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SEISMIC BEHAVIOUR AND DESIGN OF BEAM-COLUMN CONNECTIONS IN PRECAST INDUSTRIAL BUILDINGS

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Seismic response and safety of precast buildings predominantly depends on the efficiency and behaviour of the connections between structural elements. Precast building system composed of an assemblage of cantilever columns tied together with beams is extensively used in Europe. The connection between columns and beams is achieved by the use of dowels. Although this connection is relatively simple, its behaviour had not been fully understood until in-depth studies were made within the SAFECAST project (i.e. Isakovic et al., 2017). Design practice was frequently based on engineering feeling, code procedures were not adequately formulated and several collapses were observed during recent earthquakes in Italy.

The overview of the related experimental and numerical studies done by the researchers in Ljubljana is presented. Typical response mechanisms were identified and numerically modelled. Finally, design procedures and formulas to be incorporated into Eurocode 8 were proposed.

A number of cyclic experiments were performed on beam-to-column connections with centric and eccentric dowels.

Figure 1. The setup of the cyclic experiments.

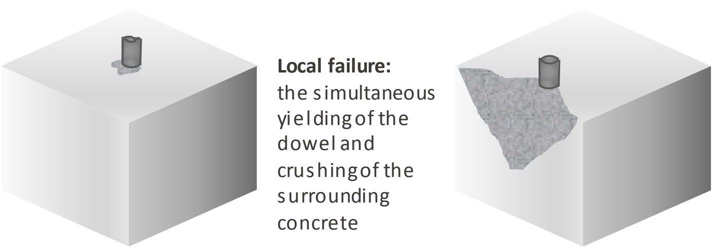

Figure 2. Two different types of failure: a) local failure (typical for connections with centric dowels), b) global failure (typical for connections with eccentric dowels and insufficient hoop reinforcement).

Two basically different types of failure were studied (Figure 2). The local failure mechanism was well investigated in the past. Based on the presented research only relatively minor modifications of the standard design formulas were proposed. The key contribution of the research was the definition of the reduction factor (0.8 – 0.9) of the shear capacity of the connection due to large rotations at the top of the column in comparison with the previous formulas, which were based on the pure shear experiments of the dowel.

The global mechanism is much more complex. The formulas in the codes, which were used to evaluate the strength of eccentric connections, were extremely conservative, because the beneficial effect of the hoops around the dowel was not taken into account. Therefore, a new design procedure, based on the strut-and-tie model, was proposed. This procedure is illustrated in Figures 3 and 4 for one of the investigated configurations of the connection with one eccentric dowel. The configuration of the connection, the model, the stresses, calculated by the FEM analysis (Zoubek, 2015), and the proposed expression to evaluate shear resistance of the connection are presented in Figure 3.

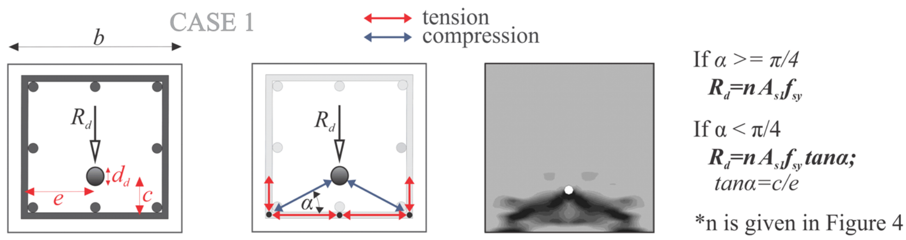

Figure 3. Strut and tie model for a connection with a single eccentric dowel and perimeter hoops (As is the cross-section area of one leg of the hoop; n is the number of activated hoops, defined in Figure 4).

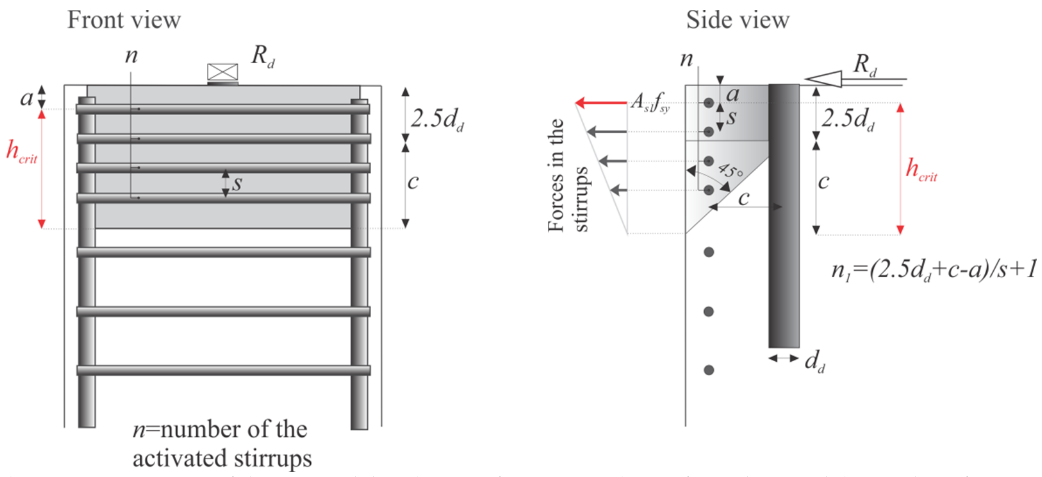

Figure 4. Schematic presentation of the assumed distribution of stresses in the confining bars and the number of activated stirrups n.

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