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COMPARATIVE ANALYSIS OF NBC WITH IS CODE FOR RC STRUCTURES

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Abstract – *Basic structure builds in Nepal utilize seismic codes of Nepal and India reciprocally, despite the fact that the codes yield distinctive plan esteems. There exists across the board conviction that Indian seismic codes plan for more prominent seismic powers in the RC outlines and are thusly progressively moderate. In any case, there is little proof that backs such a wide proclamation. Any statement of that sort could be made simply in the wake of investigating, in each code, all the contributing parameters that oversee the last structure seismic burdens. Since the hypothesis for calculation of seismic powers in the two codes is sensibly uniform, it takes into account a sound near the investigation. The result of the investigation gives enough proof to out-rule such a general explanation, that Indian seismic codes are more moderate than Nepali seismic codes. Results are not excessively broad; both the codes could be moderate contingent on conditions-the conditions being the area of the site, soil type and the number of stories.*

Key Words: NBC 105:1994, IS 1893:2016, RC frame, base shear coefficient, seismic shear coefficient, response spectrum, seismic zoning factor, response reduction, importance factor

1. INTRODUCTION

Before the introduction of NBC in 1994 AD, the structural design of RC buildings in Nepal used to be done by referring to Indian Standards. Such reference was relevant as well given the fact that Nepal borders India in three directions, thus, the design response spectrum and the diversity of soil type incorporated in Indian seismic design code IS 1893: 2002 would reasonably be applicable for Nepal. After 1994, the seismic design code of Nepal NBC 105:1994 started to come into practice. Since there was no restriction in the use of Indian Standards in the government level itself, even after the introduction of Nepali Standards, the Indian code was equally popular, if not more. Even as of now, the compliance of one code would sufficiently ratify earthquake resistant design; hence depending upon the designer's expertise, both codes are widely used and accepted.

As the building code compliance got implemented more stringently especially in the Kathmandu valley in the past decade, the awareness and understanding of building codes grew among engineers. With it, emerged a new line of belief that Indian seismic code is more conservative than NBC. Although not documented anywhere, the design engineers presumably expressed such thought as a generalization of their narrow scope of design practice. Most structural engineers in Nepal design residences 2 to 5 stories, schools 1 to 4 stories, commercial complexes 4 to 8 stories and apartments 8 to 14 stories and as the geotechnical investigation of the site is often discounted except for tall buildings, the soil type II: Medium soil is commonly adopted for design purpose. It is quite reasonable to assume that based on such a narrow scope of design practice, engineers could have made a doubtful generalization. To declare that IS 1893: 2002 gives conservative results or NBC 105: 1994 yields less exaggerated results, a very broad set of parameters needs to be analyzed.

1.1 OBJECTIVE OF THIS PAPER

- ✓ To comprehend the seismic investigation strategy include in NBC 105:1994 and IS 1893:2016.
- ✓ RC structures laying on hardened or medium soil, the seismic interest as processed utilizing IS 1893 is constantly higher than NBC 105
- ✓ To contrast, the investigation working concurring with NBC and IS code.2. STUDY OF NBC 105:1994 and IS 1893-1:2016:

2. METHODOLOGY:

All construction regulations have their own standards, so it isn't shrewd to blend the necessities of one code in with another. Indian seismic code was set up based on deterministic seismic danger investigation from verifiable information of past quakes though Nepali seismic code was set up based on probabilistic seismic risk examination of all issues inside 150 km limit of Nepal. Keeping the equivalent into thought, the relative investigation has been led by treating the two codes freely all through and counting the last structure aftereffects of the two.

The two codes have their own structure reaction range. The nature and substance of the range are comparable in the two codes yet they vary in the standardization of the estimations of what has been named as Spectral Acceleration Coefficient (Sa/g) in IS1893:

2002 and Basic Seismic Coefficient (C) in NBC105: 1994 as given in Fig. 1 and 2. There are three ranges for three sorts of soil; Type I: Stiff soil, Type II: Medium soil and Type III: Soft soil. The meaning of these sorts coordinates in the two codes, so a specific site that would fall under Type I

according to NBC would likewise fall under Type I according to IS, etc.

