Fe Analysis of Reactive Powder Concrete in Direct Shear

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ABSTRACT : *Steel fibre reinforced concrete is a new building material although the cradle of intense research traces back to the seventies. In order to investigate the possibilities of current FE programs for implementation of steel fibre concrete this study was conducted. The aim of this study was to show the use of steel fibre concrete with FE calculations, to point out the possibilities and restrictions and to give recommendations for practical usage. Because of the complexities associated with the development of rational analytical procedures, present day methods continue in many respect to be based on the empirical approaches using result from a large amount of experimental data. The finite element (FE) method offers a powerful and generic tool for studying the behaviour of structures. The power of the FE method is in its versatility. The structure analyzed may have arbitrary shape, arbitrary supports and applied tractions. Such generality does not exist in classical analytical methods, even when the structural geometry is simple.*

Key words: *RPC, non linear analysis, ATENA, shear*

I. INTRODUCTION

Today's complex construction being planned by a civil engineer is predominantly calculated by means of Finite Element (FE) programs. For this reason it is quite evident that new building materials have to be considered in FE programs to support fast acceptance of them in practice.It must be emphasized that the programs are rarely used by a civil engineer in practice. This is mainly due to the face that they are often too complex for general applications that are the time for getting to know the work mode does not justify the advantages you get. Furthermore most applications demand merely for linear calculations that is material non-linearity is not regarded.

The behavior of members and structures , specifically their response to loads and other actions, has been the subject of intensive investigation for many years However, challenges in designing complex structures has prompted the structural analyst to acquire a sound understanding of the structural behaviour of concrete structures. In many cases, in non-conventional designs, code provisions cannot be relied upon to provide realistic informational on designs issues such as the load-displacement response and strength and failure modes of a structures and/or its structural elements. Such information is required for safe and cost effective design. In concrete and reinforced concrete structures, the behaviour under loads can be complex.

More specifically for concrete issues such as confinement, cracking, tension stiffening, non-linear multi-axial material properties, complex steel-concrete interface behaviour and effects, that are commonly treated in an approximate way, The FE method has thus become a powerful tool that allows the analyses of complex structures and structural phenomena.

While simplified 2D analysis can fully represent all the aspects of the response of structures and structural elements where triaxial behaviour is important. With rapid developments in numerical techniques, non linear 3D analysis of structural elements has become increasingly available.

II. MODELING

Modeling is the primary task of any analytical study and the result obtained to a large extent depends on the simplification taken during in this step. Modeling involves creation of geometry of overall structure by including elements of various components representing respective structural behavior including boundary conditions in the considered problem, Material properties of various elements and loads on various elements and its combinations were defined.

III. NON-LINEAR ANALYSIS

Once the model is built, the non-analysis is performed after defining the various loads and supports.
The CC3NONLINEAR CEMENTITIOUS2 is suitable for fibre reinforced concrete, such as SHCC (strain hardening cementitious composites) .Tensile softening regime and the shear retention factor are modified based on the model, proposed in KEBELE, P .This model is based on a notion of a representative volume element (RVE) which contain distributed multiple crack (hardening) as well as localized cracks (softening) the overall strain of the RVE is then obtained as a sum of strain of material between cracks (which may possibly contain non linear plastic strain due to compressive yielding),cracking strains due to multiple cracks, and cracking due to localizes cracks. In this study an inverted 'L' shape specimen with varying depth of shear plane is studied and results are compared with the experimental results by keeping same loading and material of RPC.

