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Behavior of Steel and Concrete of RCC Slab Against Fire

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Abstract: In this paper the behavior of steel and concrete of RCC slab against fire in two steps of utilizing finite elements package ABAQUS for finding thermal respond, Thermal analysis and structural analysis.
In first step the diffusion of fire on depth of members and in second step these diffusions considered as thermal load as it called mechanical analysis. Structural supports depend on the concrete type and members reactions.
The RCC slab model to explain how is the slab thickness and width percentage of reinforcement various case of model face to fire leads. Reactions of RC slab at high temperatures are also studied.
Keywords: Steel, Concrete, Floor Slabs, Temperature.

1. Introduction

Fire has known as the one of the serious risk for building and structural members but concrete should have the main opposition against fire. Long time high temperature has more effect on mechanical properties of members there for here compared the bulk alteration of members and microstructure [1, 3, 5].
After fire the evaluation of the structure decay should be done, in order the damage level and cracking because of fire both together decrease the mechanical strength [4, 7].
How to know the behavior of structure against fire is to describe duration resistance of structure placed under fire [9, 10].

2. Mechanical Behavior of The Materials

2.1 General

The mechanical behavior analysis to define the stress- strain characteristics of the materials, the stress-strain characteristics of the materials determine by behavior of the materials.
In this paper the environmental and high temperature mechanical behavior has considered. When evaluated temperature is involved the main properties required to carry out an accurate calculation of the temperature distribution in a composite cross-section are specific heat, thermal expansion and thermal conductivity.

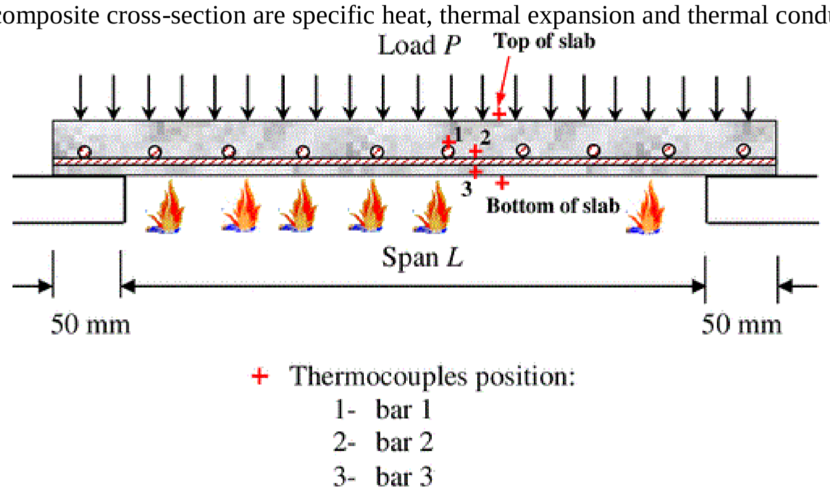

Fig.1 Description of slab against fire

2.2Thermic properties of concrete

The effects of fire on concrete of constructions are one of the important considerations in design. To prevent from fully developed fire expand to upper floors the slab should withstand the leads and prevent falling during and ager the fire [9].

This will cause the surrounding structure to respond against these effects and turnout compressive force in the heated concrete slab.

2.3Thermic conductance

Thermic conductance is the capability of materials to conduct hear and called ratio of heat it demonstrate the similar steam of heat through concrete of thickness on the area expose to temperature margin across the two opposite faces [12].

2.4Particular heat

The quantity of heat per unit mass is particularity of heat which changes the temperature of materials by degree. The particular heat of concrete with siliceous aggregates as a function temperature is according to Eurocode2, British Standards Institution [8].

3. Thermic Enlargement

When concrete subjected to a temperature change it shows thermic enlargement. In concrete structure because of developing of stresses, cracks occur the reason of cracking is the non-uniform thermic enlargement. As a function of temperature is the thermic enlargement of concrete according to Eurocode 2, British Standards Institution [8].

The modulus of elasticity of concrete reduces with an addition in temperature. The decrease of the modulus of elasticity is because of the burst of bonds in the microstructure of the cement paste at the point when the temperature increments and is the aftereffect of the beginning of quick short - term creep.

