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A COMPARATIVE STUDY ON STRUCTURE IN BUILDING USING DIFFERENT PARTITION RECEIVING EXPENSE EARTHQUAKE

*Sutrisno[1] ,[2] Rusnardi Rahmat Putra, [3] and Ganefri

[1]Students of Technology and Vocational Education, Padang State University, Indonesia

[2]Civil Engineering Department, Padang State University, Indonesia

[3]Electrical Engineering Department, Padang State University, Indonesia

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ABSTRACT: Light weight building is one of the principles earthquake resistant building design. The size of the seismic forces that building received depends on the total weight of the building and the earthquake that hit the acceleration (F = ma). The heavier a building, the greater the seismic forces that will occur in the building. This study will show the comparison of the behavior V-story building structure, deviation (deplection horizontal) and the reinforcement columns for three diffrent types of building which is using different materials partition, ie partition with material brick, concrete block and lightweight concrete (Hebel). It was simulated using software SAP2000 to get all three. Simulated object is a 10 storey building with 35 m total height which is 3.5 m height for each floors, located in an earthquake zone 4, the criteria and the soil being analyzed by static method equivalents. The simulation results showed that the bigest value of V-story, deviation and reinforcement column contained in the building material brick partitions, while the smallest is the partition material Hebel. Hebel partitions large percentage decrease compared to brick partition for V-story, deviation and reinforcing successive columns are 16.1; 15.3%; 18.0%.

Keywords: buildings, earthquake, V-story, deplection horizontal, reinforcingcolumns.

1. INTRODUCTION

Planning for an earthquake resistant building it is necessary to apply some of the principle. Among them the building should be ductail, homogen building shape configuration, diaphragm and a strong bond floor, and the relationship between the structure has a relatively homogen strength in all direction. The earthquake resistant building should also has a light weight building, the light weight reduces the seismic forces received, because the magnitude of seismic force received depends on the amount of the buildings total weight and the earthquake that hit the acceleration (F = m.a). The heavier a building, the greater the seismic forces that will occur in the building.

The structure that receives the load will deform or change the shape of the structure due to the imposition received. A structure must be able to accept the load, both on the rod tip structure or at the rod assembly or nodal structure. For planners, understanding the behavior of the structure due to the work load is necessary, because it is useful in determining the next step.

Currently there are a wide variety of material choices in building wall partition. Such as brick, concrete block, and light weight concrete (*hebel*). Each has advantages and disadvantages. In addition to the differences in quality and size, as well as between concrete block, brick, and light weight concrete differ in terms of the load on the building.

Favorable circumstances and impediments of the utilization of chose progressed and reasonable materials in structural building tasks are examined. A weighted scoring philosophy for enhanced assessment of their points of interest and burdens, with a perspective to helping choices, is proposed [7].

This study will show the comparison of the behavior V-story building structure, deviation (*deplection horizontal*) and the reinforcement columns for three diffrent types of building which is using different materials partition, ie partition with material brick, concrete block and lightweight concrete (*Hebel*).

2. THEORITICAL REVIEW

2.1 *V-story*

Regular building structure can be planned against nominal earthquake assessment under the influence of earthquake plans in each direction of the main axis of the structure plan, in the form of nominal static earthquake load equivalent, which in turns is defined in the article bellow [4]:

1. If the category of the building has a Virtue Factor I, according to Table 1 and the structure to a direction of the major axis layout structure and at the direction of loading Earthquake Plan has

an earthquake reduction factor R and Fundamental natural vibration T1, then nominal shear load equivalent static V is happening on the ground level can be calculated according to the equation : $V = \frac{C_1 I}{R} W_t$ (1) where C_1 is the Earthquake Respons Factor values obtained from Spectral Respons Plan for Fundamental natural vibration period T_1, whereas W_t is the total weight of the building, including live load accordingly.

