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Analysis the basic cutting shear and the tension of column of steel frames subjected to wind load by using three design codes

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Abstract

Globalization of the construction industry and the development of international codes and standards have intensified the need of better understanding the underlying differences between standards of the wind loading. this paper, discuses the linear analysis of steel frames 2,4,7,10,15 and 20 floors, explained by using three design codes, ANSI 7-10, NBCC 05 and Iranian building code, part 6. In this paper we discuss the criteria that includes: cutting the base and Master Civil Construction. .One result of this study indicates that the proposed rules in the bylaws of America, Canada and Iran for the building that are analyses in a linear static way, in some cases, do not provide adequate safety against wind. According to sixth topic the basic cutting is less than the cutting according to NBCC regulations and the cutting according to NBCC regulation is less than ANSI regulation. According to all 3 regulations, the basic cutting increases by increasing the height. According to the 6th topic, in every frame compared to a shorter frame the maximum stress, increases by increasing the height and reduces by increasing spans. According to the sixth topic the maximum shear stress increases by increasing the frame height.

Keywords: Wind, Steel frame, basic cutting, Master Civil Construction

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1. INTRODUCTION

Based on the Across-wind loads of typical tall buildings , M. Gu, Y. Quan[1], Previous studies have indicated that the across-wind dynamic responses of super-tall buildings are usually larger than the along-wind ones. With the increase of heights, the across wind dynamic response of super-tall buildings has been a problem of great concern. In this paper, 15typical tall building models are tested with high-frequency force balance technique in a wind tunnel to obtain the first-mode generalized across-wind dynamic forces. New formulas
for the power spectra of the across-wind dynamic forces, the coefficients of base moment and shear force are then derived. Parametric analyses of the effects of factors on the across-wind loads of the buildings are performed. Besides, a SDOF aero elastic model of a square tall building with an aspect ratio of 6 is selected from the above buildings and is tested to investigate its across-wind dynamic response and aerodynamic damping characteristics. The power spectrum of the across-wind force of the square building is employed to compute its across-wind dynamic responses with and without considering the effect of the aerodynamic damping. The computed responses are then compared with the corresponding responses from the aero elastic model test to verify the present formulas of the across-wind loads of buildings.

Based on the performance based Seismic and wind engineering for 60 story Twin towers in manila, M.R. Willford and R.J. Smith[6], This paper describes the structural design of two similar 60 storey towers in Manila using performance based procedures for seismic and wind actions. High-rise buildings designed by performance based methods not only perform better than conventionally designed ones, but are also less expensive to construct. The buildings incorporate the Arup Damped Outrigger System, and the savings realized by this are discussed. The difference in the hydraulic and geometry characteristics causes a complexity in flow hydraulic and creates an interaction between the main channel and floodplains, resulting in an apparent shear stress and a transverse momentum transfer[7]. Such differences cause an channels and the investigation of the apparent shear interaction between deep flow in the main channel and stress in them as well as the effect of various parameters[8]. Breakwaters are structures which are constructedin order to create peace in a pool of ports, topreventport erosion, and to protect the shipping channel [9]. This research investigates the change of the velocity on seawall crown by considering the obstacles in different layouts and slopes[10]. Since it's important to examine the offshore structures from different aspects and perspectives, we would have to evaluate many different parameters about them[11]. The intended slopes for seawalls were 22, 27, 32, 39 degrees, respectively and had the roughness heights on wall surface were 15 cm, 20 cm and 30 cm. Moreover, four types of roughness layouts on the wall surface were investigated[12].

2. Program input

Although these standards determine wind loading in the along-wind direction using a random-vibration-based gust factor approach, the parameters are defined differently. These parameters are re-written in a consistent format and compared with each other. Some of the difficulties in using international standards is the use of different terminology and the incorporation of factors within other terms, making it hard for designers to work in a global environment. Rewriting the basic equations in a general format will help designers decipher the nuances of the different codes/standards and understand the resulting differences in the response. Note that the scope of this analysis is limited to dynamically sensitive buildings of regular shape. All the standards recommend that extremely tall and irregular shaped structures be designed using wind tunnels.

Along wind Loads In all three standards, the along wind loads are determined by multiplying the wind pressure by the tributary area of the building. The general expression for pressures on a building for all the standards can be expressed as

$$p = q.G.C_p \quad (1)$$

where q =velocity pressure; G =gust factor; and C_p= pressure coefficient. The following investigates both internal pressures and external pressures, acting in the windward and leeward directions. The loads are then determined by combining the pressures acting on a wall and the corresponding tributary area. Moments are determined by multiplying the load at a given height by the corresponding height. Base shear forces and moments are then determined by the sum of the loads and moments at each level .The velocity pressure can be expressed as:

$$q = V_0 \,.\, C_{exposure}.C_{terrain}.C_{direction}.C_{importance}.C_{other} \quad (2)$$

where ρ = air density; V_0 = basic wind velocity; $C_{exposure}$ =velocity profile or exposure factor; $C_{terrain}$= terrain and topography factor; $C_{direction}$ = directionality factor; $C_{importance}$ =building importance factor; and C_{other} = a

factor accounting for other things such as hurricane zone, shielding, or mean recurrence interval. The effects of terrain, directionality, building importance, and other factors are not considered in this study. However, the definitions of velocity profile are analyzed in detail and compared between the standards. However, the definitions of velocity profile are analyzed in detail and compared between the standards.

Averaging times for wind velocity vary between the standards and within the standards. the reference height at which the gust factor and other parameters are calculated is different between the codes/standards, as summarized in Table 1. These differences between averaging time and reference heights affect the intermediary parameters and resulting responses, making a simple comparison between the standards challenging. Throughout this analysis, the effect of differing averaging times has been minimized as much as possible.

Table 1: Averaging Times and Reference Heights

	ANSI	NBCC	Sixth- topic
Averaging time for basic wind velocity	3-s	1-he	1-hr
Averaging time for design velocity at reference height	1-hr	1-hr	1-hr
Reference height for gust factor	0.6h	h	h

The wind velocity in each code is described by a profile law, either power or logarithmic. The velocity profiles are dependent on the exposure category. Each standard uses three to five exposures categories, and can be described by six general exposure categories.