The coefficients are perused out from the ranges against the time of the structure (T) which is given by T = 0.075 h0.75 in IS and T = 0.06 h0.75 in NBC,

where h is the total height of the structure.

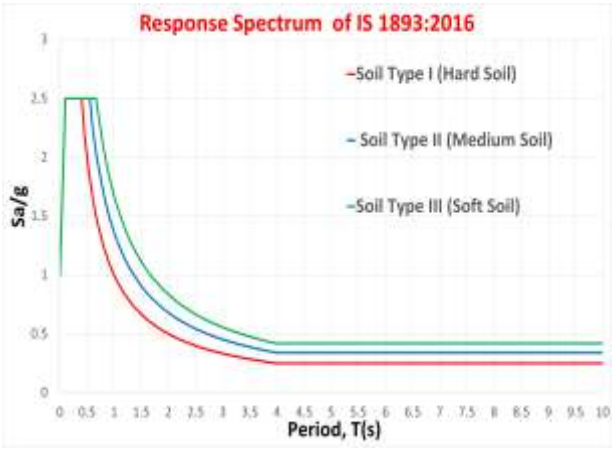

Fig 1: *Response Spectrum curve for IS 1893:2016*

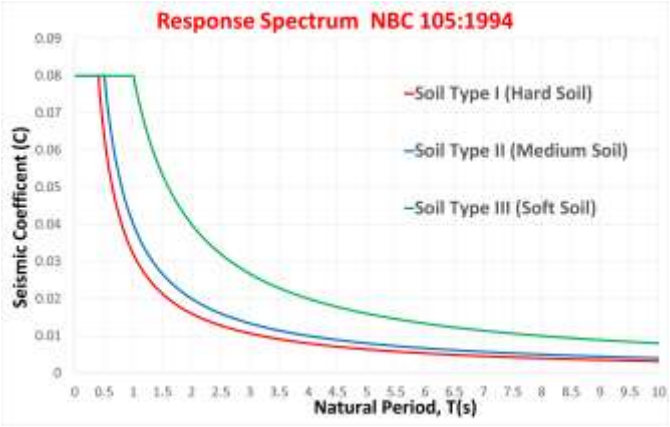

Fig 2: *Response Spectrum for NBC 105:1994*

In this way, the complete height of the structure is a significant parameter that can be subbed by the more handily saw variable, the number of stories in the structure. The stature of the regular story in RC structures in Nepal shifts among 2.7m, 3m, 3.3m and 4m relying on the area and design necessity. Diverse story statures could likewise yield various outcomes and thus, should be represented.

	NBC		IS	
	Symbols	Values	Symbols	Values
Basic coefficient	C	Based on T & soil type	S_a/g	Based on T & soil type
Time period	T	$0.06\ h^{0.75}$	T	$0.075\ h^{0.75}$
Seismic zoning	Z	0.9 for Zone A 1.0 for Zone B 1.1 for Zone C	Z	0.36
Reduction factor	K	1.0 for SMRF 1.0 for Dual	R	5.0 for SMRF 5.0 for Dual
Importance factor	I	1.0 Normal 1.5 Important	I	1.0 Normal 1.5 Important
Base shear coefficient	C_d	CZIK	A_h	$S_a/g*I/R*Z/2$
Load comb. factor	LCF	1.25	LCF	1.5

Table 1*: Values of essential parameters*

The two codes have a seismic zoning factor (Z). The entire of Nepal falls under Zone V (Z = 0.36) in light of an arrangement of the Indian Standard though as per Nepali Standard, the nation is partitioned into three zones which, for straightforwardness, will be called

Zone A (Z = 0.9), Zone B (Z = 1.0) and Zone C (Z = 1.1).

The significance factor (I) considered in the two codes is indistinguishable and need not be considered as an administering variable right now; structures like emergency clinics, schools, fire stations, films, power stations and so forth are intended for half more noteworthy seismic powers than ordinary structures.

