DAMAGED IN FRAME REINFORCED CONCRETE BUILDINGS CONCRETE STRENGTH

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Annotation: Often, when examining damaged in frame reinforced concrete buildings, there was a low strength of concrete, an error in the installation and joining of fittings, the absence or small number of clamps, etc.

As a result, the nodes of a frame building made of monolithic reinforced concrete are destroyed and the buildings may collapse.

Keywords: reinforced concrete nodes, columns, crossbars, rebars, deformation, stiffness of nodes, breaking, testing, frames.

Introduction: Any building is a complex structure, the quantitative assessment of which, even in the simplest case of static impact of uniform vertical loads, can be made only approximately, with more or less serious deviations from the actual working conditions of buildings.

The main part: As it was established, buildings with a frame of monolithic reinforced concrete and steel successfully withstood the test of seismic resistance in many strong earthquakes. At the same time, it was found that during poor-quality work, and sometimes due to errors made in the project, both reinforced concrete and steel frame structures were subjected to significant damage, and in some cases, collapses.

The transverse reinforcement outside the node had practically no effect on its dynamic characteristics. On the contrary, the transverse reinforcement within the joint significantly affected the nature of the destruction.

When testing all types of samples, chipping of the surface layer of concrete was observed, excluding those samples (type III) in which 4 clamps (Ø≈ 9.5 mm) were placed within the joint. The authors note that this amount of transverse reinforcement within the joint is half of the minimum amount required by the norms.

The work is devoted to the study of the bearing capacity of reinforced concrete frame nodes under repeated loads in the inelastic stage. The column is connected to the crossbar by means of anchor rods, which are a continuation of its working fittings. The column had less reinforcement compared to the crossbar ($p = p' = 0.006$ or 0.0104).

Repeated alternating load ± Rp was applied vertically at the end of the console.

The maximum deflection during the test exceeded the permissible Du by 5-10 times. Some of the samples were tested under additional overload with a constant axial force equal to 0.5 0.75 and 1 of the limit value at which the bolt loses stability.

Axial loaded had a slight effect on the change in the bearing capacity and stiffness of the node.

A significant difference in the nature of destruction was observed in samples tested with and without axial load. Samples tested without axial loading were destroyed by shear. With an increase in the number of loading, the strength and rigidity of the samples decreased. They are characterized by large shear deformations, which led to the formation and opening of vertical and diagonal cracks. The overloaded samples were destroyed by shear with buckling of the rods as a result of longitudinal bending. Bulging was accompanied by severe destruction and staining of concrete in the node area.

V.Townsend and R.Hanson investigated the effect of axial stretching on the bearing capacity of nodes during repeated loading. The prototypes were calculated according to the existing American standards for the design of earthquake-resistant structures. When determining the bearing capacity of the nodes, the yield strength of steel was introduced into the calculation. The strength of concrete was 28.1 MPa.

A transverse repeated load was applied at the ends of the crossbar, and a constant axial load was applied along the axis of the column. The load level was assumed so that plastic deformations occurred in the reinforcement. With an increase in the level of plastic deformation, the stiffness of the node decreased intensively.

R. Park and T. Pauley subjected the external interstitial nodes of the reinforced concrete frame to repeated alternating loads simulating a strong earthquake. The samples of the series were full-size nodes, consisting of a column 38x33x266 cm and a crossbar 25x45x175 cm. the length of the free ends of the crossbar and column was chosen so that the ends of the elements coincided with the zero points of the diagrams of the bending elements of the frame. In the central zone of the node, the main tensile σt and compressive σc stresses arise. These stresses can reach a significant value and cause oblique cracks in the node zone. In the area of the anchor rods bends, the main stresses increase, therefore, as already noted in, the central part of the node needs transverse reinforcement to perceive shear forces.

a-loading scheme of the node; b-stress state in the central zone of the node; c – distribution of stresses from the coupling forces between concrete and steel; d, d - reinforcement of the central zone of the node

Since the authors were interested in the bearing capacity of the central zone of the node, the samples were designed in such a way that the plastic hinge appeared either in the crossbar or in the column. So, in the samples of the two series, the bearing capacity of the crossbar was less than the total bearing capacity of the column. On the contrary, in the samples of the other two series, the appearance of a plastic hinge was expected primarily in the column.

Repeated loading of the node was carried out by a static alternating load V and corresponding to a plasticity coefficient of 2.5-10, and in some cases 15-20 (the plasticity coefficient is equal to the ratio of the curvature Ө at any load V to the curvature ӨU corresponding to the elastic limit of the concrete crossbar). Half of the samples were tested with an axial load equal to 16% of the maximum bearing capacity of the column.

All samples were destroyed outside the central zone of the node. With an increase in the number of loads, the bearing capacity of the node decreases. The minimum load-bearing capacity was for samples with anchoring of the longitudinal reinforcement in the form of a closed loop.

An increase in the percentage of reinforcement of transverse reinforcement in the central zone of the node contributed to an increase in the crack resistance of concrete and the bearing capacity of the node. It is noted that the destruction of concrete in the central part of the node from repeated loading occurs when the transverse reinforcement reaches the yield strength. Compared to other samples, nodes with protrusions had the maximum load-bearing capacity. The intensity of the decrease in their bearing capacity with an increase in the number of loads is significantly less, therefore it is recommended to increase the number of transverse reinforcement in the node area, the free length of the anchor, and also provide protrusions in the nodes.

The work is devoted to the research of reinforced concrete elements under skew-symmetric alternating repeated loadings in the elastic-plastic stage. Prototypes in 1/8 of natural size were made of four types a crossbar with a cross section of 20x12cm; a crossbar – a wall on one side; a crossbar – a wall with a thickness of 4 and 6 cm, on both sides (3rd and 4th types).

Main conclusions

1. The nature of the destruction depended on the size, shape, transverse and longitudinal and reinforcement.
2. A separate crossbar and a crossbar in combination with the upper wall were destroyed at the support from bending.
3. The longitudinal stretch, the reinforcement reached the yield strength (388-409 MPa), and concrete with a compressive strength of 15-20.3 MPa was destroyed by extreme tensile stresses.
4. In most samples, the destruction of the compressed zone of the concrete wall was observed during bending. Some of them collapsed from the cut.
5. The destruction from the cut occurred in samples with a very small percentage of transverse reinforcement of the walls and the crossbar.

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