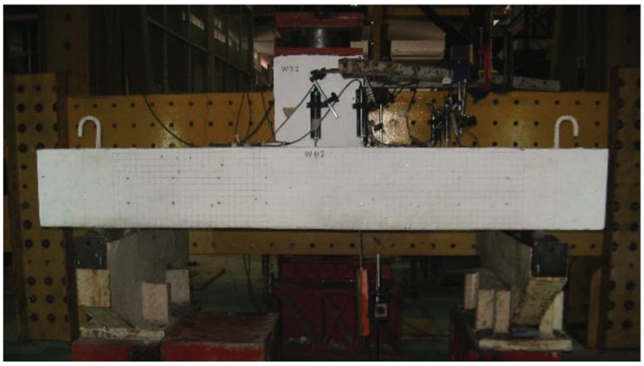

Fig. 8—Photograph of test setup.

8. The finite element part in this research was presented for a link to the later parametric study on the shear behavior of wide beams. This parametric study is under process and further details will be comprehensively presented after the result is published. However, the concrete element used in finite element modeling was solid (3-D solid). The bars were modeled as a truss element. The connection between concrete and bars was considered as embedded. The nonlinearity of concrete uses the Hognestad model and the stress-strain variation of steel was assumed as a bilinear curve.

9. The top part of the support that was contacted to the specimen was with a circular cross section; therefore, the clear shear span was assumed to be from the center of support to the face of column stub.

10. In comparison to the large differences between ultimate loads, the self-weight was assumed to be little and if the self-weight is calculated based on concrete self-weight, the specimens were designed with similar concrete geometries and it does not have a significant effect on the main results.

11. Equation (7a) or (7b) was used to calculate $V_{Rd,c}$. The average value of concrete compressive strength, the real steel bar diameter, and d = 210 mm (8 in.) were used in the equation. Therefore, any change in the calculations may be due to rounding of these values.