Table 2 : Assumptions and Codes of use

Lateral load	Gravity load	software:Etabs 9.70
Iranian building code,part6	Iranian building code,part 6	Type of analysis:linear
NBCC		Design Regulations:AISC-LRFD
ANSI		Failure stress of steel=3700 kg/m^2
		Yield strength of steel=2400kg/m^2

Table3: View the table model

Visibility Factor	The base pressure	The average wind speed in the region of inteterest	Regulations
2	5dan/m^2	100Km/h	Iranian building code,part6
2	0.5KN/m^2	27.78m/s	NBCC
0.85	varies with alititude	61.8m/s	ANSI

Table 4: Specific gravity load

Live load:kg/m^2	Dead load:kg/m^2	Type of load
1000	2500	Loading details

3. Program out put

3.1.Base shear

Cutting the Base Shear: The total amount of lateral force or shear at the basic level.

Reduction(%)	ASCE(ton)	Reduction(%)	NBCC(ton)	sixth topic(ton)	floors

30.33	4.34	17.72	3.92	3.33	2
35.52	10.11	14.08	8.51	7.46	4
44.97	20.13	16.35	16.13	14.01	7
50.57	31.83	17.36	24.81	21.14	10
55.45	52.45	18.94	40.13	33.74	15
74.34	76.71	28.41	56.5	44	20

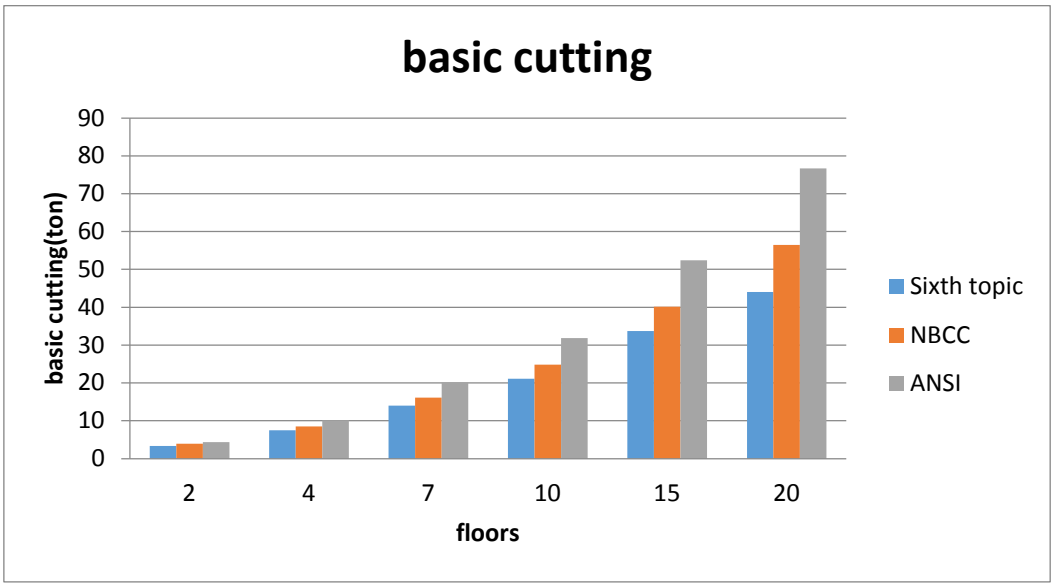

Chart1-basic cutting

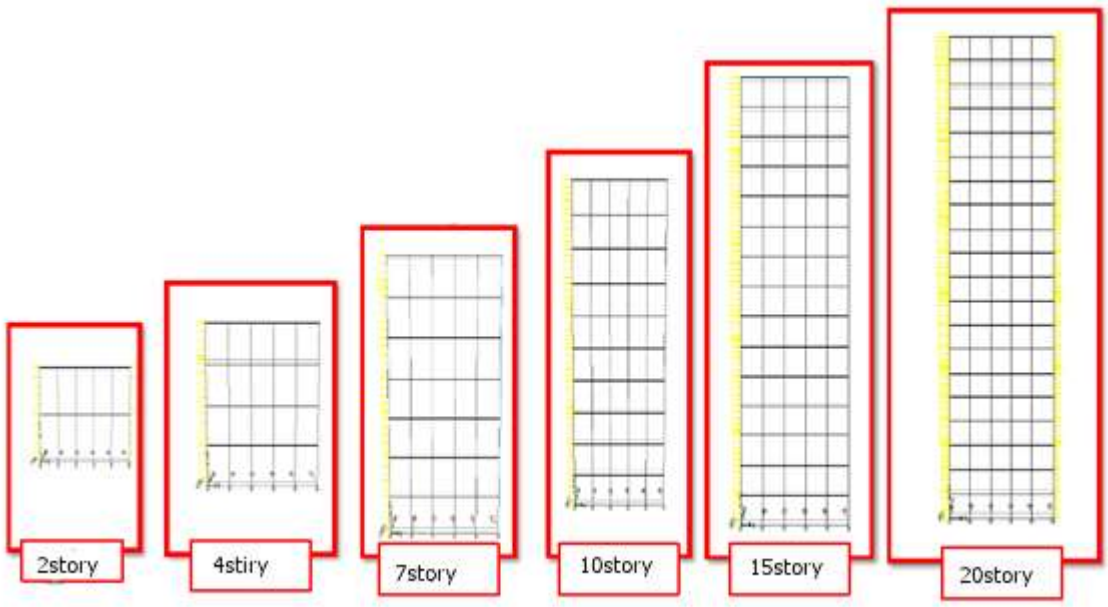

Figure1: Two-dimensional structural analysis model

3.2.Out put Graphs Extracted from ETABS program

3.2.1.Shear stress of columns

The shear stress in each category is computed from the average of shear stress of each class is computed and the shear stress on the floor ,then we compute the difference of the five spans shear tension frame and 3spans shear tension frame ,we also compute the difference between3 spans shear frame and one span shear frame and at last we plot the calculations.

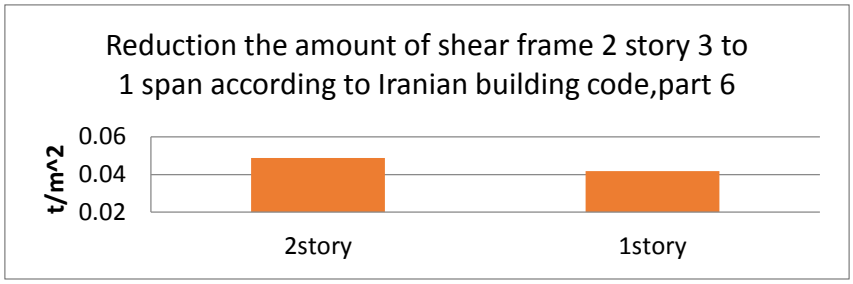

Chart2-Reduction the amount of shear frame 2 story 3 to 1 span according to Iranian building code, part 6

