A Comparison of Seismic behavior on Multistoried RC Buildings by the Provisions of Indian and Australian Building Codes

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***Abstract*— In this paper a comparative study of the seismic provisions of Indian and Australian code has presented. The structure being a residential Regular RCC framed building with Ground and Five Floors. Various seismic parameters has been considered for analysis. The Equivalent Static Method Analysis has performed using STAAD PRO software. The building frame is an Ordinary Moment Resisting Frame (OMRF). The values of Base Shear, Column's moments & axial forces, Beam's moments Lateral displacements and Storey drifts coming out from the analysis are compared for IS1893-2002 & AS 1170-2007. Comparing the results the Indian code is found to be more conservative than the AS 1170**

***Index Terms*— IS1893 2002, AS1170, Base Shear, OMRF, STAADPRO**

I. INTRODUCTION (HEADING 1)

I. Earthquake is a phononmenon due to tectonic activity. It is very important to investigate and understand the reasons for earthquake disasters and to take necessary steps to eliminate the catastrophic consequences.

II. Most of the human and other losses resulting due to earthquake are due to failure of human made facilities such as buildings and other structures

III. The severity or the earthauake disaster depends on four factors. Firstly the magnitude of the earthquake is a major factor. The more the magnitude of the earthquake more will be the groundshaking. The distance between the earthquake origin and the region of population is the second factor. The more the distance lesser will be the intensity of ground motion. The third factor is the population and the development in the particular region. The fouth one is the quality of the construction of the structures or the methods of design and construction. Many buildings may be able to resist the moderate groundshaking though they are not as per the requirements of the design for seismic conditions. This is because of the masonary infilled walls. However for a building to resist a severe earthquake it has to be designed considering all the aspects of earthquake resistant design. Mostly the design and construction of seismic resistant structure follows the provisions of the seismic codes. Though the effects of the earthquake groundshaking and the basic concepts in the design of earthquake resistant structures are same everywhere, the seismic codal provisions in different countries are different. This difference in the seismic codes is due to the application of basic concepts as per the seismic activity of that particular country, the design methodology, the experiences of the professionals and their educations.

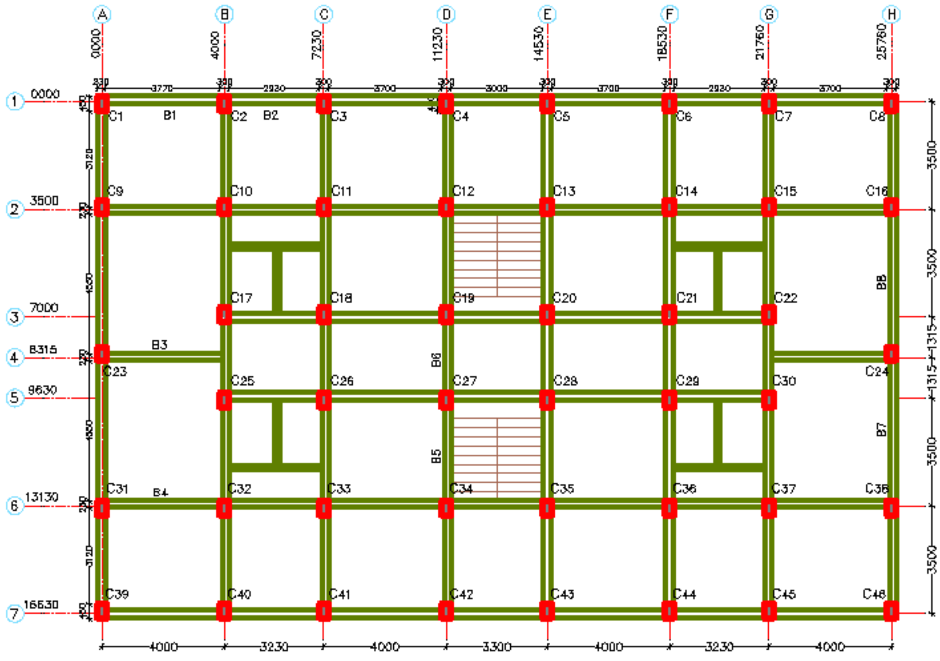
IV. The scope of this paper is to apply the seismic codal provisions and compare the results using three different codes for the RCC building of same specifications for OMR frame. In this paper following codes are compared 1. Indian Standard i.e, IS 1893 & Australian code i.e.,AS 1170 2007

