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BEHAVIOR OF BEAM-COLUMN JOINTS WITH DIFFERENT BEAM-COLUMN CONCRETE STRENGTHS

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STATEMENT

This thesis is submitted to Ain Shams University, Cairo, Egypt, for the Degree of Master of Science in Civil Engineering (Structural).

No part of this thesis has been submitted for a degree or qualification at any other University or Institute.

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Abstract of the MSc thesis submitted by
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ABSTRACT

In high-rise buildings and heavy loaded structures where RC columns are subjected to heavy loads, High Strength Concrete (HSC) used in column construction is essential for the purpose of reducing column size and increasing column capacity. However, from the economical standpoint, combination of high and normal strength concrete (NSC) in building construction is becoming common practice, where HSC is used for columns and NSC is used for the surrounding beams/slabs floor system. This creates a situation where concrete strength of the column portion at the beam/slab floor level is lower than concrete strength used for rest of the column. Previous studies indicated that such variation in concrete strength affects the load carrying capacity of the RC columns.

A beam-column joint is a very critical zone in reinforced concrete framed structure where the elements intersect in all three directions. Joints ensure continuity of a structure and transfer forces that are present at the ends of the members. In reinforced concrete structures, failure in a beam often occurs at the beam-column joint making the joint one of the most critical

sections of the structure. Sudden change in geometry and complexity of stress distribution at joint are the reasons for their critical behavior. In recent years, the design of joints in reinforced concrete structures was generally limited to satisfying anchorage requirements. In recent decades, the behavior of joints was found to be dependent on a number of factors related with their geometry; amount and detailing of reinforcement, concrete strength and loading pattern.

The casting of the beams and slabs at a particular floor level is carried out together with the beam-column connection zone using the same grade of concrete. In the case of the columns designed with markedly higher concrete strength compared to that of the beams, such casting sequence forms beam-column connection zones with significantly lower concrete strength than in the upper and lower columns. When the connection zone is subjected to large shear stresses as in the case of columns, the capacity of the columns might wrongly be assessed if it is based solely on their higher concrete strength. This research presents the results of tests on six beam-column specimens in which the influence of concrete strength in the connection zone, on the ultimate capacity of the joint was investigated. All specimens were provided with identical reinforcement in the beam and column portions.

This research studies structural behavior of the beam-column joints under failure loads having different values of concrete strength (fcu) for beam (NSC) and column (HSC). Two variables were considered including concrete strength and type of load.

Ultimate load and characteristics of the beam-column joints were experimentally investigated on six specimens. All specimens have height of

1300 mm with column heads of height 400 mm in the lower and upper part of column with cross section of column 150 x 250 mm. Also every specimen has one beam 800 mm long, 150 mm width & 250 mm depth framed at mid-height of a column and cast using concrete compressive strength of 38 N/mm^2. Concrete compressive strength of columns in six specimens (S1, S2, S3, S4, S5, and S6) was increased from 38 N/mm^2 to 94 N/mm^2 in order to increase the column load carrying capacity.

Using F.E package **(ANSYS 14.0)** their behaviour were investigated, analysed and verified. This Program has wide varieties of elements, a large library for material properties and several load types which covers almost aspects needed to model the experimental work conducted in this thesis.

The presented research introduces an experimental and analytical study in order to investigate the effect of concrete compressive strength between column (HSC) & beam (NSC) on the behaviour of beam- column joints. Experimentally, a total of six specimens were tested under (Concentric & Eccentricity at 5 cm) loads. All specimens were tested up to failure and the behaviour was fully monitored. Moreover, a nonlinear 3D- finite element analysis was established using (ANSYS 14.0) program and verified with the experimental results in order to give design recommendations for those structural elements. Test results showed a good match between both experimental tests and F.E models.

Key Words: Beam-column Joints, High concrete strength, Normal concrete strength, Concentric load, Eccentric load, Non-linear structural analysis.

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