2. Nominal basic shear load V under Article 6.1.2 should be distributed throughout the building structure height to become equivalent F_i of nominal static earthquake load that captures the center of mass of the i-th floor level according to equation : $F_i = \frac{W_i z_i}{\sum_{i=1}^{n} W_i z_i} V$ (2)

Where Wi is the weight of the i-th floor level, including live load appropriate, z_i is the height of the floor level of the i-th measured from lateral clamping level under Article 5.1.2 and Article 5.1.3, while n is the number of the top level floor.

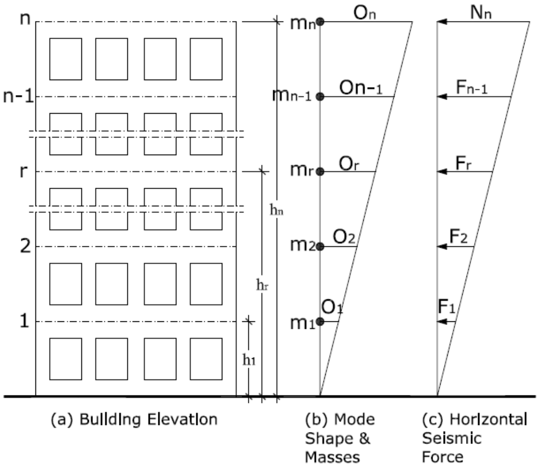

Figure 1. Equivalent Static Analysis to determine shear force base [1].

2.2 *Deviation (deplection horizontal)*

In the design of earthquake resistant structure, deviation Δ_M between the level should not exceed 0,02 times the high level is concerned to limit the possibility of the collapse of building structures that can cause human fatalities. These limits specified in SNI 1726 Ps 8.2.2. it should be noted. Unlike on the UBC, SNI limit performance serviceability limit between the rate structure should not exceed 0,03/R x height level or 30 mm, the smallest value is applicable. This brick work is intended to prevent tensile strenght of steel and concrete excessive cracking [2]

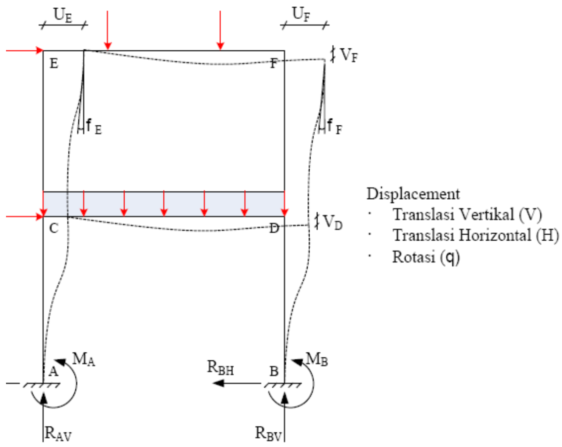

Figure 2. Displacement of Portal.

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2.3 Equivalent Static Analysis

Equivalent static analysis is a method that is simple and wide used to determine seismic load plan. This method uses the assumption that the response of building against earthquake loads occur on the first dynamic variety, which is equivalent to a variety of static. For this reason this method is called Equivalent Static Analysis. Response occurred, particularly in the building less than 10 floors, it is often assumed to be linear [1].

For the building structure, equivalent static analysis can be performed on a regulatr structure building. The provisions concerning regular building structures mentioned in article 4.2.1[4].

If the building has an irregular structure, then in addition to an equivalent static analysis is also required further analysis, the dynamic response analysis. Calculation of an irregular building dynamic structure response against earthquake loading, can use a wide spectrum analyzer method or methods of analysis dynamic response time history. Article 7.1.3, if the final dynamic response values are espressed in the base shear force nominal, the value should not be less than 80% of the base shear force resulting from equivalent static analysis.

3. RESEARCH METHODS

To get the desired goal, researchers should simulate the comparison three buildings contained of 10 floor and height 35 m with a height between each floor 3,5 m. the object is assumed to be in an earthquake zone 4 with medium soil criteria then analyzed by equivalent static method using SAP2000 software.