Fundamentally seismic codes have another key viewpoint which represents the flexibility, repetition, and over-quality of the RC individuals. In IS1893: 2002, this perspective is managed by Response decrease factor (R) which lessens the plan flexible seismic powers by a sum dependent on the auxiliary arrangement of the structure; so higher R esteems would mean lesser structure seismic powers and more noteworthy dependence on repetition, over-quality, and pliability. In any case, in NBC105: 1994, Structural execution factor (K) is utilized which, on the opposite, is a multiplier and thusly more prominent K esteem implies bigger plan seismic powers.

Another factor that should be accounted is the heap mix factor since in NBC, in all heap blends, a factor of 1.25 is utilized for the quake loads while in IS, a factor as high as 1.5 is utilized for the tremor loads. Every one of these parameters (allude Table 1) get various qualities in the two codes, however, when every one of them is considered, the

consolidated impact gives a base shear coefficient which is fairly equivalent.

SN	Basic variables	Symbol	Range
1	Storey height	h_{st}	2.7m, 3.0m, 3.3m, 4.0m
2	No. of story	n	1, 2, 3, 4, 5….15
3	Soil type	ST	I, II, III
4	Zone within Nepal	Z_{nep}	A,B,C

Table 2*: Variables in the analysis*

It is worth noticing that the base shear dispersion to the floor levels in NBC is directly contrasted with explanatory dissemination in IS, which whenever left unaddressed could yield deceiving results. IS code accept explanatory circulation of base shear to the floor levels, so base shear is conveyed with respect to the result of seismic load of the floor and square of the stature of the floor from ground, while NBC expect direct appropriation, so base shear is dispersed in relation to the result of seismic load of the floor and the tallness of the floor from ground.

3. RESULT AND DISCUSSION:

It was seen that the story tallness of the RC building doesn't assume any significant job in examining the distinctions in the structure seismic powers of the two codes, so the outcomes for the most famously embraced story stature of 3m, have just be exhibited.

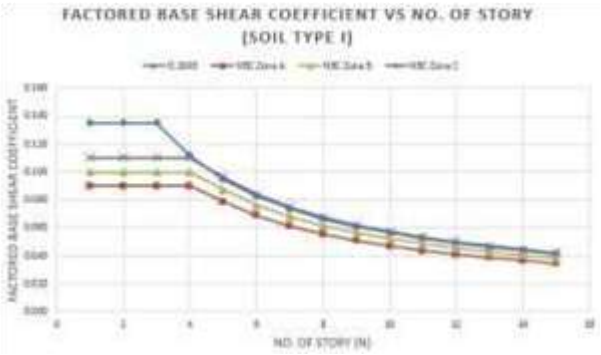

Fig. 3*: Base shear coefficients for ST I*

Fig. 4*: Base shear coefficient for ST-II*

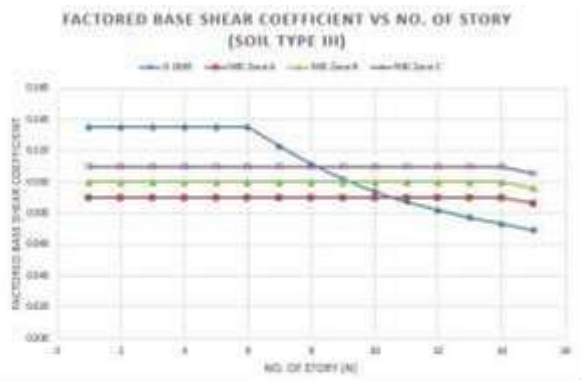

Fig. 5: *Base shear coefficients for ST III*

It is important that for soil types I and II, the calculated base shear coefficients acquired from Indian Standard pretty much surpass those got from Nepali Standard, yet for soil type III, the considered base shears got from Indian Standard is nearly lesser when the structure is more than 8, 9 and 10 stories tall (and up to 15 story) individually in the event of structures in Zone A, B and C. Be that as it may, as the charts of NBC Zone A, NBC Zone B, and NBC Zone C in Fig. 5 will decay exponentially after the 15 story stature, further derivations require further investigation.

