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Seismic Performance Assessment OZN Structures by using Aluminum Shear Link

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***Abstract*— Use of aluminum shear-link is generally for resisting earthquake load in structures. The Shear link is basically an I-shaped beam made of low yielding aluminium alloy and being systematically placed in various structural systems for the purpose of dissipation of seismic energy. Due to lateral loads transmitted to primary structural members to limit the maximum force the aluminium beam is designed to yield in shear. Shear yielding of aluminium is very ductile and large inelastic deformations (about 10% strain) are possible without tearing or buckling. Moreover, shear yielding of the web maximizes the amount of material participating in the plastic deformations without a high concentration of plastic strain. In this paper we just absorb the behavior of a Structural model of sub structure and super structure assembly after applying aluminium shear link, using M20 concrete and adopting limit state design as per IS:456 with the help of shaking table. The effectiveness of aluminium shear link by numerical studies showed by mainly two structural systems: Truss Moment Frames (TMFs) and Concentric Braced Frames (CBFs). Shear-link systems demonstrated a huge amount of energy dissipation per unit drift, more symmetrical and accurate distribution of story drifts, minimize base shear, huge amount of energy dissipation per unit drift.**

However, to enhance the seismic capacity of structure some suggestions were proposed based on research result.

Keywords*— *Shear Link; Seismic; Buckling; Shaking Table; TMFs; CBFs; Strain; IS:456

A. INTRODUCTION

Several Buildings have been constructed in India and all around the world as well however some of the buildings among them do not follow traditional structural design due to many reasons like new structural design system and height of structures as well. So, it is necessary to verify the safety of these building and by this investigating their seismic performance is also essential. However, from 1980s the introduction of shaking table test filled the gap between predicting the seismic performance accurately of a given

structure and that of differences between real structure and analysis models. Various seismic retrofitting technique have been practically adopted for the safeguard of structure among all aluminium shear link holds a remarkable result for retaining seismic load. The inelastic cyclic behaviour of the shear-link as a seismic energy dissipater gave very good result by showing large inelastic deformation and remarkable ductility (about 10% strain) are possible without any tear and buckling of the member in model testing. Whereas I-shaped beams of low yielding ductile alloys of aluminium designed to yield in shear mode when suitably placed can limit the maximum lateral force transmitted to primary structural members. Thus, selecting aluminium shear link in model testing using M20 grade of concrete according to IS-456 by considering durability of structure and other design requirement is being adopted.

B. Primary Requirement of research

The primary requirement of this paper is to observe and describe the inelastic cyclic behavior of aluminium shear-link as a seismic energy dissipater in a testing model of base 50cm×30cm having raft foundation using Fe-415 with clear cover of 1cm, erected by four column of dimensions 8cm×8cm×40cm having c/c of 1cm using M20 concrete having aluminium shear link and at the top consisting of six beams, four at corners (30cm×8cm×6cm)and two at lateral direction (51cm×8cm×6cm) all casted with M20 concrete and also by using aluminum shear link for further seismic load testing.

C. MODEL MATERIALS AND STABILITY

PPC is being used with fine aggregate in the making of M20 concrete 1:2:4 of having water cement ratio of 0.45 as per IS :456 (2000) given in table 1. The timber is being used as a formwork material as per IS:883 and being clamped by nails of size 2d (2.54cm). Aggregates will comply as per the requirements of IS:383. Natural aggregates should be preferred as far as possible. The tensile strength and elastic modulus are

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being given in table 2. However, the standard deviation is being considered as 4.0 as per IS:456 given in table 3

Table 1 Minimum cement content, maximum water cement ratio as per IS:456(2000) (Clauses 6.1.2, 8.2.4.1 and 9.1.2)

Minimum grade of concrete	**Minimum cement content kg/m3**	**Maximum free water cement ratio**
M 20	320	0.45

Material	Elastic modulus (MPa)	Tensile Strength (MPa)
Fine-aggregate concrete	22360.68	2.2 ~ 4.2
Aluminium	69000	290

Table- 2 Model material properties

A. *STABILITY OF THE STRUC1lJRE*

Stability against Overturning, moment Connection, Lateral Sway, Sliding, Probable Variation in Dead Load is also taken in consideration to exclude maximum error in testing.

Assumed Standard deviation (Clause 9.2.4.2 and Table 11)

Table 3 Assumed standard deviation value

Grade of Concrete	Assumed Standard deviation N/mm2
M20	4.0

D. *TEST MODEL SCALING FACTOR*

In shaking table test the scaling factor of dimensions, acceleration, elastic modulus and density is the most important factors. The test was carried out on the shaking table. According to the shaking table, Dimension of structure the length scale of 1/20 was adopted. Based on the model material properties, the scale of materials elastic modulus was 1/2.8 and scale of mass density was selected 1/4.2 as per the bearing capacity of shaking table. Then scaling factors of other parameters of the test model to prototype were conducted and listed in Table 4 The result were obtained using the new LNEC 3D earthquake simulator.

