FIRE RESISTANT ANALYSIS OF RC BEAM COLUMN JOINT

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Abstract

One of the biggest dangers to structures is fire. Because it is non-combustible and has a low heat conductivity, concrete behaves well in a fire. Concrete may serve as a cover to protect steel bar, which is why concrete frames performs well in a fire. For the purpose of analysing the behaviour of beam column junctions under fire, ANSYS software's finite element approach is used. The extent of a structural member's fire resistance is influenced by the number of exposed sides. As a result, the period to collapse varies greatly, and thermal analysis can determine this. According to the standard ISO 834 fire curve, temperatures are allocated to the various sides of the joint.

Keywords: Beam Column joint, Temperature Analysis, FEA, ANSYS, ISO 834 fire curve

INTRODUCTION

The most often utilised material in civil engineering projects, including anything from buildings to bridges, is concrete. The advantages of utilising concrete are its low cost, quick building time, availability, etc. But one of the advantages of utilising concrete that is sometimes disregarded is the fire safety it provides. It provides improved defence against the threat of fire in buildings.

In the building sector, sustainability of structures is a key problem. High temperature exposure is an extreme circumstance that can cause material characteristics to change, which can affect the overall behaviour of a structural part. Due to variations in coefficients of thermal expansion, concrete behaves complexly when exposed to high temperatures. High strength concrete's mechanical characteristics at high temperatures differ from those of normal concrete in two key ways: first, there is a decrease in strength from temperature varying from 100°C to 400°C, and second, the HSC can spall. The coding and design requirements are taken into account while designing by taking strength loss into account.

A building assembly's capacity to resist the impacts of fire is referred to as having fire resistance. To restrict the occurrence of flames through cracks developed at exposed side should be under permissible limit of heat transfer, are two ways to control the spread of a fire. Engineering examination of the behaviour of structural components subjected to fire takes into account:

1. Fire exposure circumstances
2. High-temperature material properties
3. The structure's thermal response
4. Heat-induced structural reaction when treaded as single unit

LITERATURE SURVEY

Bruce Eillingwood et al. (1991) describes reactions under fire-exposed RC structural elements. The fire tests in reference to 6 full-scale beams are running continuously over one support are given. Near continuous support, severe shear fractures appeared in all six beams. For predicting the thermal and structural response of exposed concrete beams, mathematical models have been developed. These models successfully predicted the behaviour of the trials for limit state design. 90 minutes after the fire started, shear cracks started to appear in all of the tested beams. After 30 minutes, flexural fractures appeared in the positive moment zone and quickly became larger. The temperature variation characteristics of RCC structure with respect to stiffness and strength, at high temperatures of steel and concrete, with capacity of the RCC frame to distribute equal pressures internally over the particular time period under exposer to the fire and its effect how reinforced concrete structures behave when subjected to flames.

Dietmar Hosser et al. (1994) conducted research on composite beams that were simply supported and linked to slabs of reinforced concrete. Finite element analysis has been used to develop a theoretical research for determining the effective slab width of composite concrete beams subjected to fire. Investigations are conducted into how the top transverse reinforcement in the concrete slab affects both fracture propagation and fire resistance. Any cross section's internal temperature field may be determined by doing a finite element analysis. Four Concrete slabs attached to composite beams are put to the test. A theoretical model was created using the ANSYS programme. The purpose of the study was to convert experimental research on composite beam fire resistance into a theoretical analysis utilising the finite element method.

David N Bilow et al. (2008) summarised the behaviour of structures during flames and discussed design strategies that have been helpful in reducing the consequences of catastrophic fires on concrete buildings. Calculating the fire load density is a new technique engineers are using to assess their vulnerability to fire. Determine the temperature at various periods based on ventilation conditions and the source of combustion. The impact of active fire prevention equipment, such as sprinklers or fire brigades, on the spread of the fire is another factor taken into account throughout the research. The impact of the temperature increase on the structure may be easily discovered once the temperature time connection has been established using a standard curve. The free water in concrete turns from a liquid to a gaseous form as a result of the increase in temperature. The pace at which heat is transferred from the concrete's surface to its interior varies as a result of this alteration.

R. Srinivasan et al. (2010) provided a finite element study of a 100 x 150 mm beam with three 12 mm diameter bars and two 6 mm diameter stirrups at 100 mm center-to-center. Finite element models may simulate reinforcement using discrete, embedded, or smeared modelling approaches. Among them, the discrete model is the one that is most favoured. A numerical approach is represented by finite element analysis. With ANSYS, the numerical analysis was carried out. In ANSYS, the element types for concrete and reinforcement are solid 65 and link 8, respectively. This research compares the outcomes of an elastic analysis to a theoretical analysis of a reinforced beam under transverse stress. By contrasting the outcomes, ANSYS software is also validated.