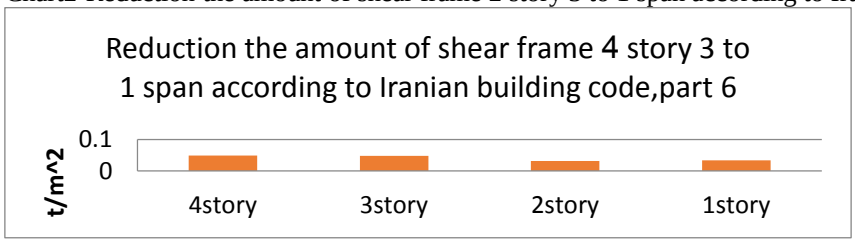

Chart3-Reduction the amount of shear frame 4 story 3 to 1 span according to Iranian building code, part 6

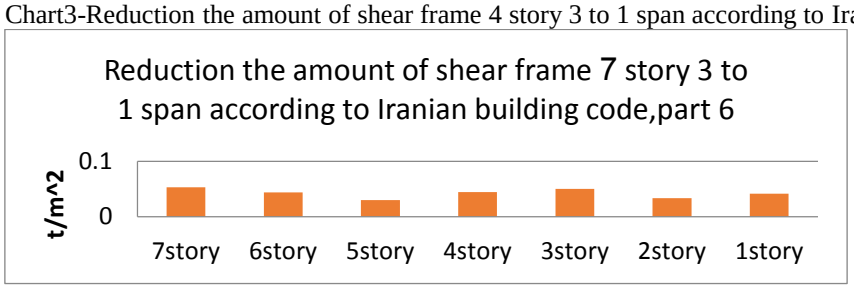

Chart4-Reduction the amount of shear frame 7 story 3 to 1 span according to Iranian building code, part 6

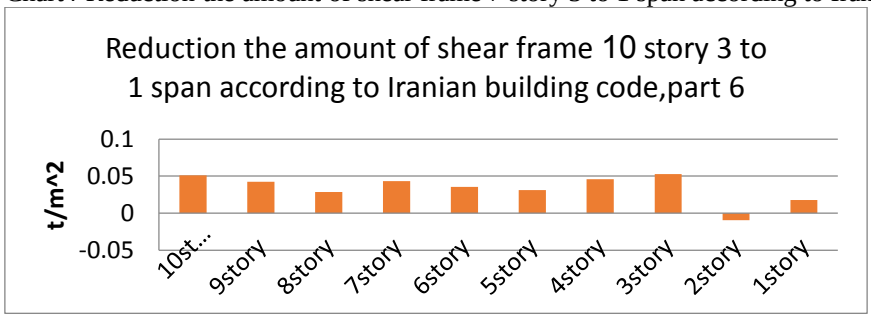

Chart5-Reduction the amount of shear frame 10 story 3 to 1 span according to Iranian building code, part 6

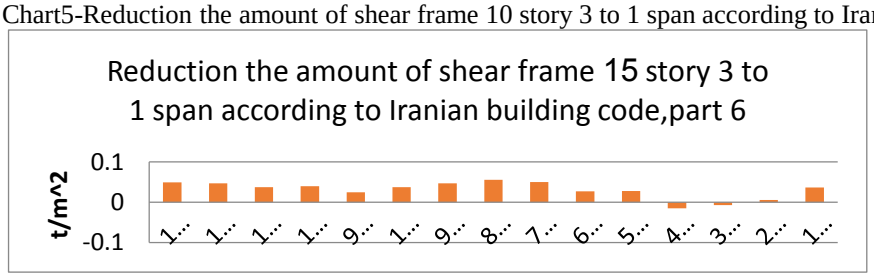

Chart6-Reduction the amount of shear frame 15 story 3 to 1 span according to Iranian building code, part 6

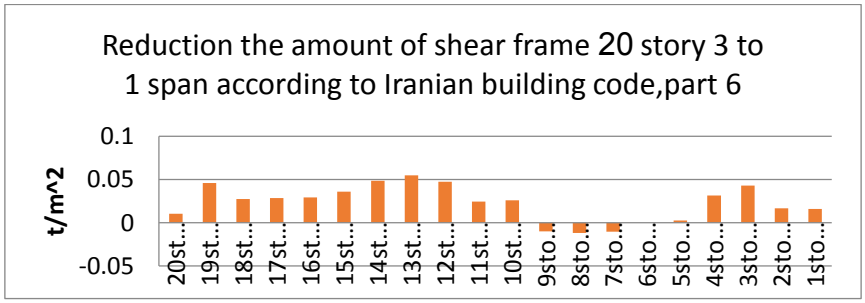

Chart7-Reduction the amount of shear frame 20 story 3 to 1 span according to Iranian building code, part 6

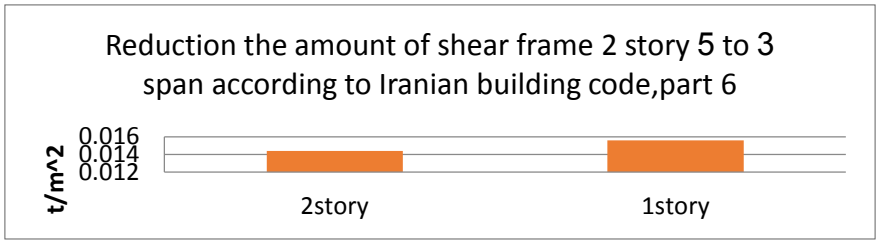

Chart8-Reduction the amount of shear frame 2 story 5 to 3 span according to Iranian building code, part 6

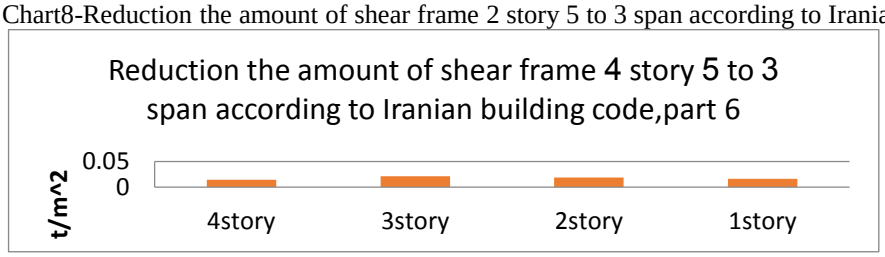

Chart9-Reduction the amount of shear frame 4 story 5 to 3 span according to Iranian building code, part 6