II. ANALYSIS AND METHODOLOGY

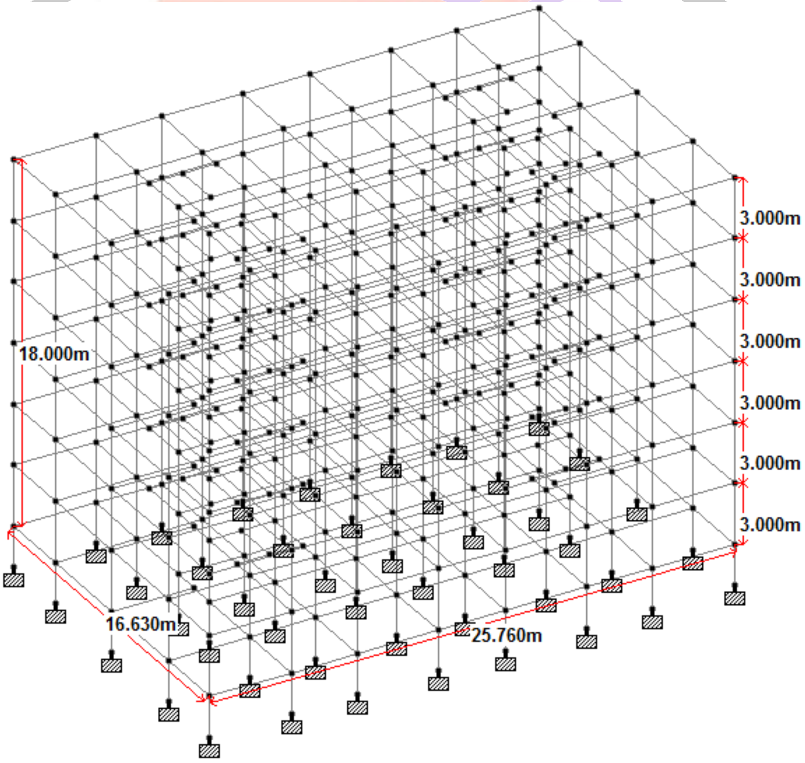
An RCC building with Gound + 5 floors is considerd for analysis and comparision. The building is a residential builing. The live load value is taken as 2 Kn/sq.m. The dimension of the building is 25.76 m X 16.63 m in Plan and height is 18m. The RCC frame is a OMRF. The column sizes are 300X450 mm and beams are 230X450mm. The time period values for each of the three codes are calculated then the base shear values are calculated. The storey forces are calculated for each floor level for each of the three codes and apllied in the software. The analysis is done using Eqivalent Static Method of analysis (ESM) in STAAD PRO software. The ESM is the very basic method of analysis.