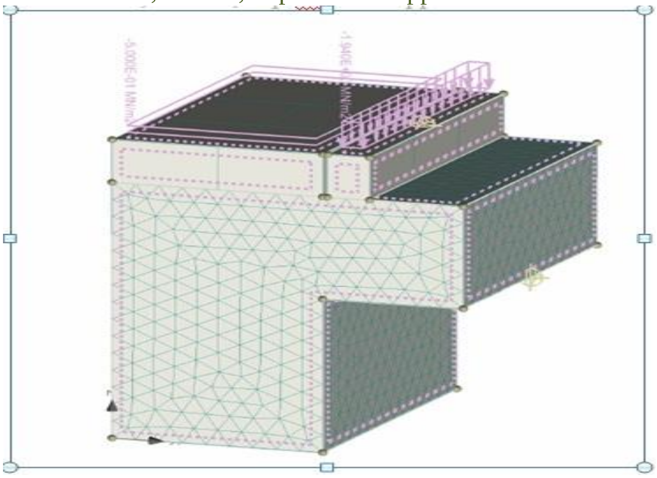

Fig.1.0 General Arrangement of specimen with FE mesh.

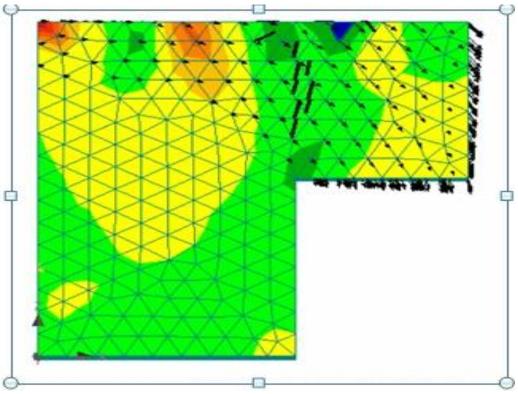

Fig.2.0 Crack Propagation In Specimen.

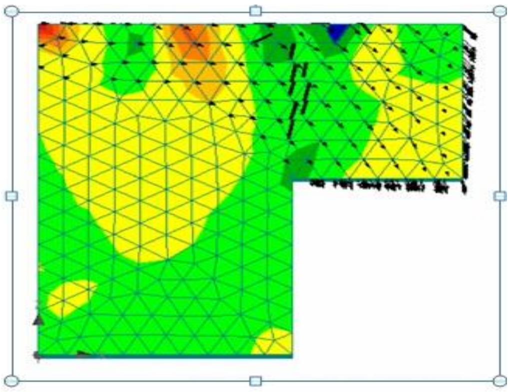

Fig. 3.0, Displacement in a Specimen.

Table .1.0 material properties used in ATENA.

MATERIAL-1	
Title	3D Nonlinear Cementitious 2
Type	CC3DNonLinCementitious 2
Elastic Modulus, E (MPa)	4.452E+4
Poisson's ration, μ [-]	0.200
Specific material weight, ρ [MN/m^3]	2.300E-02
Coefficient of Thermal Expansion, α [1/K]	1.200E-05
Tensile Strength, F_t [MPa]	7.071E+00
Compressive Strenth, F_c [MPa]	-1.360E+02
Specific Fracture Energy, G_f [MN/m]	1.694E-04
Critical Compressive Displacement, W_d [m]	-5.000E-04

Exc., def. the shape of fail. surface, e [-]	0.520
Multiplier for the direction of the pl. flow, β [-]	0.000
Fixed crack model coefficient [-]	1.000
Plastic strain at compressive strength, ε_{cp} [-]	-2.833E-03
Onset of non-linear behavior in compression F_{co} [MPa]	-1.485E+01
Reduction of compressive strength due to cracks, c [-]	0.8
MATERIAL-2	
Title	3D Elastic Isotropic
Type	CC3DElastIsotropic
Elastic Modulus, E (MPa)	2.100E+05
Poisson's ration, μ [-]	0.300
Specific material weight, ρ [MN/m^3]	2.300E-02
Coefficient of Thermal Expansion, α [1/K]	1.200E-05

