Analysis of Multistory Building with shear wall by using ansys

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Abstract

The frequent occurrence of the earthquakes in the world and construction of tall buildings, especially over the last few decades demands for the construction of earthquake resistant buildings. Many of the tall buildings had collapsed in recent earthquakes and the reasons attributed were poor design and construction practices. The objective of this work is to discuss the possibilities of modeling reinforcement detailing of reinforced concrete models in practical use. To carry out the analytical investigations, the structure is modeled in a Finite Element software ANSYS. The specimens are modeled as a) discrete model and b) smeared model. It reports the results of the analysis of the flanged shear wall with two different types of modeling under cyclic loading. The consequences of small changes in modeling are discussed and it is shown that satisfactory results are obtained from the two models.

Keywords*: Ultimate load and Moment carrying capacity, ANSYS software, Shear Wall, Modeling, gradual loading, Energy dissipation.*

I. INTRODUCTION

Earthquakes demonstrate vulnerability of various inadequate structures, every time they occur. The lessons taught from the aftermath of earthquakes and the research works being carried out in laboratories give better understanding about the performance of the structure and their components. Damage in reinforced concrete structures was mainly attributed to the inadequate detailing of reinforcement, lack of transverse steel and confinement of concrete in structural elements. Typical failures were brittle in nature, demonstrating inadequate capacity to dissipate and absorb inelastic energy. This necessitates a better understanding of the design and detailing of the reinforced concrete structures under various types of loading.

An extensive description of previous studies on the underlying theory and the application of the finite element method to the linear and non linear analysis of reinforced concrete structures is presented in excellent state of-the-art reports by the American Society of Civil Engineers in 1982 [ASCE1982]. The results from the FEA are significantly relied on the stress-strain relationship of the materials, failure criteria chosen, simulation of the crack of concrete and the interaction of ther enforcement and concrete. Because of these complexity in short and long term behavior of the constituent materials, the ANSYS finite element program in traduces a3 D element Solid model which is capable of cracking and crushing and is then combined along with model soft he interaction between the two constituents to describe the behavior of the composite reinforced concrete material. Although the Solid model can describe the reinforcing bars, this study uses an additional element, to investigate the stress along the reinforcement because it is in convenient to collect thesmearre bar data from Solid model.

II. RESEARCHSIGNIFICANCE

The practical application of non linear models in the analysis of reinforced concrete structures by Antonio F.Barbosaetal (2000). The results of some analyses performed using the reinforced concrete model of the general-purpose finite element code ANSYS are presented and discussed. The differences observed in the response of the same reinforced concrete be am as some variations are made in a material model that is always basically the same are empha sized. The consequences of small changes in modeling are discussed and it is shown that satisfactory results may be obtained from relatively simple and limited models. He took as imply supported reinforced concrete beam subjected to uniformly distributed loading has been analyzed. The internal reinforcements we remodeled using three dimensional spar elements with plasticity, Link8, embedded within the solid mesh. Finite element model so for dearly reinforced concrete beams and post tensioned concrete beams, developed in ANSYS using the concrete element (Solid) have accurately captured the non linear flexural response of these systems up to failure. Qi Zhang(2004) presented the application of finite element method for the numerical modeling of punching shear failure mode using ANSYS. The author investigated the behavior of slab column connections reinforced with Glass Fiber Reinforced Polymers (GFRPs). SOLID and LINK8 elements represented concrete and reinforcing teel barsres pectively. Aquarter of the full – size slab column connections, with proper boundary conditions, were used in ANSYS formodeling. The author reported that the general behavior of the finite element models represented by the load deflection plotsat centers how good agreement with the test data. However, the finite element models showed slightly higher stiffness than the test data in both the linear and non line arranges. Anthony J.Wolanski, B.S (2004) did research on the flexural behavior of reinforced and prestressed concrete beams using finite element analysis. The two beams that were selected for modeling were simply supported and loaded with two symmetrically placed concentrated transverse loads.

III. ANALYSIS OF FLANGEDSHEARWALL

A. Structure and Analytical Model

Asixstorey RC building in zone III on mediums oil is analyzed using the soft ware STAAD– PRO. The analytical model is shown in Figure1. It is assumed that no parking floor for the building. Se is mic analysisis performed using Equivalent lateral force method given in IS1893:2002 and also by dynamic analysis.

Description of Structure

No of bays in X = 3m
No of bays in Y = 3m
direction Story = 3.5m
height = 0.45mx0.3m
Column size

Beam size = 0.3mx0.45m25kN
Density of concrete = /m^3
Live load on roof Live = 1.5kN/m^{2}3
load on floors Floor = kN/m^2
finish = 1kN/m^2

Brick wall on peripheral = 230mm
Brick wall on = 150mm20
internal beams = kN/m^3
Density of brick
wall

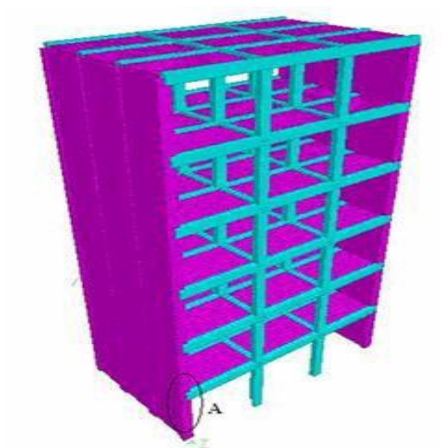

Figure 1:Analytical model

B. Computation of Design Forces

The she arforces, bending moments and axial forecast the bottom of the shear wall for the 13 load combinations (IS1893 (Part1): 2002) are obtained. Seismic analysis is performed using Equivalent lateral force method and also by dynamic analysis.