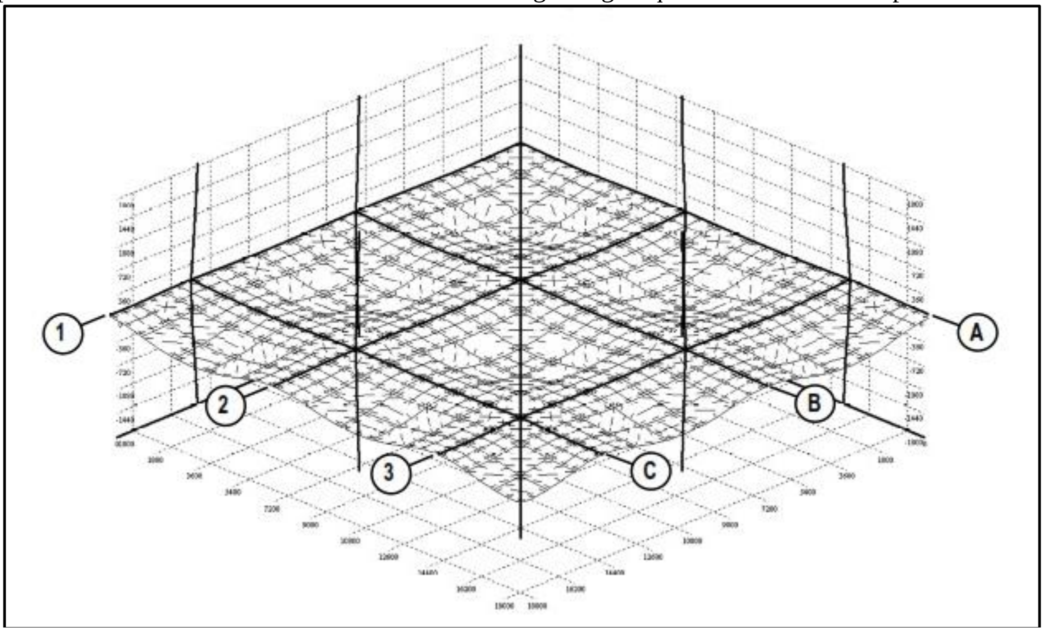

Fig.2 Deflection profiles of bottom layer of floor slab

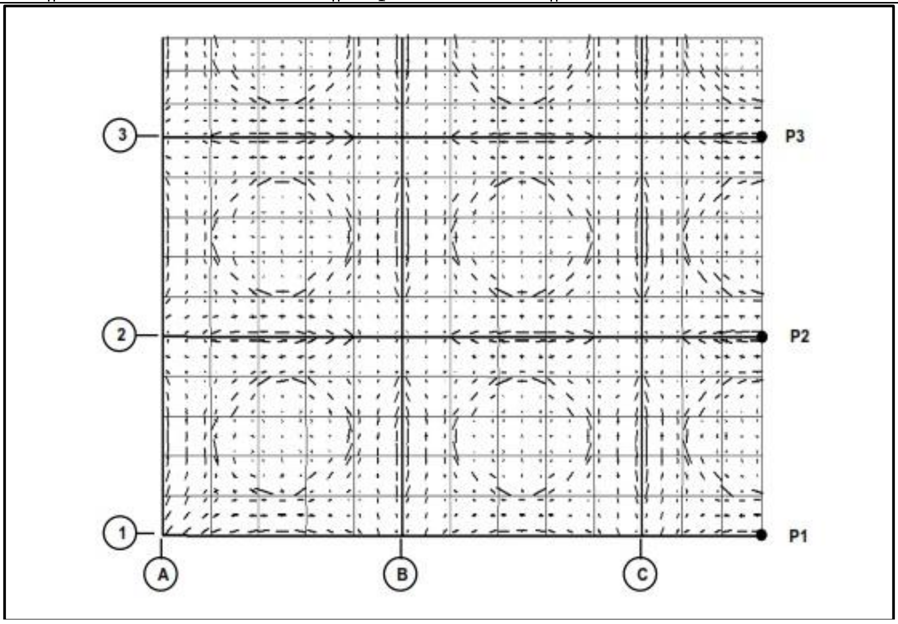

Fig.3 Distribution of principal membrane

3.1Thermic properties of Steel

strain characteristics of reinforcing steel are essentially similar to structural steel. Their behavior is initially elastic after which yielding and strain hardening develops. A piecewise linear approach was found to be sufficiently accurate to represent the stress –strain relationship. Moreover, these curves are utilized in the model when the stress –strain data is not available. The stress–strain relationship for structural steel is represented as a simple elastic –plastic model with strain hardening.

The mechanical behavior for both compression and tension is assumed to be similar. Fig. 5 represents the stress–strain relationship for steel. The effects of thermal conductivity, specific heat and high thermal expansion of the reinforcing steel are considered when the temperature changes.