Table 4 Test model Scaling factor

Para meter	Len gth	Elas tic mod ule	Str ain	Mas s Den sity	Ti me	Str ess	Accele ration	Frequ ency
Scali ng Facto rs	1:2 0	1:2. 8	1:1	4.6: 1	1:0 .98	1:3 .0	1:2.5	9.81: 1

E. *Model Designing and Construction*

The test model is constructed by considering a simple structure with the application of aluminium shear link. However, the structure is being constructed with a simple reinforcement and the application of shear link is being taken at a prior level specially at column reinforcement as well as in beams also. The bottom of the structure is being designed with raft foundation to provide better stability to the structure. The Column and beams are being designed by limit state method of designing as per IS Code provision (IS:456 2000). All the members are being strictly design according to the scaling factor in the test model. So, the structure was simplified while designing test model for convenience of model construction and test. Main measures are listed as following.

- Key structure members, including column, beam and cross beam were kept and simulated strictly according to the scaling factors in the test model.
- The rigidity and mass of the upper portion of the structure were simulated and small members like lintel and stairs were deleted.
- Wall is not being applied to the structure and the frame modelling is being acquired.
- The mass and rigidity of top portion of the structure were simulated.

Fig-1 Different construction phase of testing model

The Constructional phase of test model is being as per IS:456(2000) with limit state design as shown in following steps with M20 concrete and using aluminium shear link also.

F. EXPERIMENTAL RESULTS

G. *Model Under Seismic load*

For the earthquakes of intensity 7, there is no such visible damage. However, the reduction in frequencies were observed. This is the sing that microcracks had already been developed For the Earthquake of intensity 7 some moderate cracks were observed. Minor cracks or damage were observed on columns. The frequencies of the model at different phases were measured by inputting a white noise signal. This was sufficient for the dynamic characteristic.

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Table 5 Peak story horizontal Displacement at X direction for small earthquake.

FLOOR	DISPLACEMENT (mm)		
	SMALL	MODERATE	LARGE
0.1	0.015	0.04	0.05
0.2			
0.3			
0.4			
0.5	0.03	0.08	0.1
0.6			
0.7			
0.8			
0.9			
1	0.15	0.4	0.5

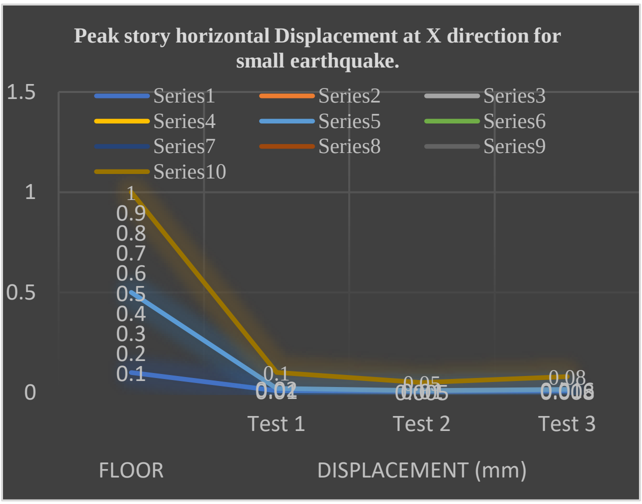
FLOOR	DISPLACEMENT (mm)		
	Test 1	Test 2	Test 3
0.1	0.01	0.005	0.008
0.2			
0.3			
0.4			
0.5	0.02	0.01	0.016
0.6			
0.7			
0.8			
0.9			
1	0.1	0.05	0.08

Table 6 Displacement of story with respect to different intensity of seismic load

Graph- 1 Peak story horizontal Displacement at X direction for small earthquake.

A. Acceleration results

Acceleration implication factor β is usually kept as the ratio of the peak value of oar accelerations to the peak ground acceleration (PGA). Value of β carried out by the dynamic