BUILDING GEOMETRY

Building Plan



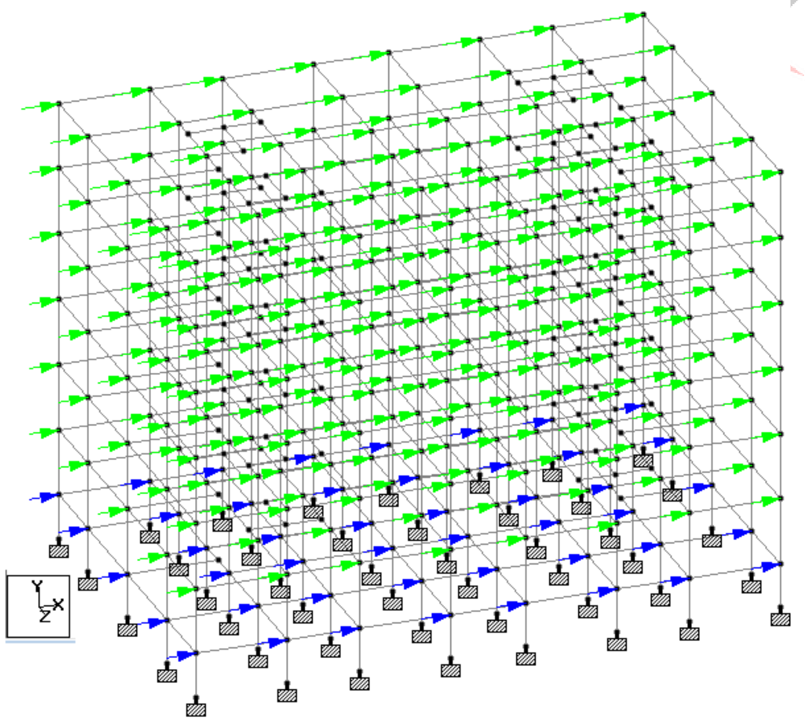
Building Dimensions



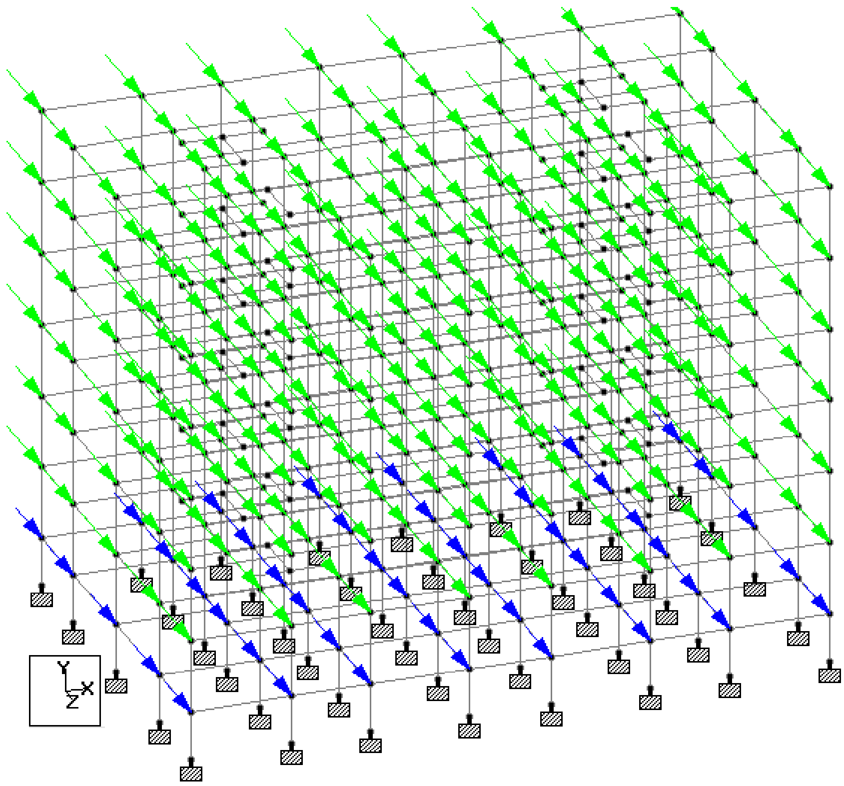
IS 1893	AS 1170
For Low Inensity Zone	For Low Inensity Zone
Z = 0.1 Sa/g= 2.5 I = 1.00 R= 3 for OMRF Ah = Z/2 . Sa/g . I/R	Z = 0.1 Probability factor kp = 0.5 Sp = Structural Performance μ = Structural Ductility factor Sp/μ = 0.38 for OMRF $C_d(T_1)$ = kp. Z . Ch (T1) . Sp/μ

