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Submission date: 14-Jan-2025 07:12PM (UTC+0700)
Submission ID: 2563969446
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To cite this article: D R Wiyono *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1071** 012002

Evaluation of Internal Forces and Support Reaction of Column and Shearwall in 15th Building Design

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Abstract. In the case of 15th building, the structure type to earthquake resistant code is dual system reinforced concrete consists of frame and shear wall. The structure is analysis by dynamic analysis for whole structure and compare base shear by static analysis. By several trial position of shear wall can give first and second mode is translation and the third mode is rotation. In this case planar shear wall is used and placed in two direction of axis. The category of structural system is Other Structure for calculation of fundamental period (T). Fundamental Period (T) of structure is more than T maximum, so value of static seismic coefficient (C_s) taken from T maximum. Each of important element is column where the dimension and reinforcement are must satisfied for requirements. Shear wall have joint together with others shear wall, so one node used by several shear wall, make duplication forces in support reaction. For foundation design we can used 1st story internal forces in finding forces and compare them with after correction of support reaction caused duplication node in used with several shear walls. This exercise could solve the problem to anticipate duplication forces in several planar shear wall using one foundation assembly from several shear walls. The results of preliminary design column based on axial forces is 23,12 % lower than internal forces. From preliminary design based on axial forces. The dimension of preliminary design columns are lower than ideal dimension with 3 % reinforcement ratio. The result of difference between internal forces columns and support reaction columns is 12,99 %. The result of difference between internal forces shear walls and support reaction shear wall is 0,80 %.

1. Introduction

In the case of 15th building the structure is dual system reinforced concrete consist of frame and shear wall. The structure is analysis by dynamic analysis for whole structure and compare base shear by static analysis. By trial position of shear wall can give first and second mode is translation and the third mode is rotation. In this case planar shear wall is used and placed in two direction of axis. The category of structural system is Other Structure for calculation of fundamental period. Period of structure is more than T maximum, so value of Cs taken from T maximum. Dimension and reinforcement of column is very important because must be resist a large portion of forces and have performance as strong column weak beam. Evaluation of column by compare preliminary design column and internal forces because there are several aspects in structure such earthquake load can change dimension to large from referred by dimension from preliminary design. The effect of axial load and moment will be evaluation for to have prediction about reinforcement or dimension, where ideal reinforcement column is about 3 %, if do not want use mechanical connection to joint reinforcement bar [1], [2]. Using shear wall can reduce building period and story drift because

behavior of fixed joint at restraint. Evaluation of shear wall by compare internal forces especially axial forces in shear walls with support reaction. In support reaction gives forces in every node, this will be duplication forces in same node for two or three or four walls connected to this node. For foundation design because there are several walls so each wall will give forces to one pile cap assembly to several walls. Correction forces in support reaction can referred to internal forces of shear walls, and by modelling separate foundation with forces from several shear walls will take number of piles.

2. Literature Study

In high rise buildings, combination of shear walls and frames in normally provide the required stiffness and strength to withstand lateral loads. Shear walls normally are much stiffer than the frames system to take of lateral load more than frame system [3], [4].Because of larger stiffness, the contribution of the frame system in resisting lateral load is usually ignored. This practical procedure must be corrected because there is important that the effect of the frames be considered in seismic resista building [5].

A rigid frame consist of vertical columns and horizontal beams, bends predominantly in a shear mode shown in Figure 1 (a) [6] and a shear wall in a bending mode, i.e, as a cantilever, as illustrated in Figure 1(b). In some building structure (stair opening, elevator shafts) which reinforced concrete walls normally show the behavior [7]. The combination between rigid frame and shear wall interacting will tend to deflect in a bending mode [8]. The analysis is comparatively simple when all vertical units of a structure show the same behavior under lateral load which the seismic system in all rigid frames or all shear walls. The load can be distributed to the units proportionally to their stiffnesses. The difference in behavior under lateral load, in combination with the in-plane rigidity of the floor slabs, causes nonuniform interacting forces to develop when walls and frames are present Figure 1 (c). This makes the analysis more complex.

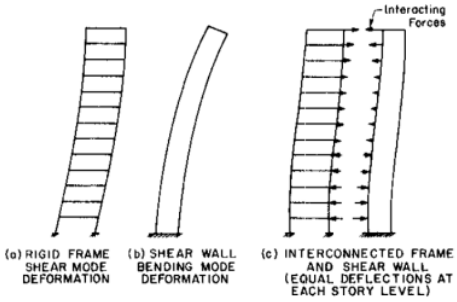
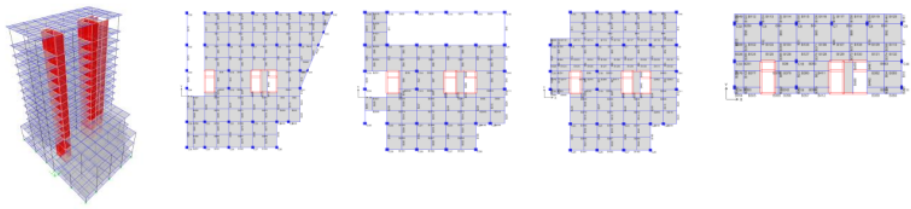


Figure 1. Deformation modes [6]

For analysis, the floor slabs are normally considered to be fully rigid within their own planes. This means that there will be no relative movement between the vertical units at each story level.