IV. RESULTS AND DISCUSSION

To the presence of dominant shear stresses, the specimen geometry was studied using finite element analysis, the stress concentration are obtained as shown in **Fig.5.**4 indicating the possibility of cracking. The shear stress distribution is shown in **Fig. 5.4** with darker zone indicating higher stresses. It can be seen as that there is a zone of shear stresses at the junction of "L" shape specimen, conforming that shear failure would occur if tensile cracking was to be restrained by fibres. As a result clear shear crack propagation can be observed at the junction of "L" shape specimen **(Refer Fig.5.2).**

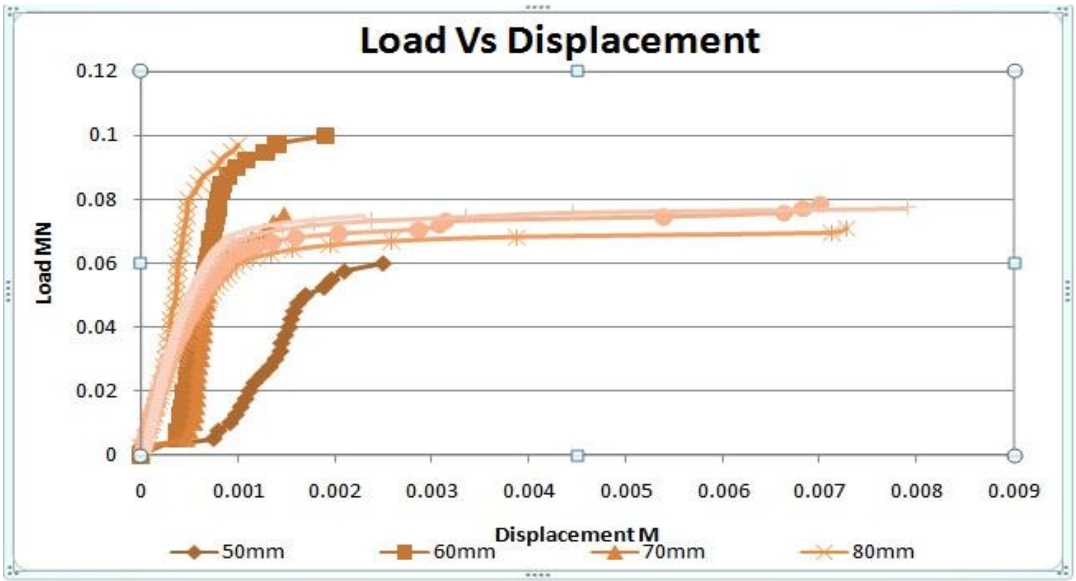

Fig. 4.0, Superimposed Load Displacement Relation with Thickness of Shear Plane Using ATENA and experimental values. .

The load deformation results of the FE modeling for 60 mm and 70 mm thickness of shear plane generally compare well with the test data. The FE results of the 80 mm grossly over predict the failure load. It is worth mentioning that 50 mm thickness of shear plane fail somewhat prematurely because of the localized crushing and tensile failure. A good co–relation between results of FE analysis experimental values can be obtained using "ATENA" having powerful simulation capability. It is using model propose by KEBELE, P. the model is based on notion of representative volume element which contain distributed multiple crack as well as localized crack.

Looking at the displacement corresponding to peak load, it would be expected that the influence of the existence of fibres on the response of the RPC would be to induce some degree of plastic behavior.

The toughening observed in the test is a result of the pull out and dowel action of the fibre during the shear cracking. The pull out resistance tends to close the cracks, while the shear forces tends to open it due to the irregularity of the crack face as illustrated in **Fig.3.0** this produces a confining effect which together with the dowel action of the fibres and friction between the crack faces, can lead to an increase in the shear strength.

V. CONCLUSIONS

FE analysis is done using ATENA, ATENA is having inbuilt material model for HPFRC which can simulate behaviour of RPC also ,the results obtained by FE analysis are well compare with the experimental results .

Optimum thickness of shear plane to be considered is 60 mm which is getting conformed by FE analysis. Initially RPC shows linearly elastic behaviour and then dominated by plastic behaviour representing the behaviour of Elasto-plastic material.

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