As the base shear gets disseminated in the floor level diversely in the two codes, the impact of such contrast is additionally of concern since it is the seismic shear powers in the floor level that administers the worries in the basic individuals instead of the base shear all in all.

On researching especially for soil type III, it is seen that the aggregate story shears for the vast majority of the floor levels of a 15 story building, turn out to be higher as processed utilizing NBC than IS code (Refer Fig. 6).

Fig. 6*: Factored story shear coefficients for N=15 (Soil Type III)*

Thus, a conspicuous derivation can be made looking at Fig. 5 and Fig. 7, that the illustrative circulation of base shear in IS code yields more prominent basic interest than the direct appropriation in NBC. The calculated base shear coefficient for IS, alluding Fig. 5, is lesser than the relating esteems in NBC Zone B and NBC Zone C for a 10 story building. In this way, clearly, if the two codes followed a similar base shear appropriation design, for all floor levels of a 10 story construction, the seismic shears ought to have been lesser in IS which is, obviously not the situation as can be found in Fig. 7.

Fig. 6*: Factored story shear coefficients for N=10 (Soil Type III)*

In light of this, it is likewise obvious that the story shears for each floor processed utilizing IS will be higher when the structure is lesser than 8 anecdotes (around 25 meters tall) in a site having delicate (Soil type III) just as when the structure is of any story however in a site with medium or solid soil.

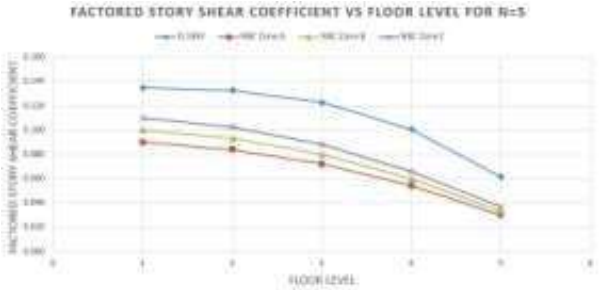

Fig. 8: *Factored story shear coefficients for N=5 (Soil type III)*

Likewise, as in Fig. 8, for a 5 story working in a site having soil type III, the hole between figured story shear coefficient for IS and NBC works out to be bigger than when the structure is 8 story tall.

4. CONCLUSIONS

Numerous variables have influence in deciding the seismic requests on the auxiliary individuals from an RC building. Subsequent to bookkeeping every such factor, it very well may be presumed that for RC structures laying on hardened or medium soil, the seismic interest as processed utilizing IS 1893 is constantly higher than NBC 105. In any case, this should, carefully, not be deciphered as anyone code being flawed, rather the two codes have their own structure standards and suppositions which extensively contrast the seismic limit of the structure is planned.

There are additionally situations when NBC can yield traditionalist results. This relies upon three central points the area of the site, the dirt kind at the site and the quantity of story of the structure. Normally, for elevated structures more than 10 to 12 stories tall (30 to 36 meters) in delicate (Soil type III), it gets hard to sum up which code gives increasingly preservationist results and when it is considerably taller, NBC 105 will yield higher seismic request and turn out to be more moderate than IS 1893.

All the more critically, these discoveries diagram the absence of amicability between the two codes which fabricates distrust on accepting the numbers that the codes endorse. In a seismically dynamic country like Nepal, it is a test to desperately stipulate unambiguous guidelines and intelligible code arrangements with respect to quake safe structure, in order to diminish tremor-related hazard in the nation. More profound research to make corrections if necessary, and actualize a solitary well-advocated seismic code in Nepal without giving wherever to different codes, must be a top-need in the approach level.

Further, significant contrasts and irregularities at last consequences of the two codes created by specialists in the field of seismicity and basic plan of every nation, have made space for vulnerability particularly when the subject being managed is very eccentric, so the auxiliary architects ought adhere to code consistency as well as should begin planning stronger, excess, breakdown preventive and better-performing structures in future.

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STANDARD CODES

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