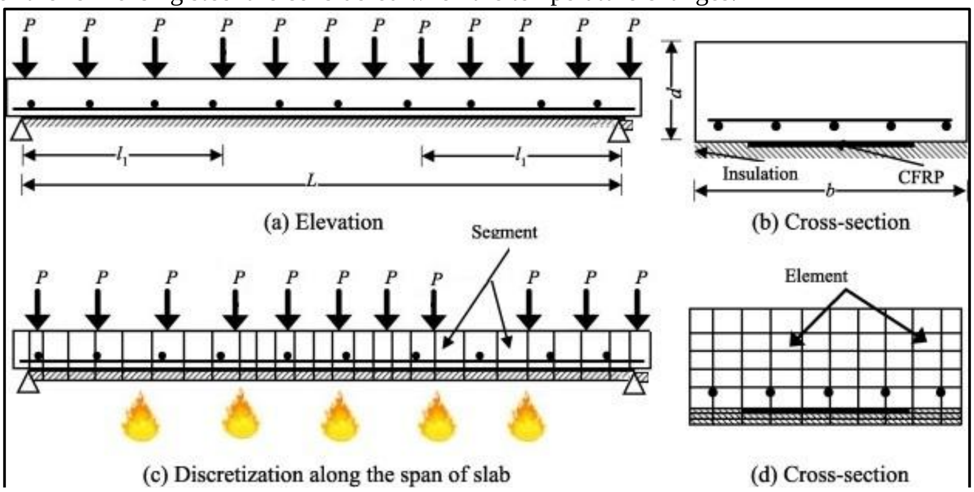

Fig.4 Thermic properties of steel

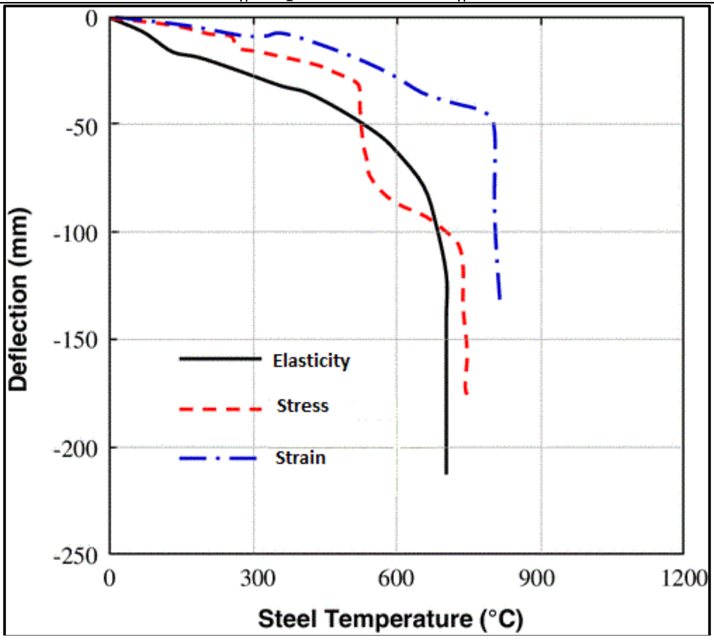

Fig.5 Stress–strain relationship for steel

3.2Thermal Conductivity

The thermal conductivity of steel depends fundamentally on the measure of alloying components and on the warmth treatment. The thermal conductivity of steel as indicated by Eurocode 3, British Standards Institution is introduced [8, 13].

3.3Thermal Expansion

The thermal expansion of steels depends primarily on the heat treatment utilized. The coefficient of thermal expansion of steel at room temperatures is relied upon to be 11:4x10-6 m^{-1} C^{-1}. Furthermore, the thermal stretching of basic and fortifying steel as indicated by Eurocode 3, English Standards Institution is assessed and is outlined [8].

4. Stress Strain Relationship of Reinforcing Steel At Elevated Temperatures

Most ordinary constructional steels have well characterized yield qualities at typical temperatures. Upon further temperature increment, a definitive quality of the steel decays relentlessly. The stress– strain connections might be connected to steel in both pressure and pressure. The impacts of high temperature on drag have likewise been considered. The stress–strain connections of structural steel as an element of temperature as indicated by Eurocode 3, British Standards Institution are appeared [8].The extreme quality of the structural steel diminishes when the temperature increments, as showed. Moreover, the modulus of versatility diminishes with an expansion in temperature. The relationship of the modulus of flexibility of the structural steel as indicated by temperatures is shown.