C. Design of Flanged Shear Wall

Thedesignmoment,shearandaxialforceattheba seoftheflangedshearwallforalength of 2.5 M obtained From the analysis are4532.97kN-m, 285.28kN and 2038.74kN respectively. The
Flanged shear wall is designed for the secritical forces as per IS13920:1993- AnnexureI. Rein forcement details of shear wall are shown in Table1andFigure2.

Table1:Reinforcement Details Off Langed Shear Wall

Shearwall (Web)	Vertical bars	16mmbars@200mmc/c.
	Horizontal bars	10mmbars@200mmc/c.
	Lateral ties	8mmbars@300mmc/c.

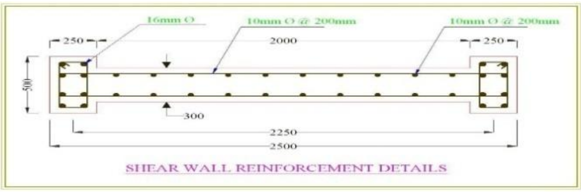

Figure2: Rein forcement details of shear wall

IV. FINITEELEMENTMODELING

The flanged shear wall is analyzed using the finite element software ANSYS. The modeling has been carried out in two ways, a) discrete modeling and b) smeared modeling. Ford is crete model, the smeared reinforcement capability of the Solid 65 element is turned off for the corresponding real constant. Here, Solid 65 element is used to model the concrete while Link 8 element is used to represent the reinforcement.

ANSYS provides a three – dimension aleight nodded solid is parametric element, SOLID 65, to model the concrete. This element has eight nodes with three degrees of freedom a teach node
–Translations in the no dalx, y and z directions. This element is capable of plastic deformation, cracking in three orthogonal directions and crushing. Link8, 3D dimensional spar element is a uniaxial tension compression element with three degrees of freedom at each node – translation sin the nodal x, y and z directions. Plasticity, creep, swelling, stress stiffening and large deflection capabilities are included.

A. Sectional Properties (Real Constants)

Ford is crete model, since there is norebar data, the real constants (volume ratio and orientation angle) are set to zero and the para meters to be considered for Link 8 element are cross sectional area and initial strain. The sectional properties adopted for discrete model are shown in Table 2.

Table2 : Real Constants for Steel Rein Forcement (Link8element)

Real Constant Set	Element Type	Particulars	Quantity
2	Link8	Cross sectional Area(m^2)	201x10^{-6}
	(Vertical reinforcement)	Initial Strain	0
3	Link8	Cross sectional Area(m^2)	113x10^{-6}
	(Horizontal reinforcement)	Initial Strain	0
4	Link8	Cross sectional Area(m^2)	50x10^{-6}
	(Shear reinforcement)	Initial Strain	0

For smeared model, parameters to be considered are material number, volume ratio, and orientation angles (θ and Φ) in X and Y directions respectively. There bars mentioned in Table3, rebar1, 2 and 3 refer to vertical, horizontal and she a reinforcements. Volume ratio refers to the ratio of steel to concrete in the element

Table3: Real Constants for Concrete (Solid element)

Real Constant Set	Element Type	Particulars	Constants		
			Real ConstantforRebar1	Real constantforRebar2	Real ConstantforRebar3
1	Solid	Material Number	2	2	2
		Volume Ratio	0.009	0.00785	0.00349
		OrientationAngle THETA1	90	0	0
		Orientation Angle PHI 1	0	90	90

B. Material Properties

The material properties defined in the model are given bellow the able 4. For the reinforcing bars, they iel dstress was obtained from the experimental test as f_y=432 MP a and the tangent modulus as 847 MP a. The concrete cube compressive strength fck determined from the experimental resultis 44.22MPa, 80% of which is used as the cylinder strength.

The multi link anisotropic material uses the Von Mises failure criterion along with the Willaman dW arnke (1974) model to define the failure of the concrete. Ecis the modulus of elasticity of the concrete, and v is the Poisson's ratio. The characteristic strength of the concrete considered was 25N/mm2 and the Poisson's ratio was 0.3.

$E_c = 5000\ \sqrt{f_{ck}} = 2.5\ x10^{10} N/m^2$

Table4: Material Properties (Anthony J.Wolanski, B.S, 2004)

Multi Linear Isotropic		
Reference Point	Strain	Stress9.802e6N/
Point1	0.00036	9.802e6N/m^2
Point2	0.00060	15.396e6N/m^2
Point3	0.00130	27.517e6N/m^2
Point4	0.00190	32.103e6N/m^2
Point5	0.00243	33.096e6N/m^2

V. FINITEELEMENT ANALYSIS

In ANSYS, the finite element models can be created either using command prompt line input or the Graphical User Interface (GUI). For the present study, the shear wall was model educing Graphical User Interface. For carrying out these is mic analysis, the command prompt line input data was adopted. For carrying out the analysis, the command prompt line input data is adopted. The convergence criteria used for the analysis are displacement with the tolerance of0.001.