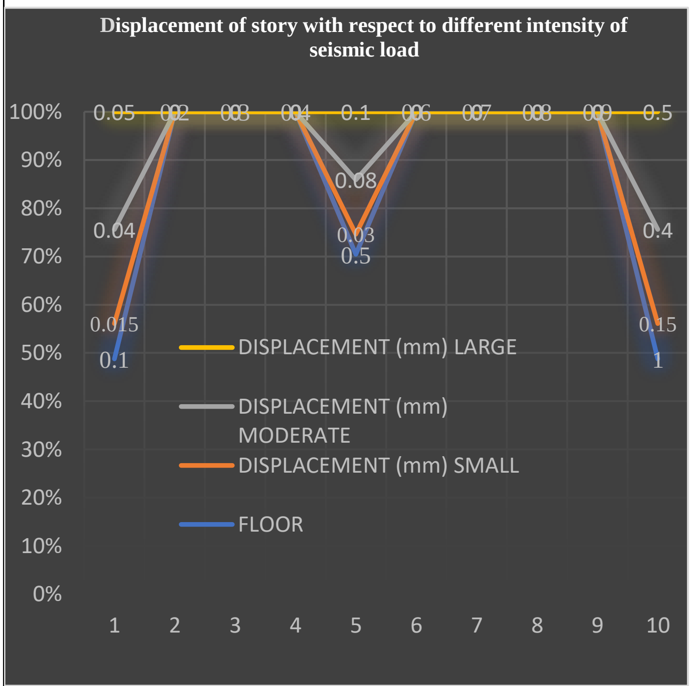


implication effect of different phase in the structure. shows the distribution of the horizontal acceleration implication factor. Most values of β are between 03 and 0.6. The maximum value of β reaches 1.2 at top of structure. There is obvious whipping effect due to reduction of rigidity and concentrated mass of crown at structure top. Special attention should be paid in designing top of structure. The Displacement of structure is being varying in ascending order from the bottom to top as shown in table 5

A. Displacement results

The Displacement result in X direction relative to shaking table at different test phase are shown in graph-1 The displacement of Y direction is same of that X direction and hence not shown. The Displacement occurs more at top as compared to bottom and there is no abrupt change. The result shows that the different deformation. In shape and value of model occurs with same peak acceleration having different input records. However, the displacement of model in different intensity of earthquake is also being seen in graph-2. The displacement value increases with the increase of height at different sectors of model structure.

Graph- 2 Displacement of story with respect to different intensity of seismic load



CONCLUSIONS

The model for testing seismic behavior is being carried out with full of precaution and care. Shaking table model test was carried out to investigate the seismic effect on testing model. The test model was designed and tested for small, moderate and large earthquake levels with the scaling factor of 1/20. The dynamic behavior of model was analyzed. However, the following conclusion were absorbed: -

1) The structure can meet the Indian Codes requirements and gave an appropriate result for the use of shear link in the nation.

2) The testing model having the scaling factor of 1/20 is feasible and reasonable to sustain the earthquake action. The has been noticed that the structure showed no response in small earthquake and would have some minor structure cracking under moderate earthquake levels. The large earthquake action showed more cracks and the Aluminium shear link within the structure showed elastic behavior.

3) At the top of the structure the four corners were showed more cracks and story drift is being increased.

4) The scaled model test required the reasonable design and systematic construction of test model is very important. During model design throughout analysis should be carried out to crosscheck the test model conformity with experimental result and simulated theory. The scaling can reveal the seismic performance of model structure.

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BIOGRAPHIS:

Hassan Haider war born in 1997 in Siwan, Bihar India. He published his review research paper at IIT Kanpur on the topic of Use of Underground Spaces in IGS local chapter (14/10/17) during his four year of graduation period from Allenhouse Institute of Technology in Civil Engineering Branch (AKTU). During his graduation period he actively participated in many departmental work, technical competitions and also completed his minor project on levelling of whole college campus to estimate alignment and drainage of institute. He is interested in research work Seismic performance assessment on structures by using Aluminium Shear link.

S.M. Ashraf Husain was born in 1970 in Kanpur city, Uttar Pradesh. He completed his Diploma Engineering (Civil) in 1990. He worked over a decade in the construction industry; mainly in Quality Control at International Level. He received his Bachelor of Technology degree in Civil Engineering from Integral University, Lucknow, in 2011. In 2014 he received his Master's Degree in Structural Engineering from Integral University, Lucknow. Presently he is Assistant Professor, in Department of Civil Engineering at Allenhouse institute of technology, Kanpur. He Published many papers in International Journals/Conferences. He is also an Associate Member of Institution of Engineer’s.

Praneet Madhav was born in 1989 in Kanpur city, Uttar Pradesh. He completed his Bachelor of Technology in Civil Engineering from RGP University, Bhopal and completed his Masters in Structure Engineering. Presently he is Assistant Professor, in Department of Civil Engineering at Allenhouse institute of technology, Kanpur. and showed his full effort in nurturing the youth and shaping their future.

Reyaz Haider was born in Siwan, Bihar. He completed his Bachelors in Engineering from MIT Muzaffarpur in the year 1991. He works continuously in the field of construction and established his own firm Global Ashiyana. His executed many construction works in different part of Siwan. He is certified registered Engineer in Nagar Parishad Siwan and Former Secretary of Z.H Unani Medical College, Siwan. Right now, he is serving the city with his firm Global Ashiyana. He is Associate member of Institution of Engineers India.