Comparision of Base Shear	
IS 1893	AS 1170
1. Total Weight W (Dead Load + 25% Live Load) W= 29804 KN	1. Total Weight W (Dead Load + 30% Live Load) W= 30019 KN
Base Shear = Ah . W Ah = Z/2 . Sa/g . I/R = 0.1/2 x 2.5 x I/R = 0.125 x I/R = 0.125 x 1.0/3 = 0.042 Base Shear = Ah . W 0.042 x 29804 1242 KN	Base Shear = Cd(T1) . W $C_d(T_1)$ = kp. Z . Ch (T1) . Sp/μ 0.5 x 0.1 x Ch(T1) . Sp/μ 0.05 x 1.49 x 0.38 0.075 x 0.38 0.029 Base Shear = Cd(T1) . W 0.029 x 30019 871 KN

Earthquake Load in X-direction



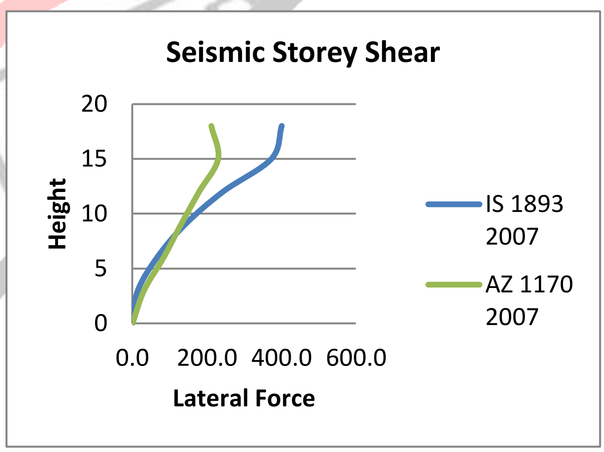
Earthquake Load in Z-direction



IV. RESULTS

1. Comparision of Storey Shear & Base Shear

S.no.	Floor Lvl		IS 1893 2007	AZ 1170 2007
	Floor	Height	Lateral Force Q (KN)	Lateral Force Fx (KN)
1	Plinth	0	0.1	1
2	1st FL.	3	15	32
3	2nd FL.	6	67	84
4	3rd FL.	9	141	131
6	4th FL.	12	244	180
7	5th FL.	15	373	231
8	TERR.	18	401	212
TOTAL			1242	871

