Effect of Shear Span on RCC Beam Subjected To Flexural Action

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Abstract- *Utilization of high strength concrete in construction sector has increased due to its improved mechanical properties compared to ordinary concrete. One such mechanical property, shear resistance of concrete beams is an intensive area of research. To Estimate the shear resistance of beams, standard codes and researchers all over world have specified different formulae considering different parameters into consideration. With the aim of taking into account this large amount of information available and to re-evaluate the current codes of practice extensive research was performed. An artificial neural network was developed to predict the shear strength of reinforced beams and, based on its results; a parametric study was carried out to determine the influence of each parameter affecting the failure shear strength of beams without web reinforcement. Finally, new simple expressions are proposed for the design of high-strength and normal-strength reinforced concrete beams without shear reinforcement. The new expressions correlate with the empirical tests better than any current code of practice does.*

I. INTRODUCTION

Fracture mechanics is the field of mechanics concerned with the study of the propagation of cracks in materials. It uses methods of analytical solid mechanics to calculate the driving force on a crack and those of ANSYS solid mechanics to characterize the material's resistance to fracture. Fracture mechanics deals with the study of how a crack or flaw in a structure propagates under applied loads. It involves correlating analytical predictions of crack propagation and failure with ANSYS results. The analytical predictions are made by calculating fracture parameters such as stress intensity factors in the crack region, which you can use to estimate crack growth rate. Typically, the crack length increases with each application of some cyclic load, such as cabin pressurization-depressurization in an airplane. Further, environmental conditions such as temperature or extensive exposure to irradiation can affect the fracture propensity of a given material.

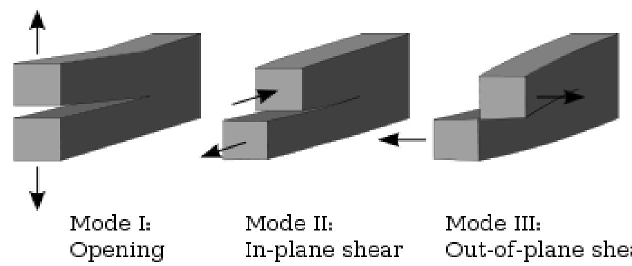

Fig 1 Mode of fracture

A. OBJECTIVES

1. To calculate shear capacity of beams and understand appropriate mode for shear failures of flexural members using ANSYS
2. To determine the crack propagation path using ANSYS
3. To determine the fracture toughness of beam specimens using ANSYS
4. To prepare the new empirical equation for shear strength this based on fracture Mechanism - Finite Element Analysis.

II. FRACTURE MECHANIC

Research work on ultimate shear capacity of beams without shear reinforcement is still continuing. Up till now no unique solution is available for its prediction. Many equations have been developed by various researchers based on theoretical concepts and ANSYS data. Each equation has its own merit and demerits. There are few equations which present very strong co-relation between dependent variable vu and independent variables fc΄, ρ and a/d. With the development of Fracture Mechanics approach for the inelastic behaviour of reinforced concrete beams it can be hoped that in few years it will be possible to understand the true interaction of so many variables affecting the shear strength of beams. In the present study it has been tried to find out the shear strength of rectangular reinforced beams without web reinforcement, considering three parameters only, i.e. f'c, ρ and a/d and equations will be developed for shear strength prediction. The focus of these researches is to evaluate size of high strength concrete beam without web reinforcement for better understanding mechanism involved.

