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Objekttyp: **Article**

Zeitschrift: **IABSE reports = Rapports AIPC = IVBH Berichte**

Band (Jahr): **64 (1991)**

PDF erstellt am: **17.05.2024**

Persistenter Link: https://doi.org/10.5169/seals-49339

Shear Strength of High Strength Concrete Beams

Cisaillement de poutres en béton armé à hautes performances

Schubtragfähigkeit hochfester Betonbalken

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1. INTRODUCTION

The primary objective of this study is to investigate the shear strength of high strength concrete beams with and without stirrups. Thirty-three beams, of which twelve were without stirrups, having compressive strength in the range of 64 MPa to 90 MPa were tested. All specimens were 200 x 300 mm in cross section. The main variables considered were concrete strength, shear span to effective depth ratio (a/d), and the amount of stirrups ($p_v f_y$). The beams were tested by two point loadings symmetric about midspan as shown in Fig. 1. The a/d used were 2.0, 2.5, 3.0, and 3.5 respectively. The amount of stirrups designed were 0.5, 0.75, and 1.0 times the estimated V_{cr}. In the analytical study, the effectiveness factors of high strength concrete beams, according to the test results of authors and other investigators, were calculated based on the theory derived by M. P. Nielsen.

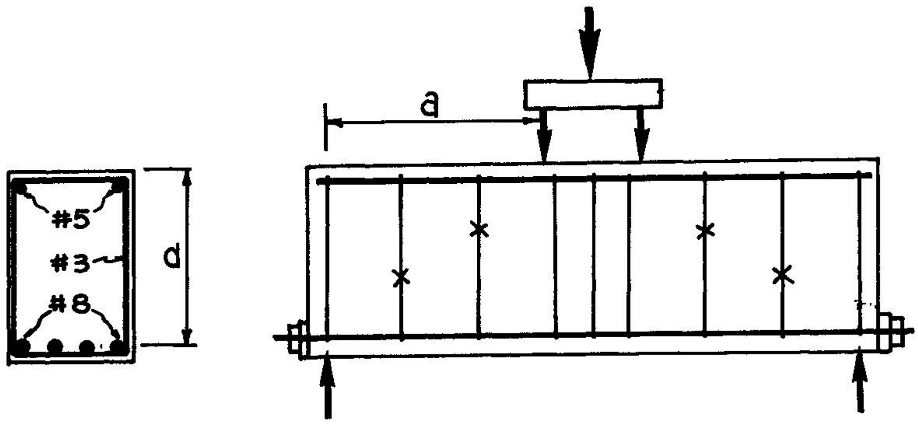

Fig. 1 Test specimen and loading arrangement

2. MATERIALS, SPECIMEN, AND MEASUREMENTS

The cement used was ordinary portland cement. River sand with F.M. of 3.0 and crushed stone with maximum size of 9 mm were used. Two mix proportions of high strength concrete, having water cement ratio of 0.26, were prepared in the laboratory. The first mix for those having compressive strength up to 70 MPa has a cement content of 600 Kg/m^3. In the second mix, 5 per cent of cement by weight was replaced by silica fume to improve the strength. The volumetric ratio of fine to total aggregate (S/a) was 0.37. At least five 10 x 20 cm cylinders from the same batch of beam were cast to determine the compressive strength. The cylinders and beams were covered by wet burlap until test. The strains of stirrups and longitudinal steels, deflections at midspan and quarter span were monitored throughout the test. The load-strain relationship of concrete strut was measured using clip-on gage with both ends attached to the appropriate holes drilled prior to the start of test.

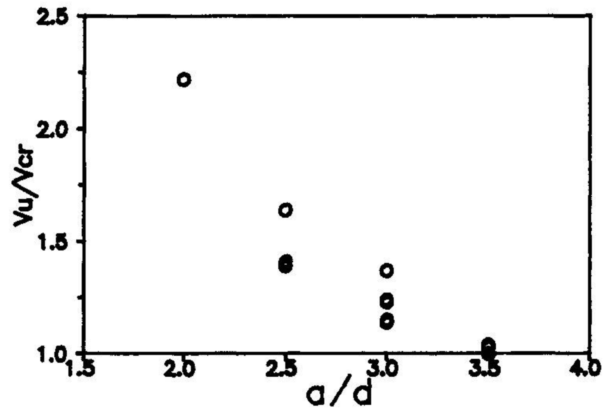

Fig. 2 Measured V_u/V_{cr} of beams without stirrups

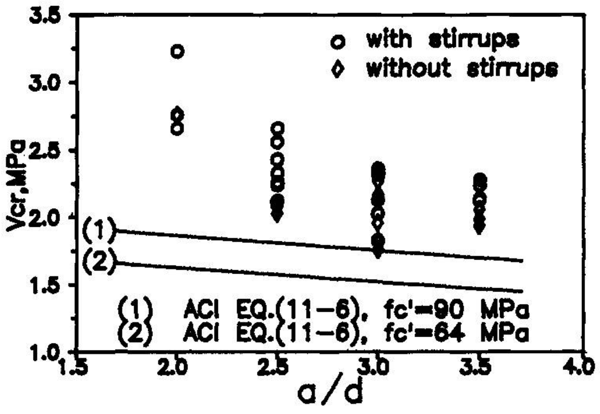

Fig. 3 Comparisons of V_{cr} measured vs. predicted

3.CONCLUSIONS

Some conclusions were drawn based on the test results:

1. Most of the beams without stirrups failed in shear - tension while those with stirrups failed in shear - compression.

2. The ratio of measured ultimated shear strength (V_u) to inclined shear strength (V_{cr}) for various a/d of beams without stirrups is shown in Fig. 2.

3. The inclined shear strength is slightly higher for beams with stirrups. The shear strength contribution of concrete predicted by current design provision (1989 AASHTO or ACI 318-89) is still conservative as shown in Fig. 3.

4. For the same a/d, the shear strength contribution of stirrups is more significant for beams with lower $p_v f_y$.

5. The effectiveness factors of high strength concrete beams without stirrups vary from 0.2 to 0.4, while those with stirrups vary from 0.4 to 0.6.