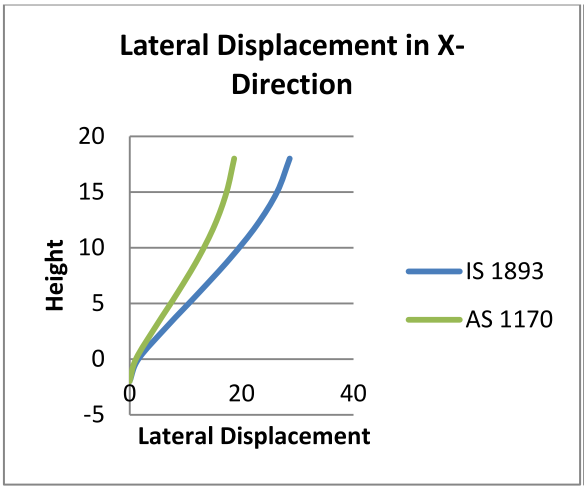


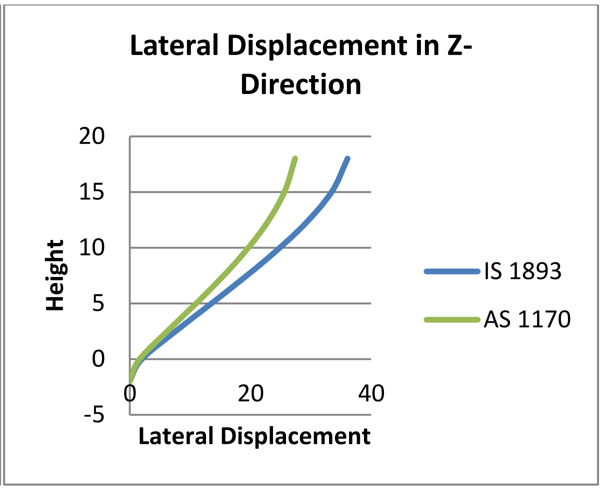
2. Colunns Moments & Axial Loads

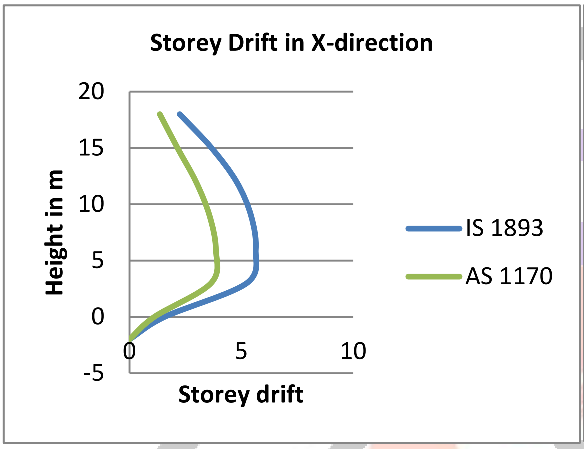
COLUMN'S MOMENT & AXIAL LOAD	IS 1893				COLUMN'S MOMENT & AXIAL LOAD	AS 1170			
	MOMENT KNm		AXIAL LOAD KN			MOMENT KNm		AXIAL LOAD KN	
COLUMNS BELOW PLINTH					COLUMNS BELOW PLINTH				
CORNER COLUMNS	41.6	100 %	914	100 %	CORNER COLUMNS	34.8	84 %	722	79 %
PHERIPHERAL COLUMNS	40.1	100 %	1100	100 %	PHERIPHERAL COLUMNS	34.5	86 %	894	81 %
CENTRAL COLUMNS	51.23	100 %	1198	100 %	CENTRAL COLUMNS	41.00	80 %	958	80 %
COLUMNS GR. FLOOR					COLUMNS GR. FLOOR				
CORNER COLUMNS	50.7	100 %	837	100 %	CORNER COLUMNS	40.8	80 %	673	80 %
PHERIPHERAL COLUMNS	47.3	100 %	1050	100 %	PHERIPHERAL COLUMNS	39.0	83 %	892	85 %
CENTRAL COLUMNS	69.8	100 %	1075	100 %	CENTRAL COLUMNS	55.9	80 %	927	86 %
COLUMNS 2ND FLOOR					COLUMNS 2ND FLOOR				
CORNER COLUMNS	52.2	100 %	521	100 %	CORNER COLUMNS	40.2	77 %	419	80 %
PHERIPHERAL COLUMNS	44.6	100 %	664	100 %	PHERIPHERAL COLUMNS	37.4	84 %	563	85 %
CENTRAL COLUMNS	70.3	100 %	693	100 %	CENTRAL COLUMNS	53.7	76 %	597	86 %
COLUMNS 5TH FLOOR					COLUMNS 5TH FLOOR				
CORNER COLUMNS	28.7	100 %	81	100 %	CORNER COLUMNS	20.9	73 %	67	83 %
PHERIPHERAL COLUMNS	24.7	100 %	111	100 %	PHERIPHERAL COLUMNS	20.3	82 %	95	86 %
CENTRAL COLUMNS	30.2	100 %	114	100 %	CENTRAL COLUMNS	20.1	67 %	98	86 %

