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DEVELOPMENT OF AN ANALYTICAL MODEL FOR THE ESTIMATION OF HORIZONTAL LOADS ON STRUCTURES

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ABSTRACT

Spreadsheets have become a popular computational tool and a powerful platform for performing engineering calculations. With this work, new entrants into the field would benefit by having insights into researchable areas, thereby speeding up research and effectively utilizing research resources. A frame of G+2 multi bay has been taken for study. Manually lateral load, distribution load, Sheer force of horizontal element has been done. Manual analysis has been done using linear static equivalent and linear dynamic response spectrum method with various country codes IS 1893:2002, ASCE 7-10, EC8 1998(1):2002. Same problem has carried out in STAAD PRO v8i for the comparison between manual and software values. A spreadsheet for seismic analysis of multistory structure for lateral loads has been developed with the help of various country codes.

Keywords: *lateral force, shear force, linear static equivalent and linear dynamic response spectrum*.

INTRODUCTION

Lateral loads on multistorey building are difficult to calculate manually with linear and dynamic methods by using different country codes. So this work can be easily done with the help of spreadsheets. The development of an analytical model is done for the estimation of horizontal load by various country codes. The G+3 multi bay ordinary moment resisting frame storey is taken as example for manual calculation with three different country codes IS 1893:2002, Euro Code(EC8)1998-1:2002, ASCE 7-10 are being used. Equivalent static method and response spectrum method are used as per different codes. The comparison between different methods is checked. The results of manual calculation are compared with software results. Much of what is done using Excel could be done manually, but electronic spreadsheets can do computations faster and with fewer errors. It has the ability to re-compute results quickly, easily, and reliably as any place in the spreadsheet changes. One value in the spreadsheet can be changed, and the results of the analysis can be automatically. Model can be saved and reused, which will allowing you to save a lot of time because don't have to re-create the spreadsheet. Often, from one year to the next, just a few numbers need updating in a saved Excel file. Once data have been analyzed in a spread- sheet, such as Excel, you can easily create charts or graphs showing the results

Procedure:

1. Example: Seismic lateral load analysis by equivalent static force analysis Method accordance with IS 1893:2002

G +3 multi bay ordinary moment resisting frame storey

Seismic zone =3

Height of storey=3m

Location = pane

No. of storey =3

Soil type=medium

No. of column=12

Size of beam= 250×450mm

Size of column=450×500mm

Thickness of slab=150mm

Important factor=1

Base shear (V_b) = A_h × W

where $A_h = \frac{Z}{2} \times \frac{I}{R} \times \frac{S_a}{g}$

Design lateral force of each floor i

$Q_i = V_b \frac{W_i \times h_i^2}{\sum_{j=1}^{n} W_j \times h_j^2}$

where :

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Q_i = design lateral force of floor i

W_i = seismic weight of floor i

h_i = height of floor I measure from base

N = no. of stories in the building.

Storey shear (V_i) :

$V_3 = Q_3$

$V_2 = V_3 + Q_2$

$V_3 = V_2 + Q_1$

Table no.1

Story	Base shear V_b (KN)	Height (h_i) m	Seismic weight(W_i) KN	Lateral force (Q_i) KN	Storey shear (V_i) KN
3	457.26	9	3080	266.847	266.847
2	457.26	6	3956	152.330	419.177
1	457.26	3	3956	38.08	457.257

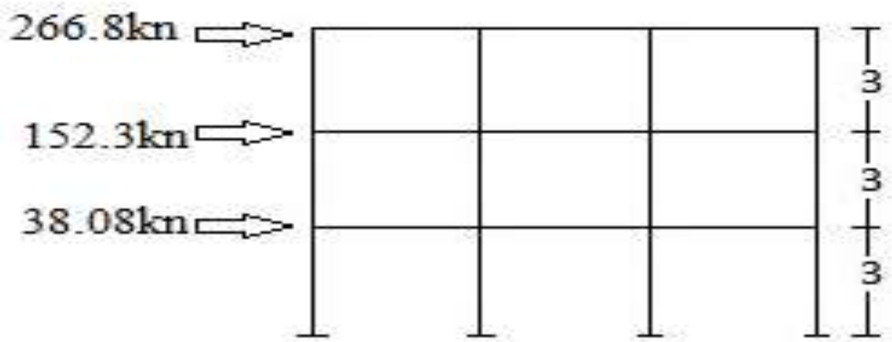

Fig no. 1. Lateral load on each storey

2. Example: Seismic lateral load analysis by equivalent static force analysis Method accordance with EC8 1998-01:2002

Structure: 3 Storeyed building

Location: Greece

Shear wave velocity: 500 m/s

Ground type: B

Importance class: 1

Purpose: Residential

Structural type: Ordinary moment resisting frame

Story height: 3m

Column dimensions: 450mm X 500mm

Beam dimensions: 230mm X 450mm

Slab thickness: 150mm

No. of column: 12

Unit weight of concrete: 25 KN/m^3

Unit weight of masonry: 20 KN/m^3

Seismic base shear $F_b = S_d(T_1) \times m \times \lambda$

Where T_1 = 0.38 sec (Fundamental natural time period)

m = Total building mass

λ = 0.85 (Correction factor for this building) if $T_1 \leq 2\, T_C$

$S_d(T_1) = ag \,.\, S \,.\, \frac{2.5}{q}$

Design lateral force of each floor (F_i) : $F_i = F_b \frac{zi \times mi}{\sum zj \times mj}$

