

Shear Resistance Mechanism of Reinforced Concrete Haunched Beams without Shear Reinforcement

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Abstract: Reinforced concrete haunched beams (RCHBs) are widely used in bridges and framed buildings, however, there have been limited studies on the shear capacities of RCHBs. The aim of this study is to clarify the shear resistance mechanism of RCHBs without shear reinforcement. A four-point bending test is conducted on three RCHBs with different haunch positions. Crack patterns, load-displacement curves and failure modes are investigated to determine the shear capacity of RCHBs. It is found that the position of the bends in the tensile reinforcement at the haunches highly influences crack propagation, failure mode and shear capacity.

1. Introduction

Reinforced concrete haunched beams (RCHBs) are often used in simply supported and continuous bridges, framed buildings for economic and aesthetic reasons. However, there is little experimental data available for predicting the shear behavior of RCHBs. Moreover, no rational and economical design method has yet been established in JSCE design specifications [1]. In this study, the effect of haunch position (with respect to the loading point) on the shear resistance mechanism of RCHBs without shear reinforcement was investigated.

2. Specimen details and experimental setup

Figure 1 and Table 1 give details of the three tested beams. The inclination of tensile bars and the bottom surface, α was fixed at 11.3 degrees. The experimental parameters of these beams were the distance of the haunch from the loading point, which is also used to name the specimens. The non-test portion of the beam span was provided with stirrups so as to ensure that failure occurred in the test portion. During the four-point bending tests, the mid-span deflection and the strain in the tensile bars at various locations were measured using displacement transducers and strain gages. Also crack propagation on the surface of the test span was captured during loading by taking pictures.

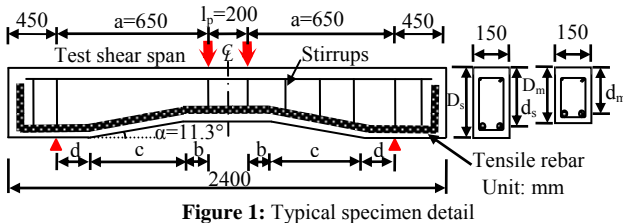


Figure 1: Typical specimen detail

Table 1: Specimens details and material properties

No.	f_c' (N/mm ²)	b (mm)	c (mm)	d (mm)	d_s (mm)	d_m (mm)
H-100	33.56	100	250	300	250	200
H-200	29.62	200		200		
H-300	36.68	300		100		

b : distance between loading point and beginning of haunch;
 d_s : effective depth at support; d_m : effective depth at mid span.

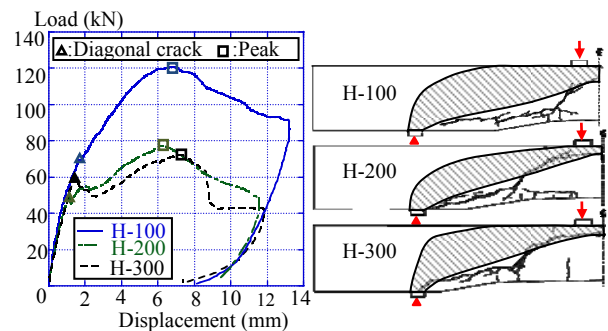


Fig. 2: Load-displacement curves

Fig. 3: Cracks at peak load

3. Experimental results

Figure 2 shows the resulting load-displacement curves. The shear capacity of beam H-100 was the largest (60.3 kN), with the values for H-200 and H-300 smaller by 36% and 40%. Figure 3 shows the crack patterns of the specimens at the peak load. In all beams, cracking initiated where the tensile reinforcing bars were bent at haunch and proceeded along the inclined reinforcing bars towards the loading point.

Due to the presence of debonding cracks, arch action developed in the test shear span. The amount of concrete above the diagonal cracks varied according to the individual crack pattern and that resulted in the arch action having a varying contribution to resisting shear force. A larger amount of concrete above the diagonal cracks resulted in higher shear capacity.

4. Conclusions

The distance of beam haunches from the loading point has a significant effect on the shear capacity of the beam. The haunched shape of RCHBs results in arch action even in slender beams, but contributions of the arch action varied in accordance to variations in the crack pattern.

References

- [1] Japan Society of Civil Engineers (JSCE), "Standard Specifications for Concrete Structures [Structural Performance Verification]," 2002.