Behavior Evaluation of Steel Beam & Concrete Column Composite Connections

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Abstract

Steel beam & concrete column composite structures have been widely studied during recent decades. Such structures have lots of benefits including lower weight of the structure in large spans, more ductility and energy absorption specifications in contrast with concrete structures, easy accomplishment of the criteria "strong column- weak beam", and faster construction in contrast with concrete structures. One of the most important parts of such composite structures are their connections. Up to now, wide varieties of experiments on composite steel beam- concrete column composite structures have been performed. Since there exists lots of ambiguities regarding the behavior of such connections, most of codes are silent about the issue. Most researches worked on the behavior of composite structures have focused on through-beam type and a few numbers on through-column type connections.

The main goal of this study is to present some details for through-column type bending connection of steel beam-concrete column composite structures and to study the behavior of these connections and then to compare them with concrete and steel connections. To do this, first, the modeling procedure in the finite element software ABAQUS is briefly described and then three connections including: steel, concrete, and composite connections are investigated by the software and accuracy results are verified by comparing them with experimental results. Then, six different RCS connections are presented where steel cover plate has been adopted in order to connect the beam to the column. Connecting steel beam to concrete column is performed by three methods: direct connection of beam to jacket, using connection plates on flange level, and using overall connection plates on flange level. Connection of the jacket to column is performed by two methods: studs and using channel for transfer shear. Result of some samples is compared with result of PCI code for studs in order to define acceptable capacity range. Using result of this study a criteria for defining stud failure in the software is derived.

At the next step, proposed connections are evaluated using ABAQUS software. Comparing results of simulating with steel connection and monolithic concrete connection demonstrates that, studs will fail before causing plastic hinge at beams. Connection with channel and direct connection of flange have an ultimate load as steel joint and monolithic joint while, connections having channel and plate on the flange level show a higher ultimate load. Ductility of these three connections is as steel connection and more than concrete connection.

Several parametric studies are performed on the presented connections which demonstrate that any increase in axial load while having confinement can postpone failure of studs and increases the ductility of connections having studs. These studies also reports that decreasing in the thickness of steel jackets to less than the thickness of the flange can dramatically decrease the ultimate load of the connection while its increase to more levels than the thickness of the flange has fewer impacts. Also, in connections with plates on the flange level sensitivity to thickness of the jacket highly decreases. At the end of the thesis some initial design recommendations are presented based on the obtained computational results.

Keywords

Steel Beam-Concrete Column composite connection, Non-linear Static Analysis, Finite Element Model, Ductility, Rigidity, Strength, Concrete Connection, Steel Connection.