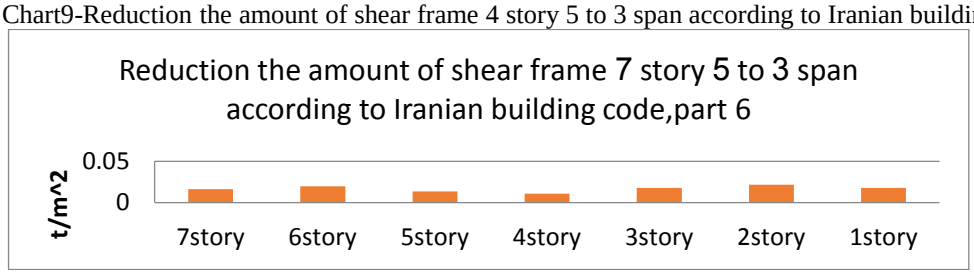

Chart10-Reduction the amount of shear frame 7 story 5 to 3 span according to Iranian building code, part 6

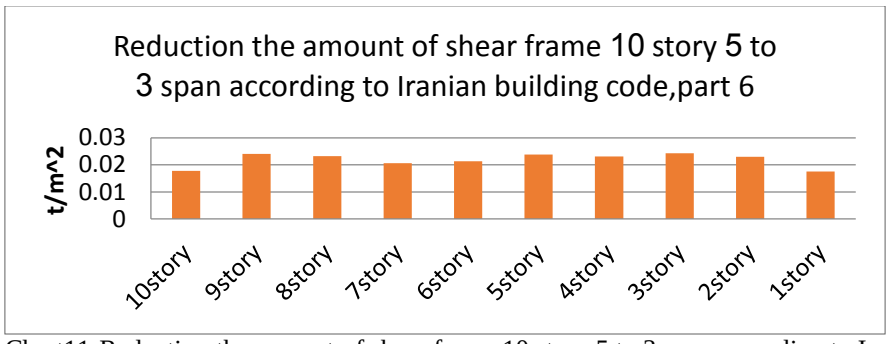

Chart11-Reduction the amount of shear frame 10 story 5 to 3 span according to Iranian building code, part 6

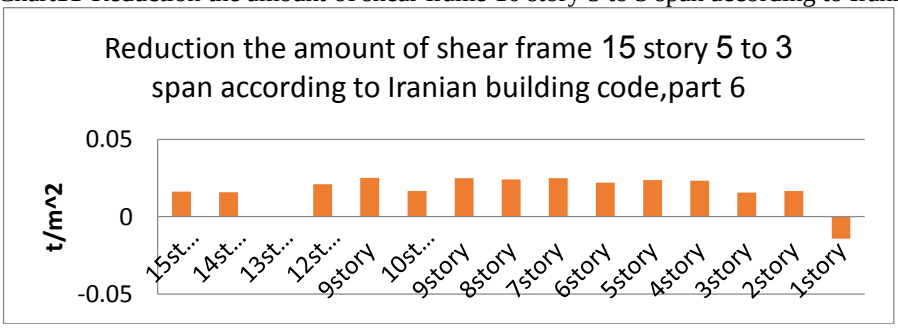

Chart12-Reduction the amount of shear frame 15 story 5 to 3 span according to Iranian building code, part 6

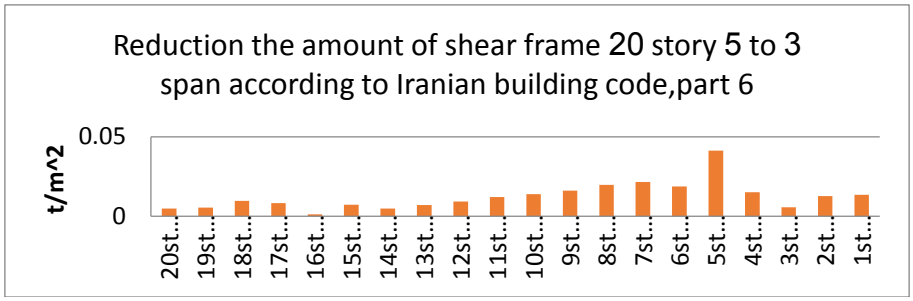

Chart13-Reduction the amount of shear frame 20 story 5 to 3 span according to Iranian building code, part 6

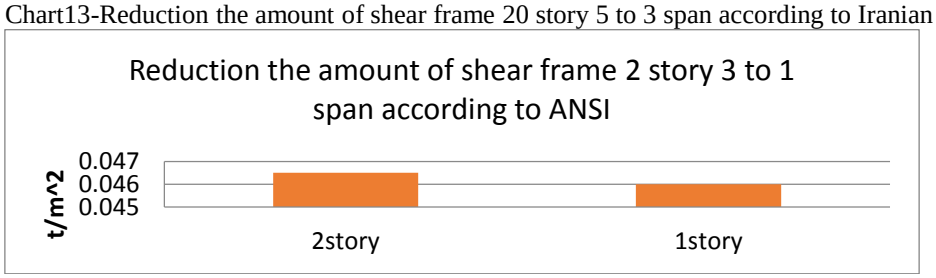

Chart14-Reduction the amount of shear frame 2 story 3 to 1 span according to ANSI

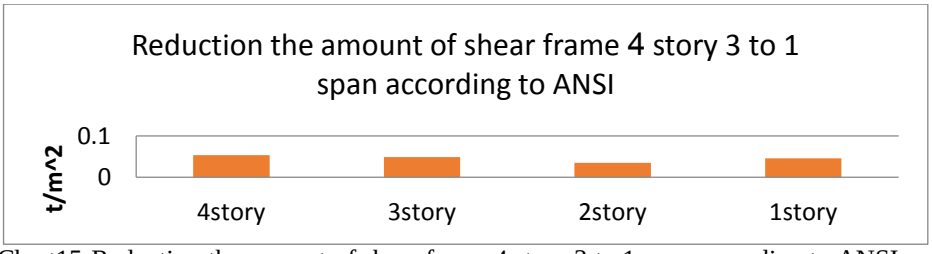

Chart15-Reduction the amount of shear frame 4 story 3 to 1 span according to ANSI

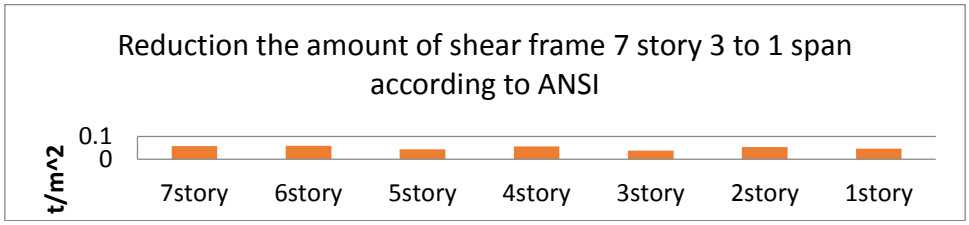

Chart16-Reduction the amount of shear frame 7 story 3 to 1 span according to ANSI