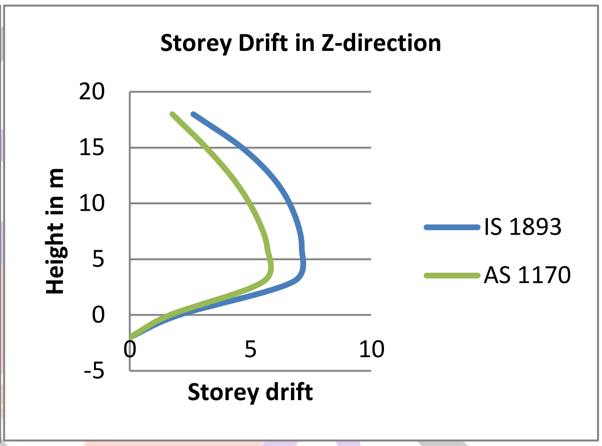
3. Lateral Displacement and Storey Drift

floor	ht. (m)	IS 1893				AS 1170			
		latereal displ.		storey drift		latereal displ.		storey drift	
		x direc	z direc	x direc	z direc	x direc	z direc	x direc	z direc
		mm	mm	mm	mm	mm	mm	mm	mm
footing lvl	-2	**0**	**0**	**0**	**0**	**0**	**0**	0	0
plinth lvl	0	**1.572**	**2.031**	**1.572**	**2.031**	**1.113**	**1.664**	1.113	1.664
1st fl lvl	3	**6.819**	**8.811**	**5.247**	**6.78**	**4.762**	**7.194**	3.649	5.53
2nd fl lvl	6	**12.464**	**15.936**	**5.645**	**7.125**	**8.625**	**12.893**	3.863	5.699
3rd fl lvl	9	**17.899**	**22.76**	**5.435**	**6.824**	**12.204**	**18.106**	3.579	5.213
4th fl lvl	12	**22.686**	**28.803**	**4.787**	**6.043**	**15.179**	**22.463**	2.975	4.357
5th fl lvl	15	**26.359**	**33.453**	**3.673**	**4.65**	**17.328**	**25.629**	2.149	3.166
terrace lvl	18	**28.607**	**36.089**	**2.248**	**2.636**	**18.686**	**27.396**	1.358	1.767


Lateral Displacement in X-Direction
Height
20
15
10
5
0
-5
0
20
40
Lateral Displacement
IS 1893
AS 1170


Lateral Displacement in Z-Direction
Height
20
15
10
5
0
-5
0
20
40
Lateral Displacement
IS 1893
AS 1170


Storey Drift in X-direction
Height in m
20
15
10
5
0
-5
0
5
10
Storey drift
IS 1893
AS 1170


Storey Drift in Z-direction
Height in m
20
15
10
5
0
-5
0
5
10
Storey drift
IS 1893
AS 1170

