V-66 NEW METHOD FOR TESTING ROTATIONAL CAPACITY OF REINFORCED CONCRETE PIER

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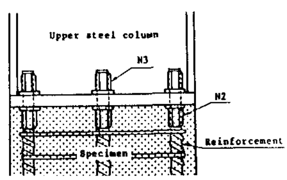
1. INTRODUCTION

To evaluate the deformational capacity of reinforced concrete bridge pier, it is feasible if rotational capacity of the plastic hinge formed by yielding of main reinforcements is predetermined. As a result, this rotational capacity is studied experimentally by introducing a new testing method which only the critical region of the pier is to be tested. Experimental work has been carried out and satisfactory results are obtained. This paper describes the method together with testing results indicating efficiency of this testing method.

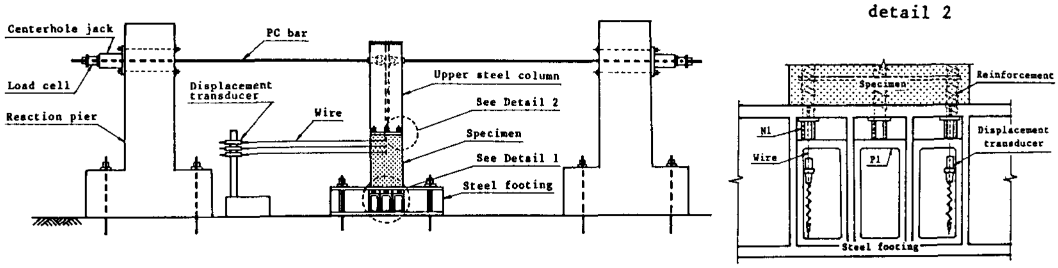
2. APARATUS AND EXPERIMENTAL LAY OUT

Fig.1 shows setting of experimental aparatus which details are given in the later drawings. Set of aparatus consists of steel footing and upper steel column which accomplishes the objective of making only critical portion of pier by concrete. Load is applied through PC bars ,connected at the loaded sides of upper steel column, by two centerhole jacks installed at both reaction piers. Deflections at 1.75d, 2.0d and 2.25d (d:Effective depth) from footing top are measured by displacement transducers at both unloaded sides of the specimen to obtain rotation at distance 2.0d. In order to be convinced that it would not be located within the plastic hinge zone the distance 2.0d from footing top was elected to obtain rotation of plastic hinge [1]. Pushing in and pulling out of the reinforcements from the footing at four corners of the specimen are measured by wire and centerhole displacement transducers, shown in Fig.2, to get rotation due to this phenomenon. Base sliding relative to footing is also observed by transducers. Deflections at 1.75d, 2.0d and 2.25d are derived from substraction of deflection due to pushing in and pulling out of reinforcement and base sliding from measured deflections in order to obtain intrinsic rotation of plastic hinge. Yielding of reinforcements locating along the direction parallel to loading direction is inspected by electrical strain gauges attached to the reinforcements at bottom of the specimen. PI gauges are used to detect the cracks in the direction along the length of main reinforcement between first and second hoop bars from footing top due to buckling of reinforcements at loaded and unloaded sides.

Loading process is controlled by deflection at loading height. Loading history is such that when top deflection reaches δy, 2 δy, 3 δy, , , till failure. (δy:deflection when strain in tension steel reaches yield strain). 3 cycles of repetition is operated in each level of peak deflection. The top deflection is computed concurrently as



detail 2



Detail 1

Fig.1 Lay out of experimental aparatus

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test is going on by adding deflection at 2d, multiplication of rotation at 2.0d with length from 2.0d to loading point and elastic deflection from 2d to loading height calculated by elastic theory.

The crucial problem of this testing apparatus is treatment of connection between concrete specimen and steel apparatus which means footing and upper steel column. Fig.2 shows solvency of this impediment. Between concrete specimen and steel footing, compression of reinforcement is supported by steel plates P1 where as tension is resisted by nuts N1 (Detail 1). Epoxy glue is applied between the surface of concrete specimen and steel apparatus for the purpose that sliding of the specimen relative to the footing does hardly take place. Between concrete specimen and upper steel column (Detail 2) nuts are used to resist both compression and tension, compression by N2 and tension by N3. As this consequence only the critical region of the pier is casted as specimen.

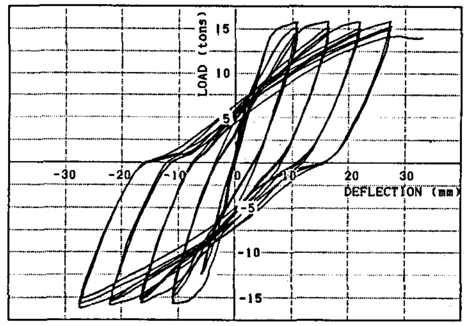

Fig.3 Load-Deflection at loading height

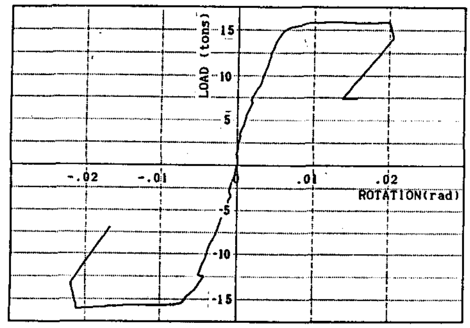

Fig.4 Envelope of Load-Rotation curve

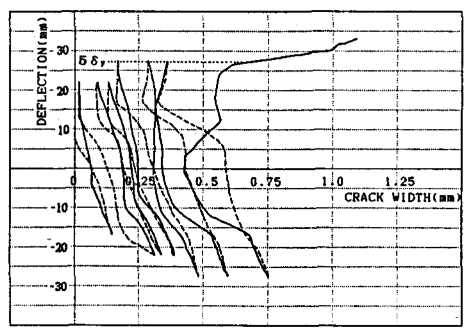

Fig.5 Relationship between Deflection at loading height and Buckling

3. RESULTS

One of the tested specimen having total reinforcement ratio =1.77%, transversed reinforcement ratio =0.22%, shear span/depth ratio =3.61 and shear/flexural strength ratio (Va/M) =1.22. Fig.3 shows load-deflection curve and it reveals that the specimen has almost constant load carrying capacity ratio up to deflection of +5 δy and drops suddenly after the 4th cycle of +5 δy during loading to +6 δy with marked increase in deflection. Fig.4 shows envelope of load-rotation curve and it manifests sudden decrease of load followed by reduction of rotation while deflection is increasing indicating shear failure characteristic. Fig.5 indicates that buckling had also taken place at the same event as the load had dropped. This pointed out that failure was caused not only by shear but both buckling and shear. Failure seemed to turn out when spalling of concrete covering, reducing the dowel component of shear resistance followed by ample shear displacement took place. The value of rotational capacity from the experiment was 0.02 rad. Nevertheless, at the time of writing this paper, experiments were still going on which more specimens were to be tested.

4. CONCLUSION

1) Since shear failure type causes decrease in rotation, we can identify failure type (shear or bending) by regarding the shape of load-rotation curve.
2) This testing method is efficient and it presents satisfactory results.

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Reference: 1) H.Shima et.al., "Rotational and Shear Deformation Capacity of Plastic Hinge of RC Bridge Pier", 40th JSCE Annual Conference, 1985, V, pp.289-290.