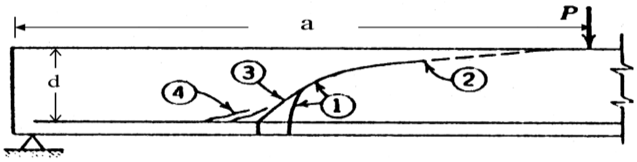

Fig 2 Formation of Diagonal Tension Cracks

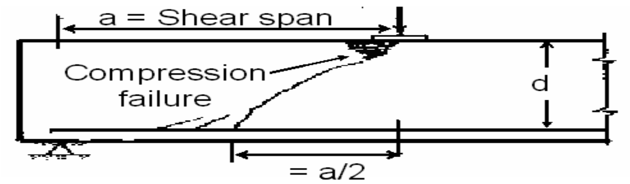

Fig 3 Shear compression failure for small span

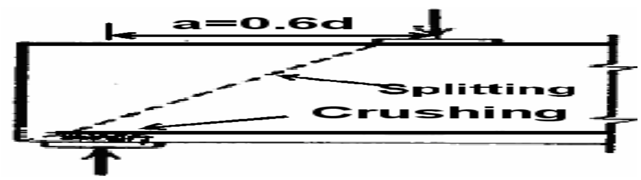

Fig 4 True shear failure

Depending upon the shear span, shear failure may be classified into three types i.e. diagonal tension failure, diagonal compression failure and splitting or true shear failure (shown in Figures 2 to 4 respectively).The shear failure of reinforced concrete beams without web reinforcement is a distinctive case of failure which depends on various parameters such as shear span to effective depth ratio (a/d), longitudinal tension steel ratio (ρ), aggregate type, strength of concrete, type of loading, and support conditions, etc. To estimate the shear resistance of beams standard codes and researchers all over the world has specified different formulae considering different parameters. The parameters considered are varying of different codes and researchers, making it difficult to choose an appropriate model or code for predicting shear resistance of reinforced concrete. Therefore extensive research work on shear resistance of high strength concrete is being carried out all over the world.

III. PROBLEM STATEMENT

As increase in shear stress which causes increase in length and width of crack, and also changes the path of crack. To estimate the shear resistance of beams, standard codes and researchers all over the world have specified different formulae considering different parameters into consideration. The parameters considered are varying of different codes and researches, making it difficult to choose an appropriate model or code for predicting shear resistance of reinforced concrete. So there is need to prepare appropriate solution for determining shear capacity.

1. To study the shear behaviour of High Strength Concrete Beams without Shear Reinforcement with reference to the effect of shear span to effective depth ratio (a/d) and longitudinal reinforcement ratio ‘ρ’.
2. Evaluation Energy equations applied to shear strength of high strength concrete.

IV. RESULTS AND DISCUSSION

A. ANSYS Modeling Of HSC Beam M50 and M60

Table 1 Detail of Beams

A/D Ratio	Size Of Beam For M50 And M60 Grade Concrete	No. Of Beams
1	150*150*700	2
1.5	150*150*800	2
2	150*150*1000	2
2.5	150*150*1150	2

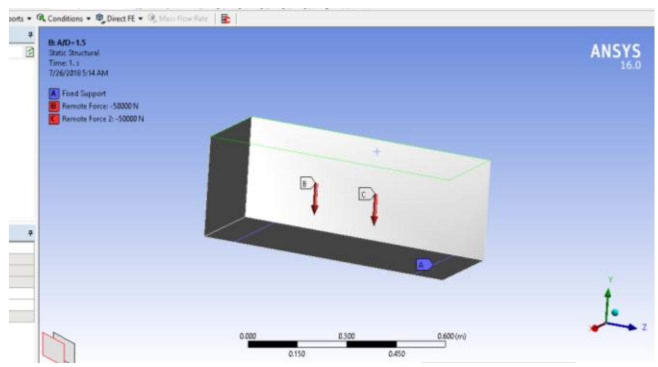

Fig 5 with two points loading

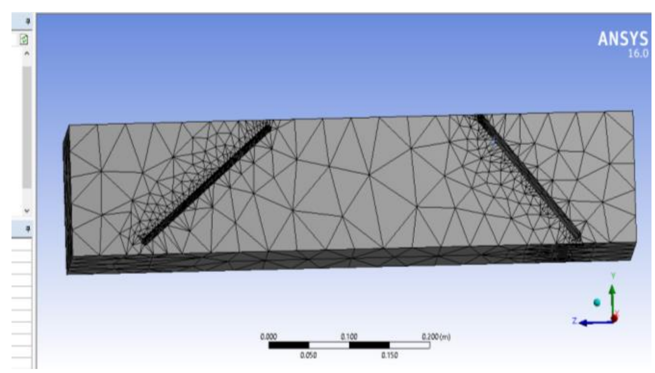

Fig 6 Cracked Specimen of Longitudinal Reinforcement

B. Shear Capacity of Beams

From applying the above nonlinear data the shear capacity in ANSYS is determined by first crack observed in ANSYS model. By observing above cracked specimens of beams, it is conclude that these beams are under Mode 1 failure that is (tensile stress normal to the plane of the crack) opening mode.