4. Beams Moments & Shear Forces

plinth	IS 1893				plinth	AS 1170			
beam nos.	moment		shear force		beam nos.	moment		shear force	
b 1	68	100 %	43	100 %	b 1	44	66 %	26	59 %
b 2	63	100 %	46	100 %	b 2	42	66 %	29	63 %
b 3	57	100 %	46	100 %	b 3	35	61 %	18	40 %
b 4	61	100 %	48	100 %	b 4	44	72 %	25	53 %
b 5	59	100 %	48	100 %	b 5	41	69 %	27	57 %
b 6	62	100 %	55	100 %	b 6	46	74 %	38	69 %
b 7	73	100 %	44	100 %	b 7	39	53 %	21	48 %
b 8	73	100 %	44	100 %	b 8	39	53 %	21	48 %
1st fl	IS 1893				1st fl	AS 1170			
beam nos.	moment		shear force		beam nos.	moment		shear force	
b 1	107	100 %	87	100 %	b 1	81	75 %	70	80 %
b 2	97	100 %	86	100 %	b 2	72	74 %	67	77 %
b 3	70	100 %	49	100 %	b 3	62	89 %	43	88 %
b 4	82	100 %	72	100 %	b 4	77	94 %	65	91 %
b 5	86	100 %	89	100 %	b 5	71	82 %	75	85 %
b 6	80	100 %	65	100 %	b 6	66	82 %	54	83 %
b 7	128	100 %	95	100 %	b 7	92	72 %	75	79 %
b 8	128	100 %	95	100 %	b 8	92	72 %	75	79 %
3rd fl	IS 1893				3rd fl	AS 1170			
beam nos.	moment		shear force		beam nos.	moment		shear force	
b 1	102	100 %	85	100 %	b 1	75	73 %	67	78 %
b 2	89	100 %	81	100 %	b 2	63	71 %	61	75 %
b 3	66	100 %	48	100 %	b 3	56	85 %	41	86 %
b 4	78	100 %	69	100 %	b 4	70	89 %	60	87 %
b 5	85	100 %	86	100 %	b 5	66	78 %	71	82 %
b 6	71	100 %	58	100 %	b 6	54	76 %	45	77 %
b 7	121	100 %	93	100 %	b 7	85	70 %	73	78 %
b 8	121	100 %	93	100 %	b 8	85	70 %	73	78 %
ter.	IS 1893				ter.	AS 1170			
beam nos.	moment		shear force		beam nos.	moment		shear force	
b 1	37	100 %	39	100 %	b 1	27	74 %	31	80 %
b 2	27	100 %	33	100 %	b 2	19	71 %	25	78 %
b 3	26	100 %	33	100 %	b 3	24	92 %	30	89 %
b 4	26	100 %	34	100 %	b 4	24	94 %	29	85 %
b 5	31	100 %	31	100 %	b 5	24	76 %	26	82 %
b 6	17	100 %	19	100 %	b 6	13	74 %	15	78 %
b 7	53	100 %	48	100 %	b 7	39	73 %	39	81 %
b 8	53	100 %	48	100 %	b 8	39	73 %	39	81 %

V. CONCLUSION

1. The value of base shear for Australian code is nearly 70% than that of Indian Code.
2. The values of Column moments for Australian code is nearly 80% than that of Indian Code.
3. The values of Axial Loads on Columns for Australian code is nearly 82% than that of Indian Code.
4. The values of Beam moments for Australian code is nearly 75% than that of Indian Code.
5. The values of Beam shear forces for Australian code is nearly 75% than that of Indian Code.
6. The Lateral displacement and storey drift values are more in Indian code
7. The design by Indian code would be more conservative than that of Australian code

VI. ACKNOWLEDGMENT

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REFERENCES

[1] *A Comparative Study on Seismic Provisions Made in Indian and International Building Codes for RC Buildings*
Dr. S.V. Itti, Prof. Abhishek Pathade and Ramesh B. Karadi
Dept. of Civil Engg., KLESCET, Belgaum – 590008 (Karnataka)

[2] *A Comparative Study on Seismic Analysis of Bangladesh National Building Code (BNBC) with Other Building Codes*
Md. S. Bari • T. Das

[3] *Comparative Analysis of RC Irregular Buildings Designed According to Different Seismic Design Codes*
Jaime Landingin, Hugo Rodrigues, Humberto Varum, Antonio Arede and Anibal Costa

[4] *Comparative Study of the European and American Seismic Safety Assessment Procedures for Existing Steel Buildings*
M. Araújo, J. M. Castro, X. Romão & R. Delgado

[5] *Comparision of codal provision sujjested by various countries*
P.R. Bose, R. Dubey & M.A. Yazdi
Earthquake Engineering department, University of Roorkee, India

[6] *Comparision of Recent U.S. Seismic codes*
R.D. McIntosh and S. Pezeshk, Members. ASCE

[7] *Comparison of Seismic Performance of D-region of Existing RC Structures Designed with Different Recommendations*
Balthasar Novak, K.Ramanjaneyulu, Constanze Roehm and Saptarshi Sasmal

[8] *"I.S: 1893-2002", "Indian Standard Criteria for Earthquake Resistance design of structures Part-I General provision and buildings, (Fifth Revision)",*
Bureau of Indian Standards, New Delhi, June 2002.

[9] *AS 1170.4-Structural design Action Part 4: Earthquke Actions in Astralia 2007*
Aistralian Standard