3.1 Equivalent Static Analysis Step

Here are the Equivalent Static Analysis steps :

1. Calculate the natural vibrating time of building.

2. Determine the base shear force coefficient that satisfies.
3. Calculate the base shear force (V) based on total weight of the building. Basic nominal shear force formulated as follows :

$$V = \frac{C_1 I}{R} W_t$$

4. Distribute the base shear force for each floor of the building structure (F) horizontal shear force for each floor (Fi) which was formulated as follows :

$$F_i = \frac{W_i z_i}{\sum_{i=1}^{n} W_i z_i} V$$

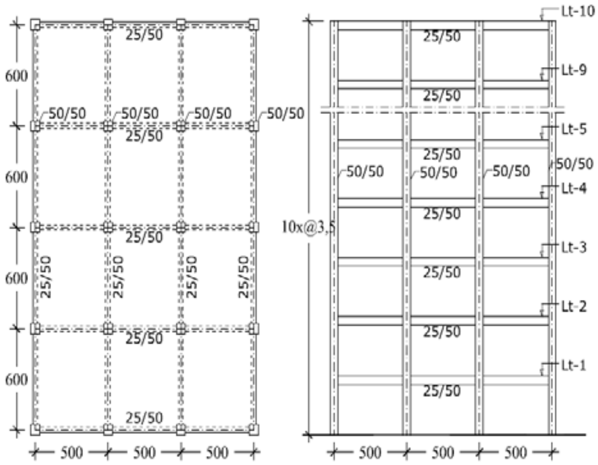
5. Analyze the structure with the influence of lateral loads to gain *V-story*, deviation *(deplection horizontal)* dan column reinforcement with SAP2000 software.
6. Estimate *V-story*, deviation *(deplection horizontal)* dan column reinforcement.

3.2 SAP2000 Operation Step

1. Defining the individual units, the individual units are selected based on units present in the structure that analyzed.
2. Drawing geometry, geometry described by size and selected unit.
3. Defining the material, the material is defined reinforced concrete according to the building that is analyzed.
4. Defining the frame section and put it, frame section is the size of beam and column then put it.
5. Defining the load and put it, the loads acting on the structure is defined, dead load, live load, and earthquake load then put it down.
6. Defining load combination that are adapted to the regulations and the work load. Structure, component, and foundation should be designed in such way so that the design strength is equal or exceed to the effect of the factored load in a combinations of the following [3,6]:
   a. 1,2D +1,0E+L+0,2S
   b. 0,9D+1,0E
   D, E, L and S respectively are dead load, live load, earthquake and snow.
7. Analyzed.

4. ANALYSIS AND DISCUSSION

4.1 Building Data as showed at figure 3.
4.2 Floor typical height 3,5 m, column dimension is assumed equal as 50 x 50 cm, beam dimension is assumed equal as 30 x 50 cm, floor plate thickness 12 cm, quality concrete (fc') = 30 MPa, quality steel (fy) = 400 Mpa, the building was used as offices.



a. Sketch b. Cross-section

Figure 3. Sketch and Cross-section.

4.2 Earthquake Data :

The building location is in an earthquake zone 4 and medium soil conditions as explained basic input at located design [8,9]

4.3 Load Data :

Brick density : 2000 kg/m^3, concrete block density : 1000 kg/m^3, light weight concrete (hebel) density : 650 kg/m^3, additional dead load on each floor (*screed* + ceramics, ceiling, *mechanical, electrical*) = 1,6 kN/m^2, additional dead load on the roof (ceiling, mechanical, *and electrical*) = 0,5 kN/m^2, Live Load (LL) on each floor = 2,5 kN/m^2 and Live Load (LL) on the roof = 1,5 kN/m^2.