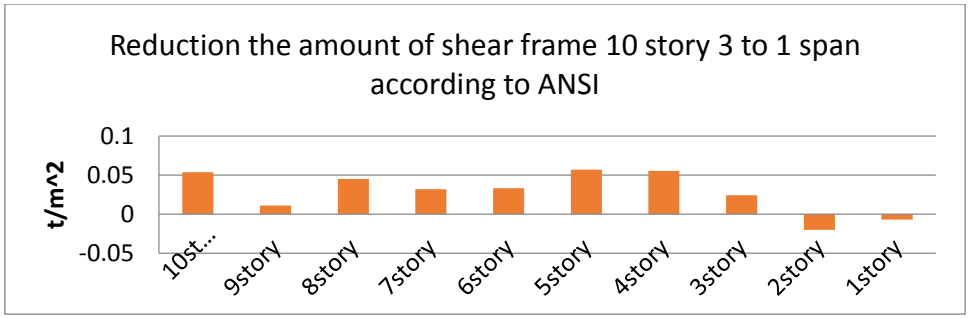

Chart17-Reduction the amount of shear frame 10 story 3 to 1 span according to ANSI

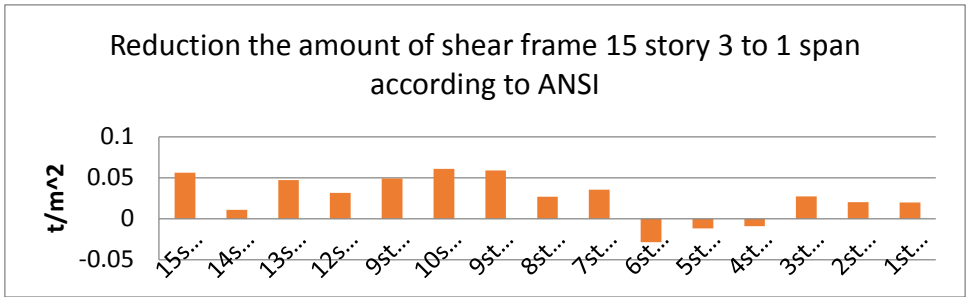

Chart18-Reduction the amount of shear frame 15 story 3 to 1 span according to ANSI

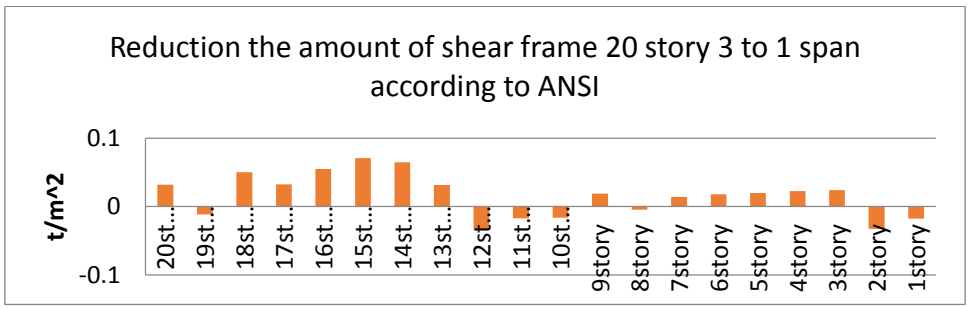

Chart19-Reduction the amount of shear frame 20 story 3 to 1 span according to ANSI

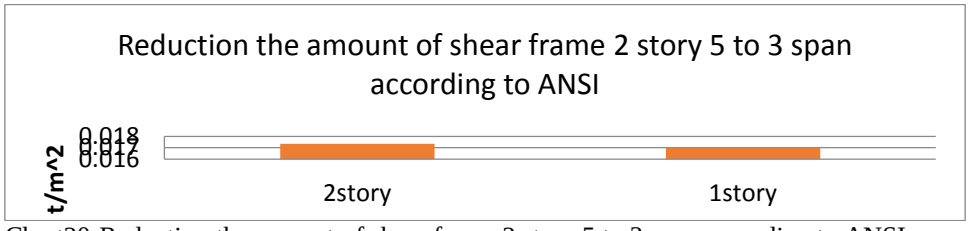

Chart20-Reduction the amount of shear frame 2 story 5 to 3 span according to ANSI

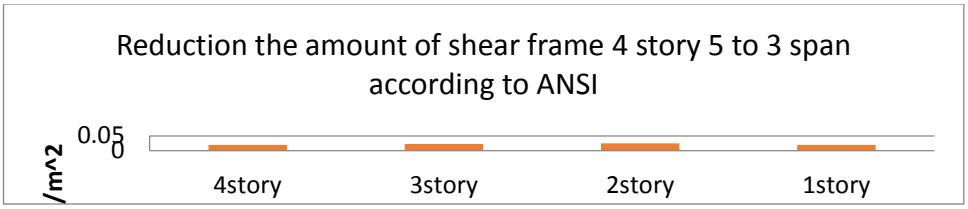

Chart21-Reduction the amount of shear frame 4 story 5 to 3 span according to ANSI

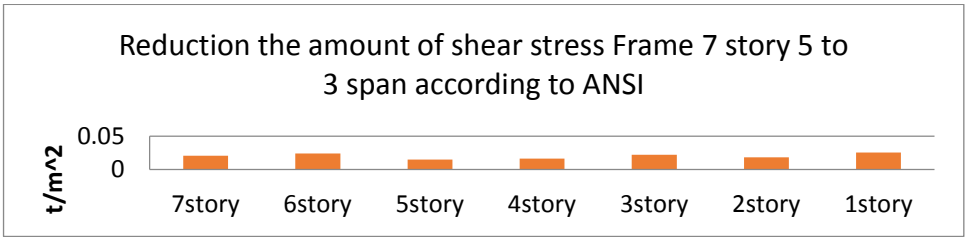

Chart22-Reduction the amount of shear frame 7 story 5 to 3 span according to ANSI

