V-327 INFLUENCE OF LOADING PATTERN ON THE FLEXURAL BEHAVIOR OF PC BEAMS WITH LARGE ECCENTRICITIES

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1. INTRODUCTION

Studies have shown that the ultimate flexural strength of externally prestressed beams is comparatively smaller than the one with bonded beams [1,2]. One of the possible methods of enhancing the flexural strength of such beams is to place the tendons with large eccentricities. In a previous study, an experimental investigation was carried out on single span beams with large eccentricities to study the influence of effective prestressing on the ultimate flexural strength [3]. In this study, the effect of loading pattern on the flexural behavior of such beams is investigated using single span specimens with large eccentricities. The results of this test are discussed in this paper with emphasis on the influence of loading pattern on the ultimate strength and increase in external tendon stress.

2. EXPERIMENTAL METHODOLOGY

The test series consists of two single span beams that were loaded with different loading pattern. The test variables and materials used are given in Table 1. The beams are 5.4 m long with span length of 5.0 m as shown in Fig. 1. The specimens are rectangular shaped having a width and depth of 400 mm and 150 mm respectively. Three deviators were provided in the form of steel struts at a spacing of 1.25 m. The beams were provided with combined prestressing consisting of pre-tensioned internal bonded tendons and post-tensioned external tendons. The maximum eccentricity of the external tendon is 625 mm at the midspan giving a span to sag ratio of 8. The tendon layout was designed to provide a near parabolic tendon profile. The difference between the two specimens is the type of loading, where one beam was loaded with two point loading and the other with one point loading as shown in Fig. 1. The amount of internal prestressing was designed to have an effective prestress force of about 200 kN sufficient to resist the self weight of the specimen during handling and before applying the external prestressing. This was provided by 4 nos. of 9.3 mm SWPR7A type pre-tensioned cables. Rectangular stirrups made of 10 mm bars were tied at a spacing of 100 mm along the beam. The design strength of concrete was specified as 50 MPa in 14 days. For external prestressing 10.8 mm diameter SWPR7B type cable was used with a design value of 25 kN. Teflon sheets were inserted between the tendons and deviators to reduce friction. In two point loading case, the load was applied at a distance of 1.25 m and in the case of one point loading it was applied at the midspan as shown in Fig. 1.

Table 1. Test variables and materials

No.	Loading type	Tendon eccentricity (mm)	Prestressing tendon		Concrete strength (MPa)
			Internal	External	
A	Two point	625	1T9.3*4 (4 x 50 kN) ($55\% f_{pu}$)	1T10.8*1 (25 kN) ($20\% f_{pu}$)	50
B	One point				

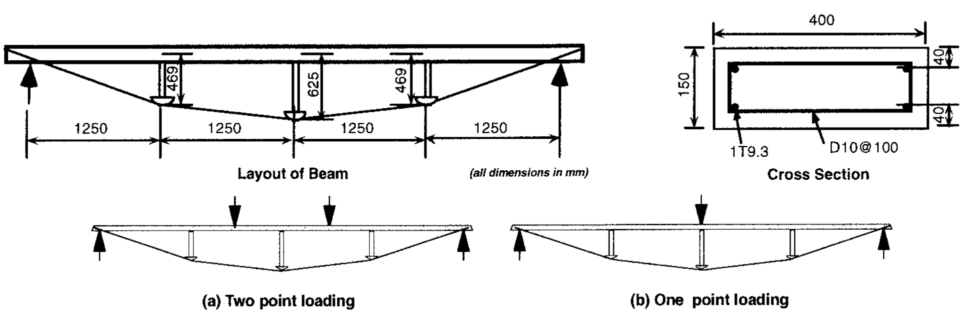

Fig. 1 Dimension of test beams and loading pattern

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Table 2. Summary of experimental results

No.	Cracking load (kN)	Maximum load (kN)	Ultimate deflection (mm)	Ultimate tendon force (kN)	Failure mode
A	37.0	94.4	130.3	118.1	crushing, yielding of tendon
B	29.2	82.2	120.1	117.8	

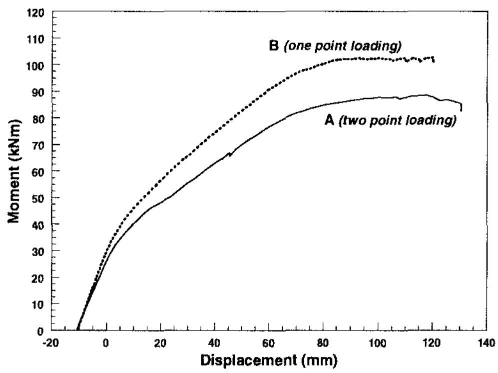

Fig. 2 Moment-displacement characteristics

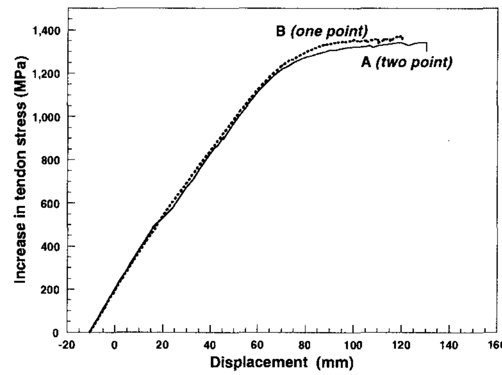

Fig.3 Increase in tendon stress

3. EXPERIMENTAL RESULTS

The experimental results are summarized in Table 2. The failure mode was due to crushing of concrete at the loading point in both the specimens. The cracking load was about 37 kN and 29 kN for Specimens A and B respectively. It should be noted that although these loads are of different values, the corresponding moments that give the moment of rupture are nearly the same, at a value of about 35 kNm. The moment displacement characteristics are compared in Fig. 2. The ultimate load for the two specimens was 94.5 kN and 82.2 kN corresponding to 88.6 kNm and 102.9 kNm respectively. The difference of this moment is about 15%. This is attributed to the tendon eccentricity at the critical section, which was 547 mm and 625 mm in Specimens A and B respectively, having the similar ratio as the moment of resistance. The deformation profile of Specimen A was nearly a trapezoidal shape at the ultimate stage, similar to the shape of the applied moment. In Specimen B, loaded at midspan, the profile at the ultimate stage was nearly triangular shape with maximum deflection at the midspan.

Considering the stress increase in single span beams, it can be seen that the two specimens showed similar behavior as shown in Fig. 3. This behavior is different from the previous findings [4], where for one point loading the stresses are generally smaller than the two point loading case. This contradiction can be attributed to the tendon layout used in the experiment, which was a near parabolic shape, whereas in the previous investigation a trapezoidal tendon layout typically used in normal structures was considered. In both the loading cases, the yielding of external tendon was observed.

4. CONCLUSIONS

An experimental investigation was conducted with single span beams with large eccentric tendons to study the effect of loading pattern. The following conclusions are made from this study.

- The ultimate moment capacity was influenced by the type of loading as well as the tendon layout. However, the ratio of moment to eccentricity was found to be the same for the two specimens.
- The rate of increase in external tendon stress was not affected by the loading pattern, which is attributed to the shape of the external tendon layout.

References

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