THERMAL ANALYSIS OF JOINT

Due to concrete's low heat conductivity, variations in the daily temperature cause temperature gradients in its sections. These gradients cause rotational distortions, which in turn cause strains in the structure. The heat flow through the body determines the temperature gradient, which is a function of the concrete's density (q), specific heat (c), and thermal conductivity (k). Thermal gradients that must be considered in thermal stress analysis are provided by many studies and codes. Temperature gradients are assumed to be uniform over the cross section in certain algorithms and studies whereas others use linear and nonlinear gradients.

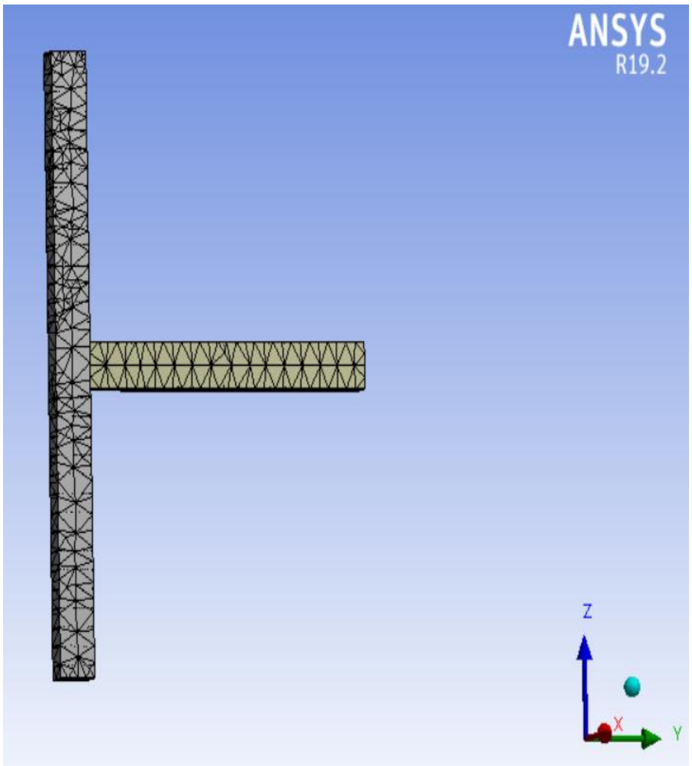

Fig. 1 meshed model

Name	Type	Design strength	E(Mpa)
Concrete	M30	Fc= 30Mpa	27386.13
HYSD	Fe 415	Fy=415	200000

Column	450*300 mm^2
	Height 3m
Beam	300*450mm^2
	Length 3200mm

The modelling of the beam column junction is finished by establishing the crucial points with in system of coordinate. The critical point are used for joining the line components resulting in formation of cross section of the beam by joining the line components. To calculate the volume, extrude the surface area created by the previous line components. Next, meshing is incorporated within the model according to requirements. Load is applied in accordance with the Standard IS code of fire curve ISO 834 and various exposure condition are studied within the duration of 4 hours:

- Two faces exposed from the inner bottom sides
- 3 faces are exposed
- 4 faces exposed.

FAILURE CRITERIA:

Nodal temperatures are generated by the model at various fire exposure periods. The predefined failure conditions are verified using this parameter. Each portion of the structural member is examined at each time step for compliance with the codes' thermal failure criteria.