4.4 Calculation

1. For medium soil acquired bedrock peak acceleration = 0,2 g and peak ground acceleration A_o = 0,28 g (Table 5. Article 4.7.2 SNI 1726-2002).
2. Tc = 0,6 second, A_m = 2,5 A0 = 0,7 g and A_r = A_m x Tc = 0,42 (Table 6. Article 4.7.6 SNI 1726 -2002).

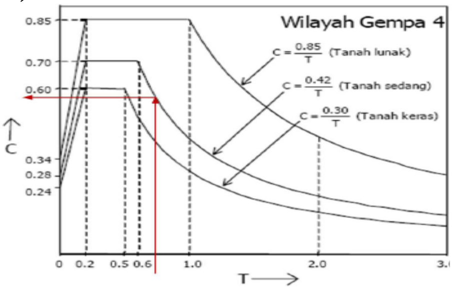


Figure 4. Determining C value with a graph

3. For a regular office building, virtue factor structure (I) = 1,0 (Table 1. Article 4.1.2 SNI 1726 -2002)

4. Earthquake reduction factor, R = 8,5(Table 3. Article 4.3.6 SNI 1726 -2002).

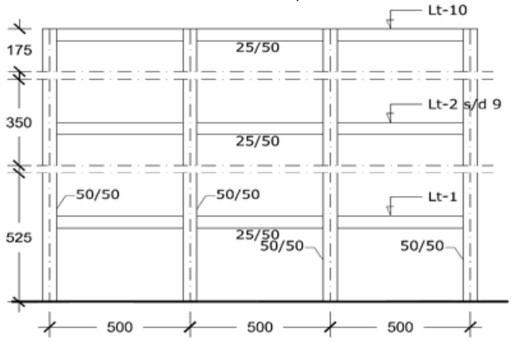


Figure 5. Division of the load calculation.

Table 1. Result of the dead load (DL) and live load calculation (LL)

Lantai	Beban, *DL* (kN)				Beban, LL (kN)
	Kolom	Balok	Lantai	Tambahan	
10	210	544	1036,8	180	540
9	420	544	1036,8	576	900
8	420	544	1036,8	576	900
7	420	544	1036,8	576	900
6	420	544	1036,8	576	900
5	420	544	1036,8	576	900
4	420	544	1036,8	576	900
3	420	544	1036,8	576	900
2	420	544	1036,8	576	900
1	630	544	1036,8	576	900

Table 2. Result of the load partition calculation.

Lantai	Beban Partisi (kN)		
	Bata	Batako	Hebel
10	526	263	171
9	869	434	282
8	869	434	282
7	869	434	282
6	869	434	282
5	869	434	282
4	869	434	282
3	869	434	282
2	869	434	282
1	1.326	663	431

Table 3. Total load calculation result per floor.

Lantai	$W_x h_x$ (kN.m)		
	Bata	Batako	Hebel
10	93.061,5	83.860,4	80.639,9
9	117.047,7	103.366,0	98.577,4
8	104.042,4	91.880,9	87.624,3
7	91.037,1	80.395,8	76.671,3
6	78.031,8	68.910,7	65.718,3
5	65.026,5	57.425,6	54.765,2
4	52.021,2	45.940,4	43.812,2
3	39.015,9	34.455,3	32.859,1
2	26.010,6	22.970,2	21.906,1
1	15.340,5	13.020,2	12.208,1
Jumlah	680.635	602.225	574.782

The graph in figure 6 illustrates that the building using hebel partition, the *V-story* value is smaller than the concrete block and brick partition. The percentage value reached 11,9% compared to using concrete block partition and 16,1% compared to using brick partition. Difference pattern of *V-story* value shows that the deviation become larger when the height level towards to the lowest level. The biggest difference found in the building with hebel partition material to brick partition material in 1st floor, that is 264,76 kN (Table 5).

Table 4. Calculation result of lateral force equivalent per portal.