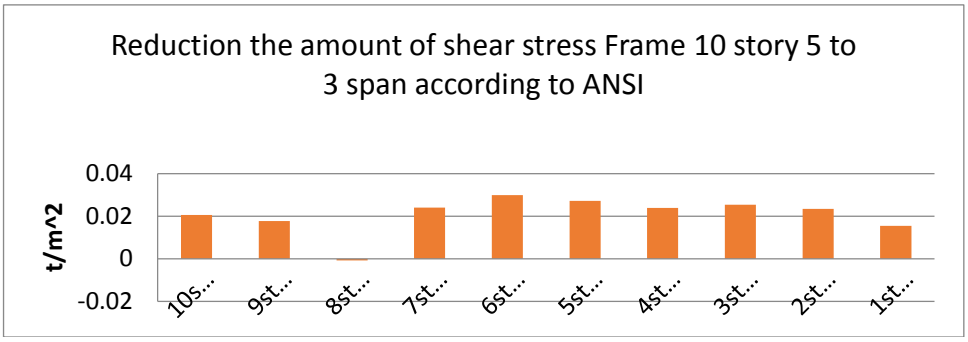

Chart23-Reduction the amount of shear frame 10 story 5 to 3 span according to ANSI

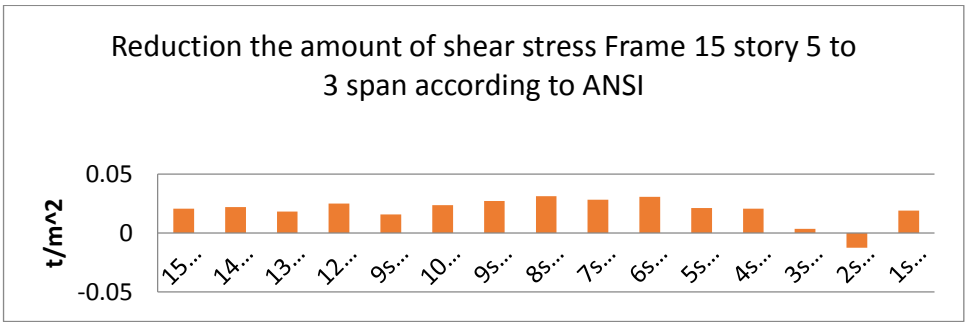

Chart24-Reduction the amount of shear frame 15 story 5 to 3 span according to ANSI

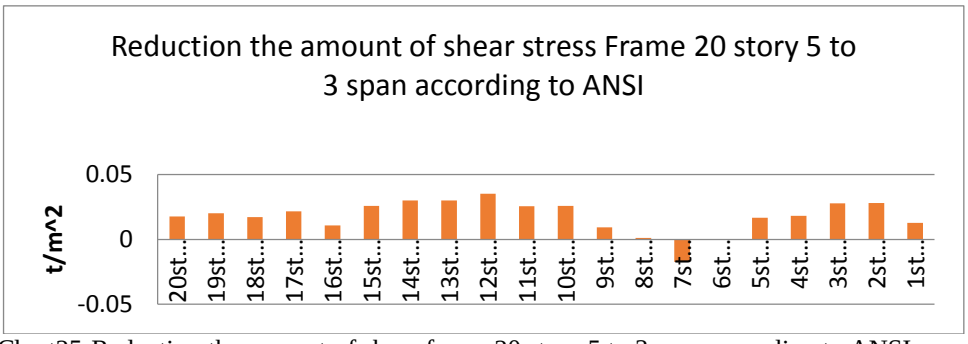

Chart25-Reduction the amount of shear frame 20 story 5 to 3 span according to ANSI

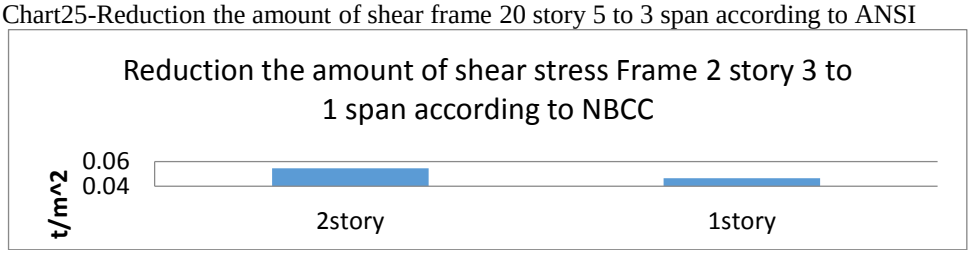

Chart26-Reduction the amount of shear frame 2 story 3 to 1 span according to NBCC

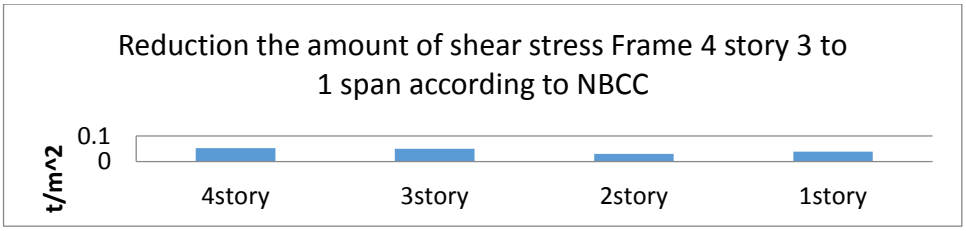

Chart27-Reduction the amount of shear frame 4 story 3 to 1 span according to NBCC

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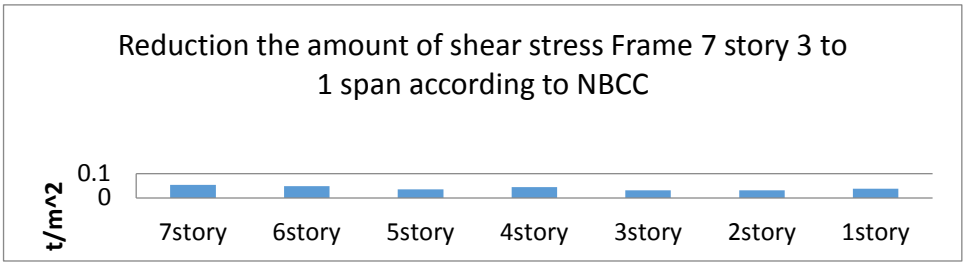

Chart28-Reduction the amount of shear frame 7 story 3 to 1 span according to NBCC

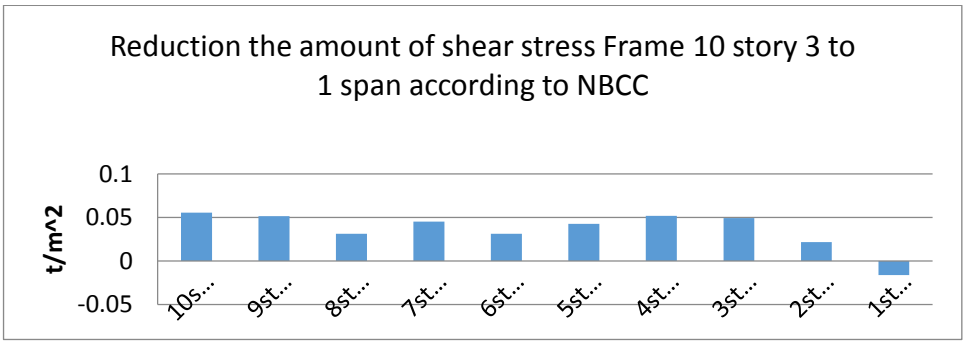

Chart29-Reduction the amount of shear frame 10 story 3 to 1 span according to NBCC