The analysis has been carried out for the shear wall subjected to reversiblecy clicloading. The axial load of 0.5 T is applied on to p nodes of the shear wall. Lateralcy clic load is applied at the to p nodes in plane with the shear wall. The displacements clead opted for the analysis is shown in Figure 3.

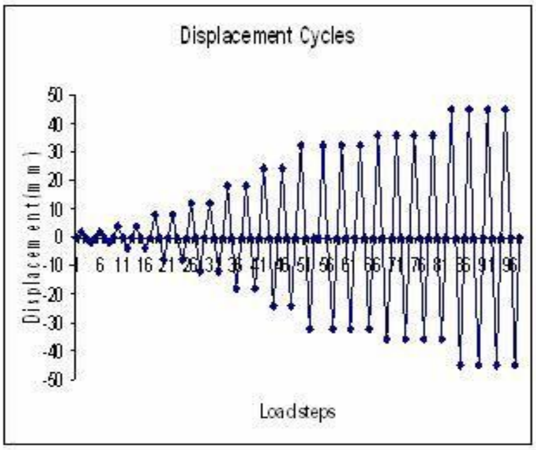

Figure3: Displacement cycle

VI. RESULTS ANALYSIS ANDDISCUSSIONS

The modeling and analysis off langed shear wall has been carried out with two different conditions, such as a) shear wall with sme are d reinforcement b) shear wall with discretere inforcement subjected to in plane reversible cyclic loading. The observations from the analytical studies are briefly described.

A. Ultimate load and Moment carrying capacity

The ultimate load and moment carrying capacity for the two types of models are shown in Table 5. It can be observed that the ultimate load and moment are comparatively higher for the models with smeared reinforcement, how evert hevariation is with in agreeable limits of less than10%.

Table5: Ultimate load Carrying Capacity of Models

Description	UltimateLoad (kN)		
	Positive	Negative	Average
	direction	direction	(*Pu*)
Shear wall with smearedre inforcement	233.347	235.875	234.611
Shear wall with discretere inforcement	214.080	214.432	214.256

B. Energy Dissipation Capacity

Concrete	
Shear transfer coefficients for an open crack	0.2
Shear transfer coefficients for a closed crack	0.9
Uniaxial tensile cracking stress	3.78e6N/ m2
Uniaxial crushing stress.	40e6N/m 2
Biaxial crushing stress	0
Biaxial crushing stress	0
Ambient Hydrostatic stress state.	0

The area enclosed by a hy steretic loop at a given cycle represents the energy dissipated by the specimen during that cycle(El–Amoury and Ghobarah2002). Figure7 shows the energy dissipated for each cycle of both the types of specimens. Smeared model exhibited high erenergy dissipation than that of discrete model. But the variation is within12.5%.

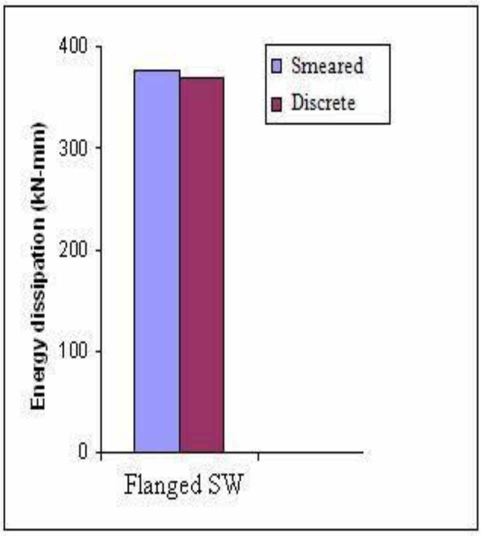

Figure4:Comparison of Cumulative Energy Dissipated

VII. CONCLUSIONS

In seismic zones, a structure can be subjected to strong ground motions, and, for economical design, a structure is considered to undergo deformations in the in elastic range; Therefore, in addition to strength requirement, the structure should undergo the so inelastic deformations without failure. From the literature reviewed it is clear that paucity of information exists in the area of modeling of reinforced concrete structures. In the present study two types of models are analysed, a) smeared model and b) discrete model. Both the models were analysed for cyclic loading. The analytical results are compared with the empirical relations in ACI318 (2002). From the analytical results, following conclusions are drawn.

- It is noticed that the smeared model exhibited higher ultimate strength compared to that of discrete model. There is 10%increasein ultimate strength for smeared model than that of discrete model.
- Spindle - shaped hysteretic loops are observed with large energy dissipation capacity for smeared model compared to discrete model. The enhancement in energy dissipation for smeared model is observed to be 7.5% higher than that of discrete model.
- Further, the ultimate shear capacities of both the models were observed to be matching with the empirical relation as perACI318.

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