Lantai	Tinggi, h_x (m)	F Lateral, F_x (kN) per portal		
		Bata	Batako	Hebel
10	35,0	67,5	60,5	58,1
9	31,5	84,9	74,6	71,0
8	28,0	75,5	66,3	63,1
7	24,5	66,0	58,0	55,2
6	21,0	56,6	49,7	47,4
5	17,5	47,2	41,5	39,5
4	14,0	37,7	33,2	31,6
3	10,5	28,3	24,9	23,7
2	7,0	18,9	16,6	15,8
1	3,5	11,1	9,4	8,8

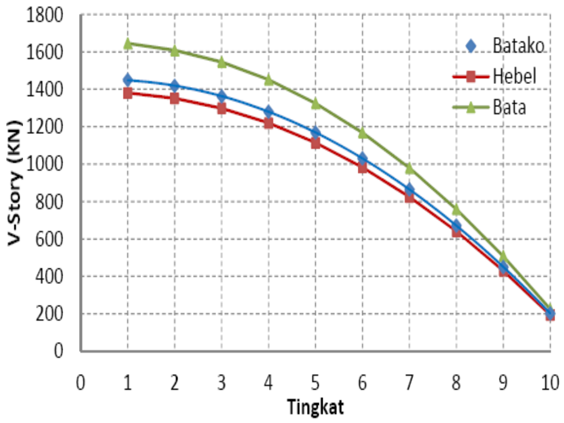


Figure 6. *V-story* and building level relationship graph.

Table 5. difference in *V-story* value per level

Lantai	V Story, Vx (kN)			Selisih (kN)		
	Bata (Bt)	Batako (Btk)	Hebel (H)	Bt-Btk	Bt-H	Btk-H
10	225,0	201,8	193,7	23,2	31,3	8,1
9	507,9	450,5	430,5	57,4	77,4	20,1
8	759,4	671,6	640,9	87,8	118,5	30,7
7	979,5	865,1	825,1	114,4	154,4	40,0
6	1168,1	1030,9	983,0	137,2	185,2	48,0
5	1325,3	1169,1	1114,5	156,2	210,8	54,6
4	1451,1	1279,7	1219,7	171,4	231,3	59,9
3	1545,4	1362,6	1298,7	182,8	246,7	63,9
2	1608,3	1417,8	1351,3	190,4	257,0	66,6
1	1645,4	1449,2	1380,6	196,2	264,8	68,6

Graph in figure 7 illustrates that the building using hebel partition, the horizontal deflection value is smaller than the building using concrete block and brick partition. The percentage value reached 12,7% compared to using concrete block partition and 16,4% compared to using brick partition. The difference pattern of horizontal deplection value, showing comparisons become even greater when the height of the level to the highest level. There are biggest difference on the 10th floor of the building with hebel material partition to brick material partition, by 40 mm (Table 6).

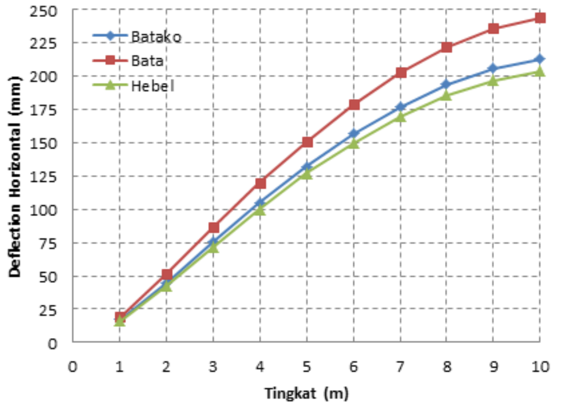


Figure 7. Graph displacement relationship building level.

Table 6. Differences of *Deflection Horizontal* value per level.