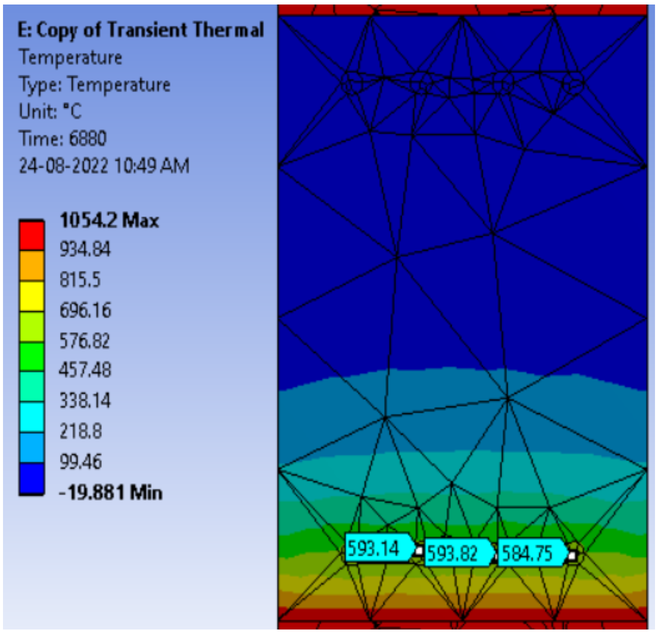

Fig. 2 temperature of joint when exposed from 2 Sides

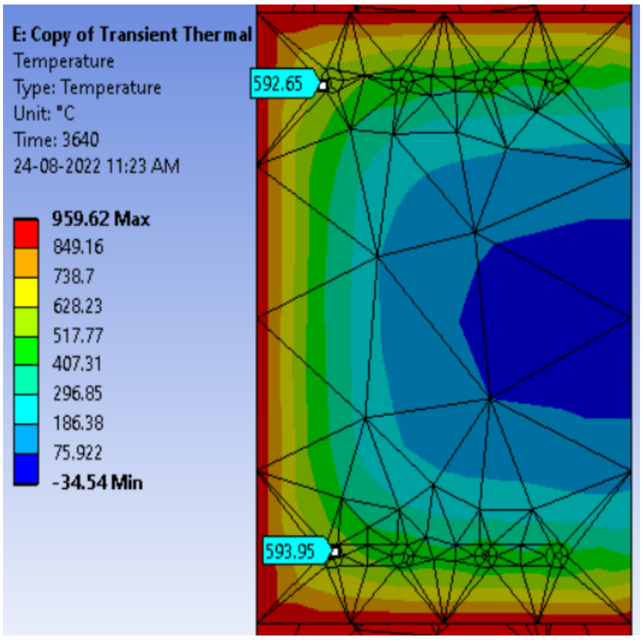

Fig. 3 temperature of joint when exposed from 2 Sides

The longitudinal bar's temperature may be higher than the critical 593°C temperature for reinforcing steel. As a result, the temperature of steel at yielding period is regarded as essential.

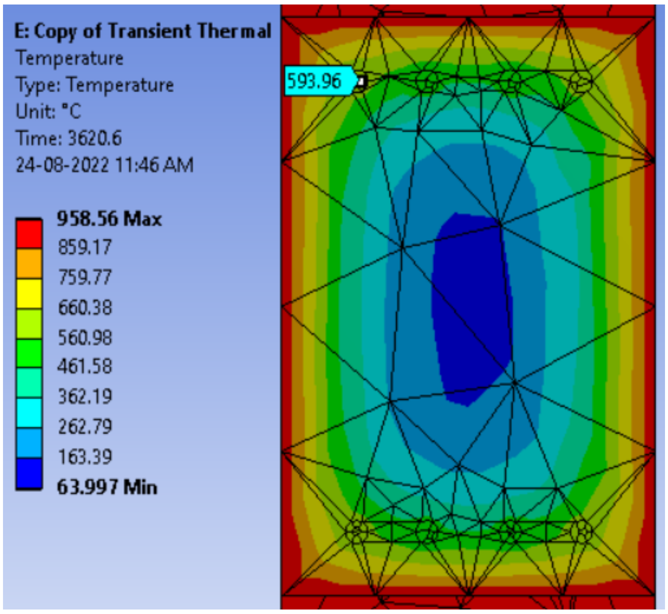

Fig. 4 temperature of joint when exposed from 4 sides

When the bottom two faces of the joint are subjected to high temperatures, the peak temperature of 1054°C is discovered, when three sides are exposed, a temperature of 959.62°C is reached as the nodal temperature. When four sides are exposed, a temperature of 958.56°C is reached as the nodal temperature.

Failure criteria of reinforcement	Type of fire exposure	Time of failure (minutes)
593°C	4 side exposed	60.33
	3 side exposed	60.67
	2 side exposed	114.67

CONCLUSION:

Following are some broad conclusions drawn from the examination of beam column joints' fire resistance:

A structure's ability to withstand fire is significantly influenced by the kind of exposure under temperature variation at faces and sides. When it's thermally loaded from one or more sides, the time it takes for failure reduces. Failure occurs more quickly when there are more sides exposed to the fire. As a result, under expose to the fire the lateral member has a greater number of its sides, period of exposer under failure is reduced. It is reliably determined and compared how long it takes for various exposure circumstances to cause failure. During a fire hazard thermal failure criteria is more significant than deflection criteria.

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