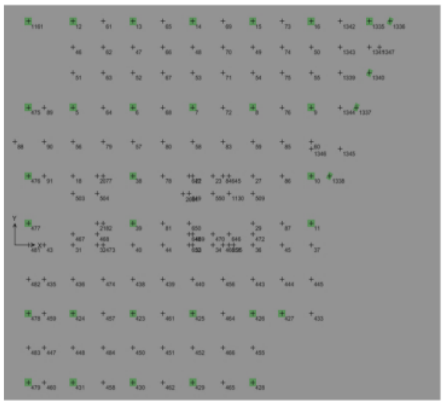
3. Analytical Model

In this study, building model is 15 story dual system with other Structure System. The function of this building is hotel in Jambi City with seismic parameter Ss = 0,7 g, S1 = 0,4 g with site class D [9]. Material property of the building of concrete is f'_c = 28 MPa and steel reinforcement is f_y = 420 MPa for plate, beam, column and wall. The gravity load for this building functioned as hotel facilities [10]. The structure is given in the Figure 2, and in Figure 3a shows point label and line label to indicate the support reaction output location in building[11].

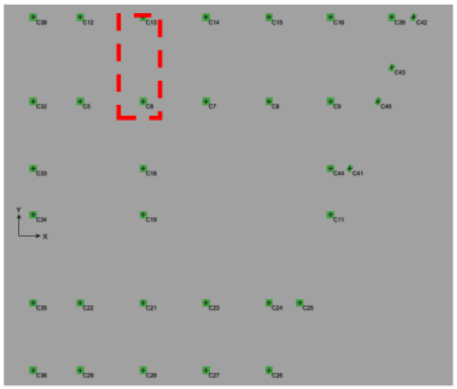


(2a) 3D Buildig Model Floor Plan | (2b) 1st Floor Plan | (2c). 2nd Floor Plan | (2d). 3rd Floor Plan | (2e). 4th -15th Typical

Figure 2. Building Model and Floor Plane Data



(3a) Point label of support reaction



(3b) Line label of column

Figure 3. Building Point label ID Data

4. Result and Discussion

Output ETABS and preliminary dimension of column is shown in table below, it is known that axial force ETABS bigger 23,12 % than axial force preliminary show in 0.

Table 1. Comparation of Colum Axial Force.

Story	Column	P Etabs (kg)	P Prelim (kg)	Magnify Factor	% Difference
STORY1	C6	1212399	999591.6	1.21	21.29
STORY1	C18	1019156	815688	1.25	24.94
		Average			23.12

In 0 and 0 shown column dimension with variance reinforcement for getting ideal dimension.

Table 2. ETABS Column dimension with variance reinforcement.

Column ID	Reinforcement Rebar Area, As (mm^2)	Column Section Area											
		Parameter	**1.00 % As**	**1.50 % As**	**2.00 % As**	**2.50 % As**	**3.00 % As**	**3.50 % As**	**4.00 % As**	**4.50 % As**	**5.00 % As**	**5.50 % As**	**6.00% As**
C6	294.38	Section Area, Ag (mm^2)	29438	19625	14719	11775	9813	8411	7360	6542	5888	5352	4906
		Dimension (cm)	172x172	140x140	121 x 121	109 x 109	99 x 99	92 x 92	86 x 86	81 x 81	77 x 77	73 x 73	70x 70
C18	169.76	Section Area, Ag (mm^2)	16976	11317	8488	6790	5659	4850	4244	3772	3395	3087	2829
		Dimension b x h (cm)	130x130	106x106	92x92	82x82	75 x75	70 x70	65 x65	61 x61	58 x58	56 x56	53x53

Table 3. Preliminary Column dimension with variance reinforcement

Column ID	Reinforcement Rebar Area, As (mm^2)	Column Section Area											
		Parameter	**1.00 % As**	**1.50 % As**	**2.00 % As**	**2.50 % As**	**3.00 % As**	**3.50 % As**	**4.00 % As**	**4.50 % As**	**5.00 % As**	**5.50 % As**	**6.00% As**
C6	294.38	Section Area, Ag (mm^2)	4841	4617	4413	4227	4055	3897	3751	3615	3489	3371	3261
		Dimension (cm)	70x70	68x68	66x66	65x65	64 x 64	62 x 62	61 x 61	60 x 60	59 x 59	58 x 58	57x 57
C18	169.76	Section Area, Ag (mm^2)	3950	3768	3601	3449	3309	3180	3061	2950	2847	2751	2661
		Dimension b x h (cm)	63x63	61x61	60x60	59x59	58 x 58	56 x 56	55 x 55	54 x 54	53 x 53	52 x 52	52x 52

From the above table can get the magnify reinforcement between preliminary and output ETABS as shown in Figure 4 below. The ideal dimension for column C18 and column C6 is shown in Table 4 below.