Lantai	Displac (mm)			Selisih (mm)		
	Bata (Bt)	Batako (Btk)	Hebel (H)	Bt-Btk	Bt-H	Btk-H
10	244	213	204	31	40	9
9	236	206	197	30	39	9
8	222	194	186	28	36	8
7	203	177	170	26	33	7
6	179	157	150	22	29	7
5	151	132	127	19	24	5
4	120	105	100	15	20	5
3	87	76	72	11	15	4
2	52	45	43	7	9	2
1	19	17	16	2	3	1

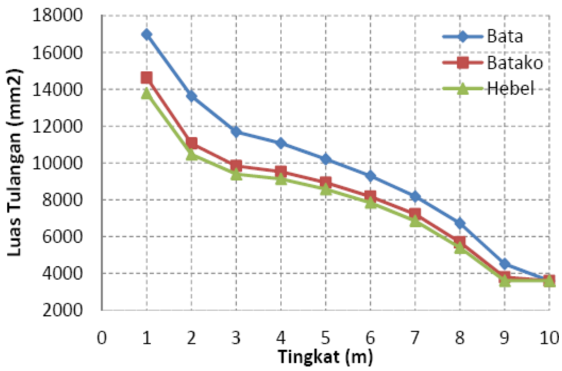


Figure 8. Graph of relationship between column reinforcement area with building level.

Table 7. Difference in value of the column reinforcement area per level.

Lantai	Tulangan Kolom (mm^2)			Selisih (mm^2)		
	Bata (Bt)	Batako (Btk)	Hebel (H)	Bt-Btk	Bt-H	Btk-H
10	3600	3600	3600	0	0	0
9	4517	3795	3600	722	917	195
8	6722	5700	5399	1022	1323	301
7	8186	7219	6850	967	1336	369
6	9297	8175	7844	1122	1453	331
5	10210	8933	8576	1277	1634	357
4	11073	9522	9130	1551	1943	392
3	11689	9837	9395	1852	2294	442
2	13632	11059	10460	2573	3172	599
1	16985	14635	13792	2350	3193	843

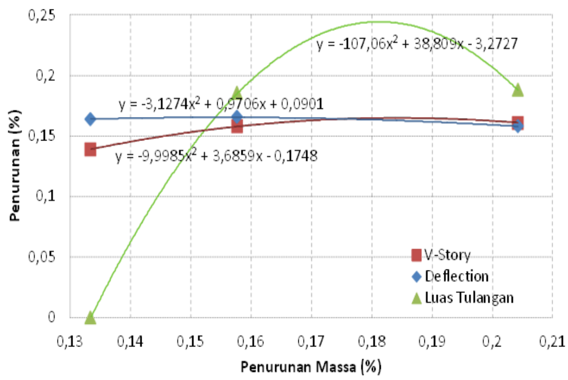


Figure 9. Graph of relationship between reduction percentage of bulding mass with V-Story, Deflection Horizontal, and column reinforcement area in the building.

The graph in figure 8 illustrates that the buildings which is using large hebel partition needs less column reinforcement area than the building using concrete block and brick partition. The percentage value reached 5,8% compared to using concrete block partition and 18,8% compared to using brick partition. Difference pattern of the needs in column reinforcement area, showing the comparison to be increasing when the height of the level to the lowest level. There are biggest difference on the 1st floor of the building with hebel material partition to brick material partition, by 3193 mm^2 (Table 7).

Graph in figure 9, shows the percentage of impairment and impairment prediction of *V-story* value, deflection horizontal and column reinforcement when the mass percentage decreases.

5. CONCLUSION

1. Both *V-story,Deflection Horizontal* and column reinforcement greatest value contained in the building using brick material partition, while the

smallest is the building using hebel material partition.
2. The decrease percentage of the building using hebel partition compared to building with brick partition for *V-story*,deflection horizontal and column reinforcement are 16,1% ; 16,4% ; 18,0%.
3. The analysis showed that the use of materials with small mass can reduce the value of *V-story*,deflection horizontal and column reinforcement.

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