Table 1 ANSYS Results Of Shear Stress

A/D Ratio	ANSYS results Shear stress (N/mm^2) OF Grade M 50	ANSYS results Shear stress (N/mm^2) OF Grade M 60
1	6.46	7.01
1.5	5.56	6.11
2.0	3.62	4.02
2.5	2.19	2.40

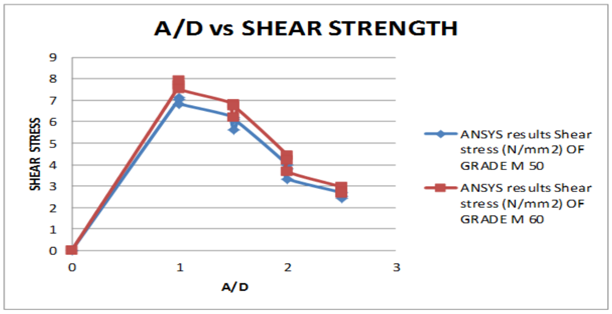

Fig 7 A/D ratio V/S Shear Stress of M50, M60 Grade of Concrete

C. Modes of Failure and Crack Propagation Path

By observing above cracked specimens of beams, it is conclude that these beams are under Mode 2 failure that is (tensile stress normal to the plane of the crack) opening mode.

Table 2 Crack Length of Beams Of M50

Sr No	Beam Specimens Of M50	Cracked Length In "Cm"
1	150*150*700	24.2
2	150*150*850	31.42
3	150*150*1000	40.2
4	150*150*1150	45.2

Table 3 Crack Length of Beams Of M60

Sr No	Beam Specimens Of M60	Cracked Length In "Cm"
1	150*150*700	22.2
2	150*150*850	32.4
3	150*150*1000	39.8
4	150*150*1150	46.1

D. Fracture Toughness of Beams

Table 4 Stress Intensity Factor Of M50 & M60 Grade Specimens

A/D	Beam Specimens	K(M50)	K(M60)
1	150*150*700	3.2	3.46
1.5	150*150*850	3.12	3.56
2	150*150*1000	2.27	2.13
2.5	150*150*1150	2.39	2.74

The graph shows the curve between stress intensity factor and a/d ratio that is shear span to depth ratio.

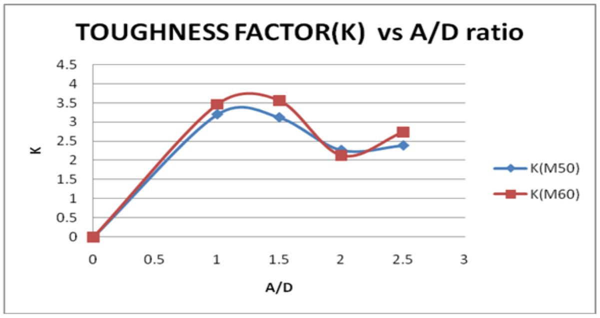

Fig 8 A/D V/S Fracture Toughness Factor(K)

From above ,it is observed that fracture toughness is mainly depend upon applied stress, geometry factor ,crack length.by observing graph ,it is observed that fracture toughness is increases as with grade of concrete but decreases with increase in a/d ratio.

V. CONCLUSIONS

1. The shear failure of reinforced beam without stirrups is a very complex fracture process and exhibits the noticed size effect. Hence, the lack of valid physically sound analytical model for the prediction of shear bearing capability of reinforced concrete beams without stirrups need more researches on application of fracture mechanics model to predict shear bearing capability of reinforced concrete members.
2. The new analytical formula can accurately estimate the size effect in shear fracture, the contributions of the shear span-depth ratio, the reinforcement ratio and the concrete quality to shear strength and reasonably interpret the failure mechanism of reinforced concrete beams without stirrups.
3. The equation stated above includes almost all the parameters required to predict the shear capacity beams without shear reinforcement. Therefore a single simplified equation can be used to predict the shear capacity of HSC beams using artificial sand with a/d = 1, 1.5, 2 and 2.5.
4. The longitudinal reinforcement ratio, strength of the concrete, shear span to depth ratio, value and depth of the beam are the most influencing parameters in the

deformational and shear behaviour of the HSC beams without shear reinforcement.

5. It is further verified that fracture mechanics can be utilized as a valuable knowledge to analyse the shear failure problems of reinforced concrete members without stirrups.

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