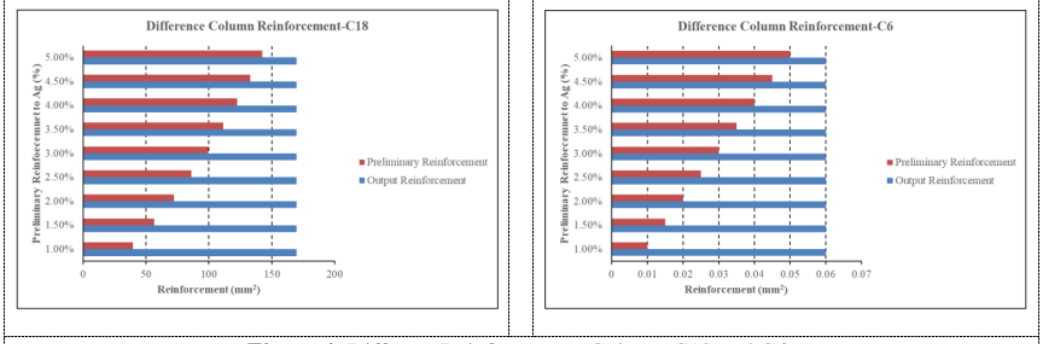


Figure 4. Different Reinforcement Column C18 and C6

Table 4. Ideal dimension column C18 and C6

Ideal Dimension C18			Ideal Dimension C6		
Ag (cm^2)	As (cm^2)	Magnifying Factor	Ag (cm^2)	As (cm^2)	Magnifying Factor
5658	0.03	1.43	9812	0.03	2.03
75x75			100x100		

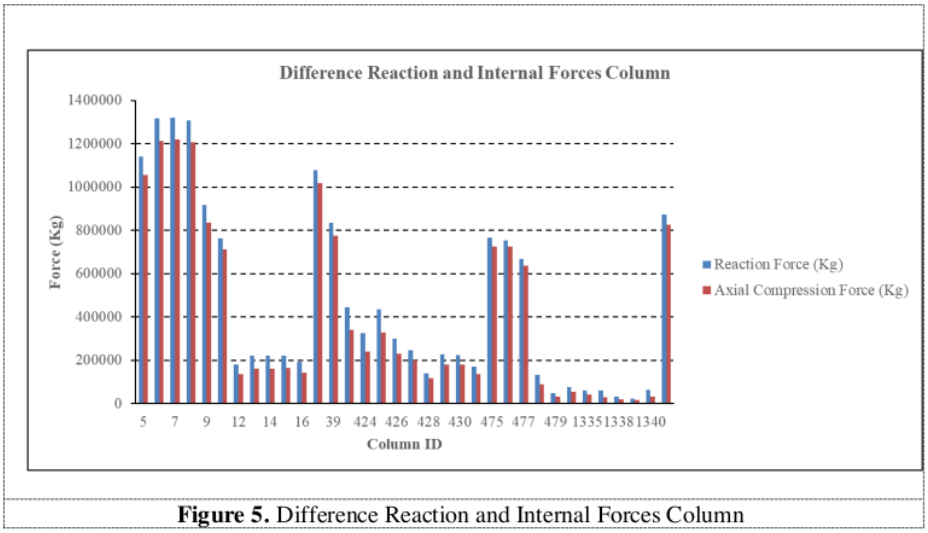


Figure 5. Difference Reaction and Internal Forces Column

Figure 5 shown that ideal dimension is 43,2 % in C18 and 202, 7 % in C6 upper than preliminary dimension.

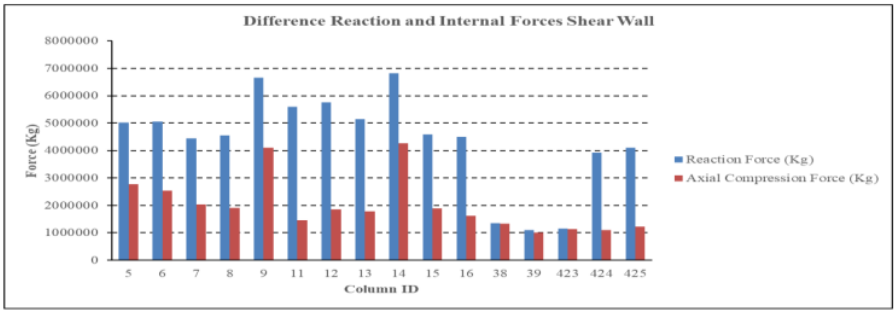


Figure 6. Difference Reaction and Internal Forces Shear Wall

Figure 6 shows that difference column reactions are 12,99 % bigger than column internal forces, and that difference shear walls are 0,89 % then shear walls internal forces.

5. Conclusion

The result of preliminary design based on axial forces is 23,12 percent lower than internal axial force. The dimension of preliminary design C18 column is 43,2 % lower than reality dimension and C6 column is 202, 7% lower than reality dimension with 3 percent reinforcement ratio. The result of difference between internal forces columns and support reaction columns is 12,99 %. The result of difference between internal forces shear walls and support reaction shear walls is 0,89 %.

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