5. Finite Element Analysis At Elevated Temperature

Finite element bundle A BAQUS was utilized to design and analyze the RCC slabs. Dynamic temperature removal express investigation was performed to include the temperature appropriation got from thermal examination to the structure investigation in order to get the required stress, strainand relocation.

5.1Finite Element Type and Mesh

Three-dimensional strong element and surface element has studied to show the test specimen in order to accomplish a precise outcome from the finite element analysis. For cement, C3D8RTAn 8-hub thermally coupled block, tri-straight relocation and temperature was utilized and steel, SFM3D4R - A 4-hub quadrilateral surface element, diminished reconciliation was utilized [9].

6. Result And Discussion

6.1General

RCC models are taken to ponder the thermal response of structure subjected to fire. Non – linear analysis is carried out with full temperature on different limit condition. Also non - linear analysis is carried out on different bars and different thickness. It is modeled in three dimensional for temperature - time curve ISO-834 [11]. ABA QUS/CA E 6.11 has been used for the analysis of thermal and structural behavior of concrete structures for different temperature. Thermal analysis is done based on steady state condition in three dimensional members.

Table1: Slab details for studying temperature distribution

Span	4.5 m
Width × Depth	925 mm × 150 mm
Temperature	ISO-834 Curve
Concrete grade	M30

6.2Temperature Analysis

The temperature analysis is performed freely of the structural analysis. To play out the temperature analysis, the geometry of the cross-section is like the structural analysis specimen. The materials in the section can change from element to element, and their properties are temperature subordinate. The mechanical conduct is significantly more confused when the temperature changes on the grounds that there are two materials included, which are for the most part concrete and steel. The test specimen model is like the structural analysis model so as to analyze the outcomes. Fire is normally spoken to by a temperature time bend ISO-834 fire (BS 456 section 20) in Fig 12 [11]. This gives the normal temperature came to during a fire in a little estimated compartment or in the heaters utilized for fire obstruction tests.

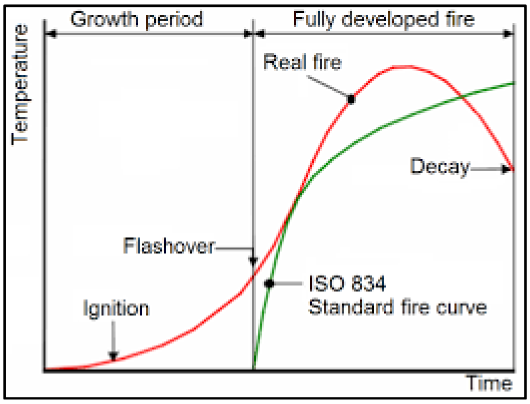

Fig.6 Fire analysis as per ISO-834

6.3 Role of Rebar in Slab

Table2: Slab details for studying Role of Rebar in Slab

Span	4.5 m
Live Load	1.5 kN/ m^2
Width	4.5m
Slab thickness	150 mm
Rebar	6mm, 8mm, 10mm dia
Temperature	ISO-834 fire
Support condition	Simp ly supported on two side Free on the other two side

6.4 Role of Boundary Condition

Table3: Slab details for studying Role of Boundary Condition

Span	4.5 m
Live Load	1.5 kN/ m^2
Width	4.5m
Slab thickness	150 mm
Rebar	8mm dia
Temperature	ISO-834 fire
Support condition	Pinned-pinned, Pinned-roller, fixed-fixed, fixed ro ller on two side & Free on the other two side

7. Conclusion

A precise finite element model has been created by utilizing ABAQUS to think about the conduct of reinforced concrete slab when exposed to fire. In view of the correlations between the outcomes acquired from the finite element models and accessible BRE slab trial results, it was seen that they are in great understanding. The mid - length redirection with span of warming is precisely anticipated by the finite element model and a maximum error of 6% was seen when contrasting the finite element model and trial ponders. Temperature dissemination was read for various layers of the slab along the profundity of the slab when temperature changes as indicated by time and it was discovered that temperature diminishes along the profundity of the slab.

Width of slab function, function of rebar and role of slab thickness were additionally seen in this paper and it was discovered that

For simply bolstered slab, by increasing width of slab the displacement of slab increase as well

- Displacement diminishes when level of steel in RCC slab increment
- Displacement diminishes when thickness increments
- Role of limit condition were likewise watched and it was discovered that fixed-fixed have the most astounding safe temperature and pursued by pinned-pinned, fixed-roller, pinned-roller.

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