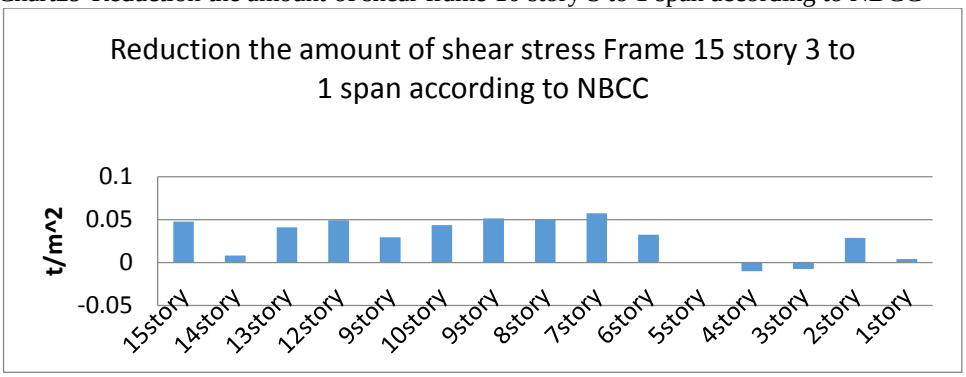

Chart30-Reduction the amount of shear frame 15 story 3 to 1 span according to NBCC

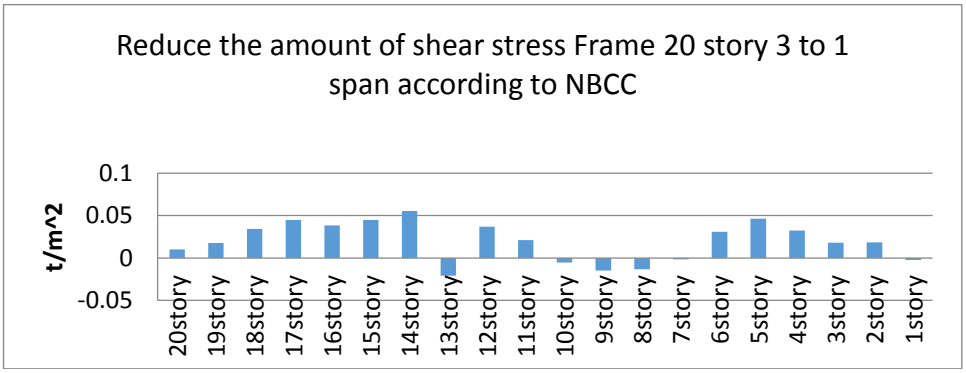

Chart31-Reduction the amount of shear frame 20 story 3 to 1 span according to NBCC

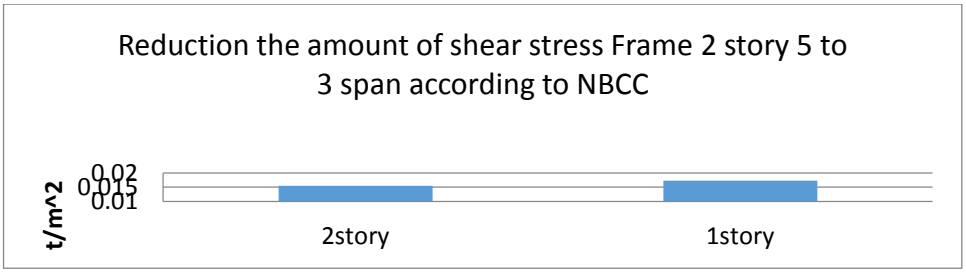

Chart32-Reduction the amount of shear frame 2 story 5 to 3 span according to NBCC

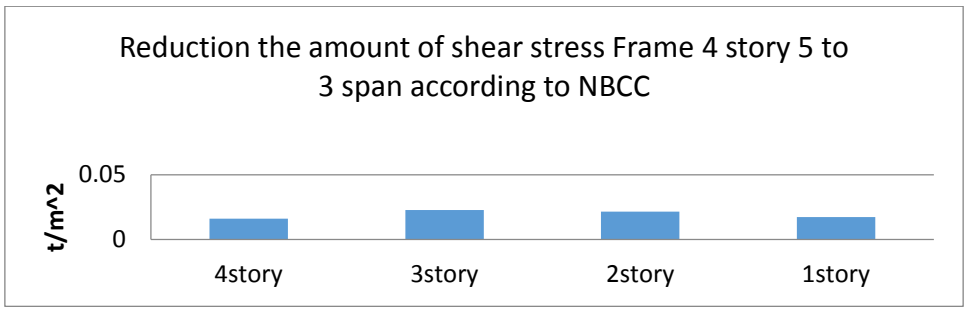

Chart33-Reduction the amount of shear frame 4 story 5 to 3 span according to NBCC

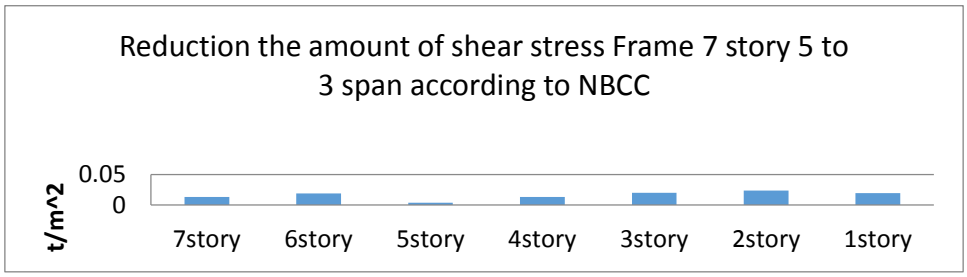

Chart34-Reduction the amount of shear frame 7 story 5 to 3 span according to NBCC

