The Influence of Steel Ductility and Link Reinforcement on Ductility of R.C Beams

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Aims and objectives

The aim of project is to study the effect of steel types on ductility of R.C beams
With the following objectives

- Variation of beam load- deflection and ultimate rotation curves with steel types
- Variation of cracks model/width with steel types

Background

One of the criteria currently used to quantify ductility is the evaluation of the plastic rotation capacity of certain regions of the structure. The plastic rotation capacity of certain regions is undoubtedly the most important factor in analysis with moment distribution. The plastic rotation capacity depends on several interrelated factors: tensile longitudinal ratio, the reinforcement ductility, the transverse reinforcement ratio, the amount of tensile/compressive longitudinal reinforcement and the concrete compressive strength.

The purpose of such a design criterion is to allow the structure to fail in a very ductile manner. Furthermore, information on expected ductile deformation will enable one not only to prevent abrupt collapse from occurring but also design concrete structures efficiently. Therefore, it is necessary for us to research how ductility affects robustness of concrete structures and how transverse reinforcement ratio affects the plastic rotation capacity.

Experimental works

Main research variables are:

1. Ductility of reinforcing bar classes A, B and C.
2. Transverse reinforcement spacing: 50mm, 100mm, 150mm

The number of beams is 27 which includes the nine types of beams. Each type has three specimens in order to reduce the scatter of material strength, specimen dimension and error during the procedures of experiments. Each specimen of beams has dimensions of 150x225x1500mm, and a span of 1000mm as shown in Figure.1. The concrete cover to the link bars was 20mm.

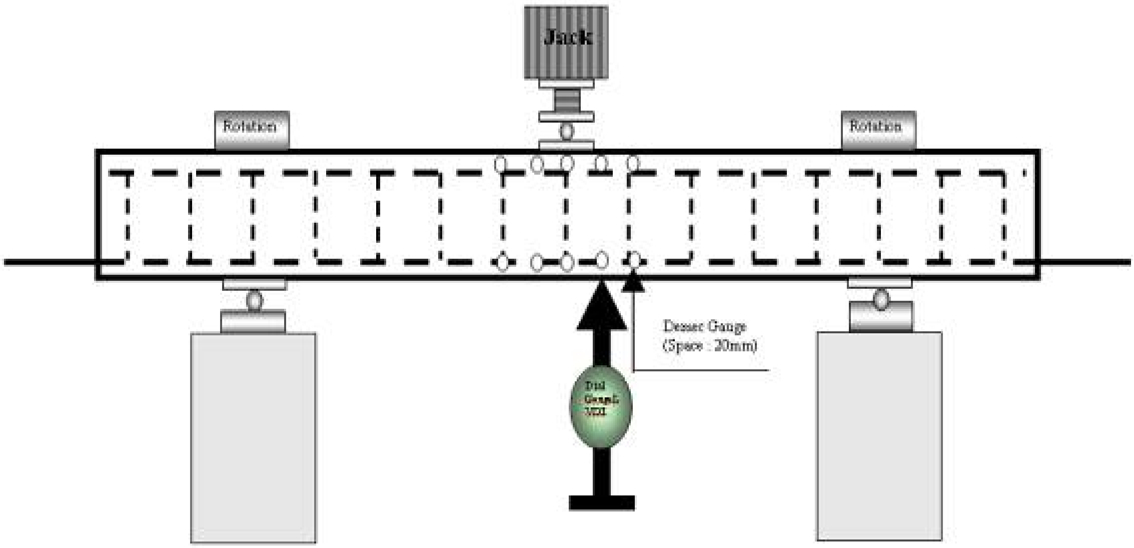


Figure 1. Beam specimens

Three point bending tests were conducted on a concrete beam. The tests were performed in a Mand Testing Rig with a capacity of 400kN for its jacks. The beam specimen was simply supported over a span of 1000mm and subjected to a central point load. The load was applied at mid-span by a steel plate(width:66mm) under one Mand jack.

Prior to the yield load, load control was used with increments of 10kN. Once the applied load approached the yield load, deformation control was employed with deflection increments of 1.0 to 3.0mm. After the applied load reached the ultimate load, the mid-span deflection was increased step by step to examine the ductile behaviour of the concrete beam.

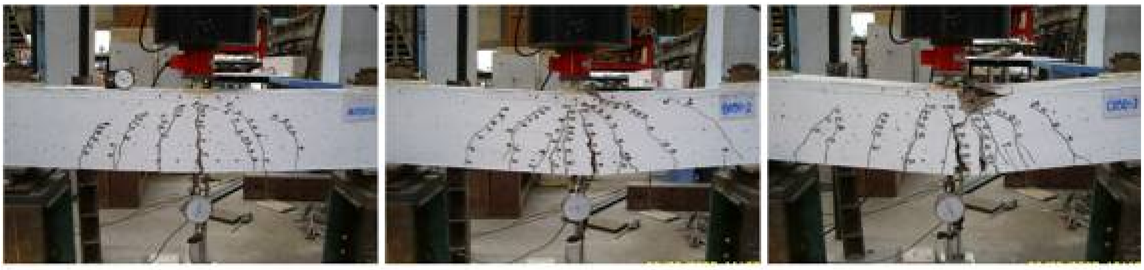
Generally, after the yield load, especially after the ultimate load when the compressive concrete was crushed, the release of the load restraint increased its deformation significantly and hence its deflection and ration was larger. Therefore, once its residual bearing capacity decreased to half of its ultimate load or its tensile bar ruptured, the beam loading tests were ended. In this experiment, when its tensile bar was broken, the beam tests were ended.

The results and Conclusions

Cracks

The cracking patterns of the beam of Grade B and C are considerably different from that of Grade A: Even though the beam of Grade A was mainly dominated by a single crack that of Grade B was dominated by more than one crack and that of Grade C was dominated by multi cracks shown in Figure 2. Different crack patterns could be explained by the different bond strengths of the bars.

It seems that different link spaces do not affect the crack patterns and crack width because the cracking patterns for 50, 100 and 150 link space of the beams were not much different.



A-100 B-100 C-100

Figure 3. Crack Patterns in the beam of A,B,C-100

Load – Deflection and rotation relationship

Due to using the different types of tensile reinforcement with Grade A, B and C, three kinds of beams showed apparently different behaviours especially in the deflection and rotation at the mid-span of beams shown in Figure 3. The main reason for the difference in behaviour seems the beams with Grade C of tensile bars has highest ductility and strongest bond strength than other beams with Grade B and A.

Three kinds of beams did not show different behaviours in the deflection and rotation at the mid-span of beams, even though the different link spaces with the same Grade in tensile bars were used. Thus, it seems that different link spaces do not affect the maximum deflection and rotation at mid-span in the beam