Shear force (V_i) :

$V_3 = Q_3$

$V_2 = V_3 + Q_2$

$V_3 = V_2 + Q_1$

Table no.2

Story	Height (z_i) m	Seismic weight(m_i) KN	Height(z_i) × mass(m_i)	$z_i \times m_i / \sum z_j \times m_j$	Design lateral force (F_i) KN	Shear force (V_i) KN
3	9	3080	27720	0.4377	310.80	310.80
2	6	3956	23736	0.3748	266.13	576.939
1	3	3956	11868	0.1874	133.06	710.008
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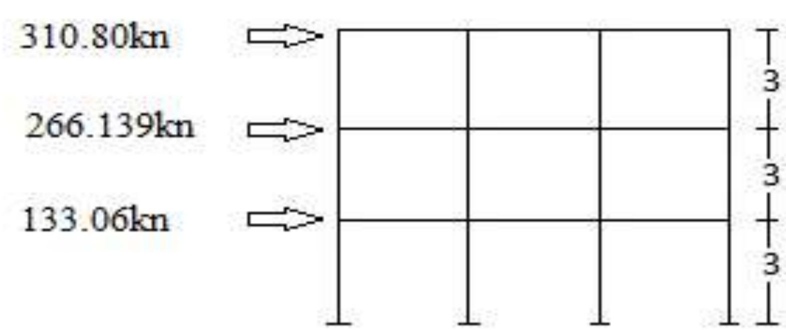

Fig.2. Distribution of lateral load according to EC8

3. Example: Seismic lateral load analysis by equivalent static force analysis Method accordance with ASCE 7-10

Given data

Structure: 3 Storeyed building

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Location: Stokton (California) (zone 3)

Occupancy catogiers: 3

Soil class: B (Medium soil)

Purpose: Residential

Structural type: Ordinary moment resisting frame

Story height: 3m

Column dimensions: 450mm X 500mm

Beam dimensions: 230mm X 450mm

Slab thickness: 150mm

No. of column: 12

Earthquake spectral response accelerations at short periods (S_s) = 1.25

Earthquake spectral response accelerations at 1 second (S_1) = 0.40

Unit weight of concrete: 25 KN/m^3

Unit weight of masonry: 20 KN/m^3

Base shear : V = Cs × W (Clause 12.8-1 ASCE 7-10)

where

C_s = Seismic response coefficient

W = the effective seismic weights

1) $C_s = \frac{S_{Ds}}{\frac{R}{I}} = \frac{0.833}{\frac{3}{1.25}} = 0.3472$

2) $C_s = \frac{S_{D1}}{T\frac{R}{I}} = \frac{0.373}{0.46\,\frac{3}{1.25}} = 0.33$

3) $C_s = 0.044\ S_{Ds}$

Design lateral force: $F_x = C_{vx}\ .V$

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$C_{vx} = W_x.h_x^k / \sum_{i=1}^{n} W_i.h_i^k$

Table no.3

Level	W_i (KN)	hi(KN)	$W_x \times h_x^k$	C_{vx}(KN)	F_x(KN)	V_i(KN)
3	3080	9	22997.6	0.424	213.5	213.5
2	3956	6	20382.83	0.376	189.3	402.8
1	3956	3	10809.91	0.199	106.2	509
∑			54190.34	1.00		

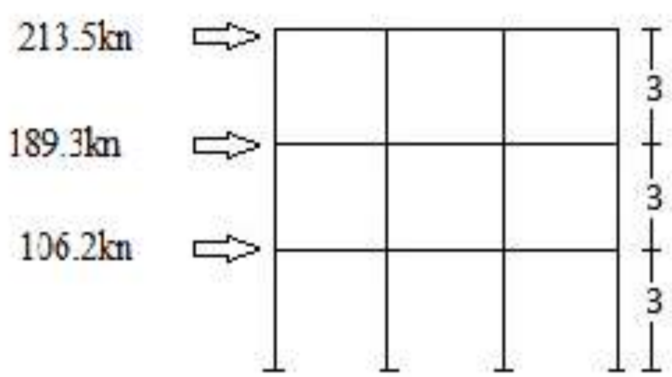

Fig 3. distribution of lateral load according to ASCE 7-10

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Table 04

level Story	IS 1983:2002		EC 8 1998-1:2002		ASCE 7 2010	
	Lateral force(Q_i) KN	Shear force (V_i) KN	Lateral force (F_i) KN	Shear force (V_i) KN	Lateral force (F_x) KN	Shear force (V_i) KN
3	266.84	267.039	310.80	310.80	213.5	213.5
2	152.330	419.177	266.139	576.939	189.3	402.8
1	38.08	457.257	133.069	710.008	106.2	509

Summary of results from equivalent static seismic analysis with different country codes

CONCLUSION

From the manual calculation maximum lateral force comes in Euro code 8 according with static equivalent method.Difference in lateral load from static equivalent method for IS Code , Euro Code, ASCE Code are come in the ratio of 1:16:0.80 from this we known their will be changes in lateral load with the change of code . Same comparison will also be carried out by the use dynamic analysis. And the result will also be compared with STAAD PRO result. From this manual calculation we will make excel sheet to calculate the later load for different code simultaneously

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