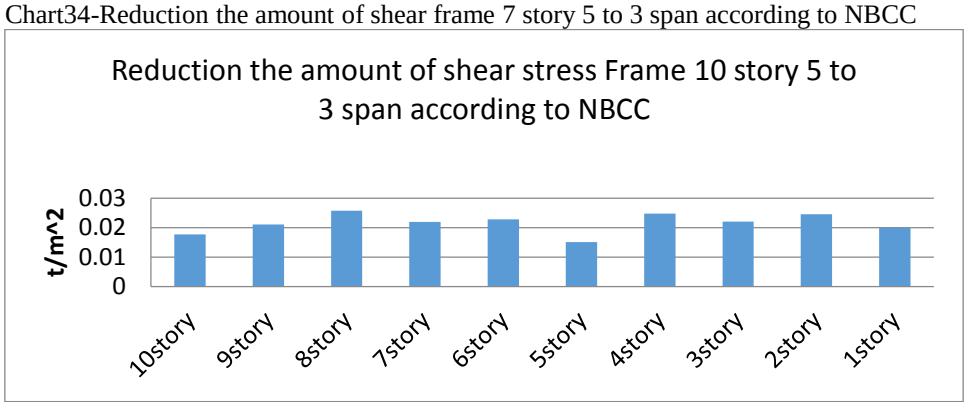

Chart35-Reduction the amount of shear frame 10 story 5 to 3 span according to NBCC

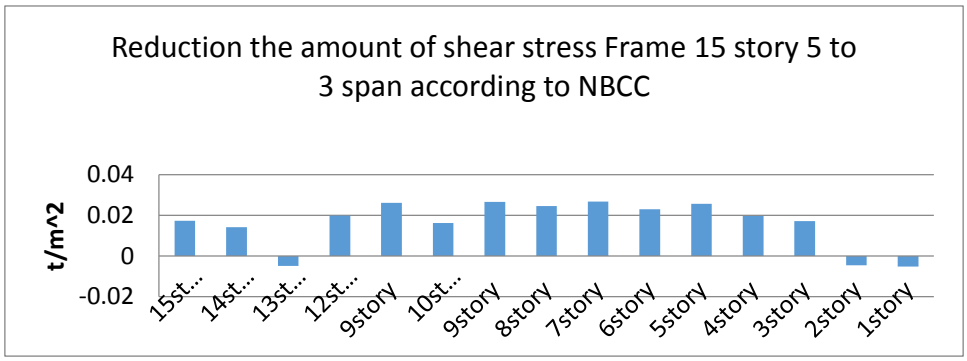

Chart36-Reduction the amount of shear frame 15 story 5 to 3 span according to NBCC

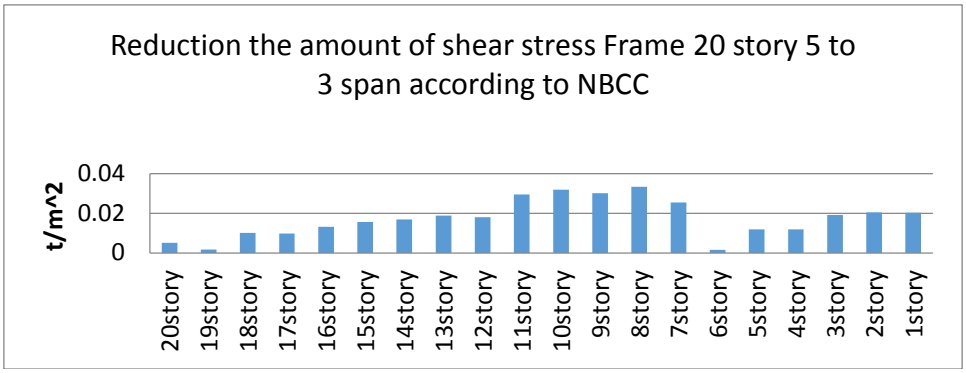

Chart37-Reduction the amount of shear frame 20 story 5 to 3 span according to NBCC

If shear stress frame 1span =X ,shear stress frame 3span=Y & shear stress 5span=Z
In all floors,2,4 and 7 story ;X,Y respectively is lesser than Y,Z.
The most floors,10,15 and 20 story; X,Y respectively is lesser than Y,Z.

3.2.2.The difference of coefficient Confidence %

Confidence, parametric design that reflects the true forces the forces expected.

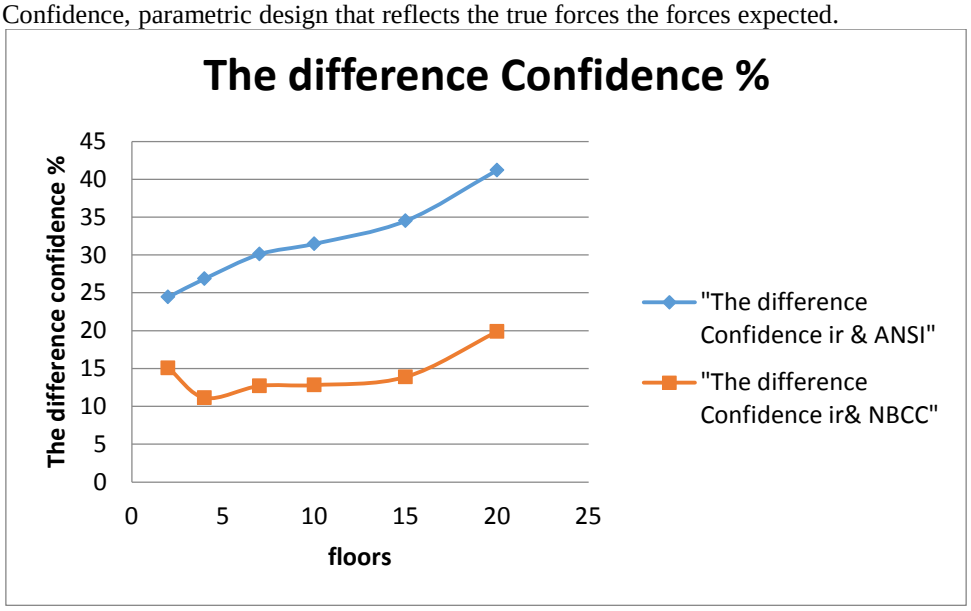

Chart38-Reduction the amount of shear frame 2 story 3 to 1 span according to NBCC

4. Discussion

- According to all 3 regulations, If shear stress frame 1span =X ,shear stress frame 3span=Y & shear stress 5span=Z
In all floors,2,4 and 7 story ;X,Y respectively is less than Y,Z.
The most floors,10,15 and 20 story; X,Y respectively is less than Y,Z.

- According to The difference Confidence the sixth topic and NBCC regulations is less than the to The difference Confidence the sixth topic and ANSI regulations.
-The difference Confidence increases by increasing the frame height except for short frames.

-According to sixth topic the basic cutting is less than the cutting according to NBCC regulations and the cutting according to NBCC regulation is less than ANSI regulation.
-According to all 3 regulations, the basic cutting increases by increasing the height.

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