

STRUCTURAL EVALUATION IN ORDER TO INCREASE THE NUMBER OF FLOORS IN THE INTEGRATED LABORATORY BUILDING AT LAMBUNG MANGKURAT UNIVERSITY

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ABSTRACT

A building's chance of experiencing structural failure may rise as its floor count rises. This occurs as a result of buildings having a maximum load capacity. A structural examination was conducted in the Integrated Laboratory building at Lambung Mangkurat University to determine the condition of the structure if further stories were added.

Three load variations are added to the building, ranging in size from the smallest (1 level) to the largest (3 floors), in order to evaluate the construction. The structural elements' size remains the same while the number of floors is increased. An analysis is conducted for each load variation, taking into account the structural elements' capacity, the fundamental period, story drift, and the number of modes needed to achieve the mass participation mandated by the building standards.

The analysis conducted with three load variations revealed that the column, beam, and slab structural elements can still support the load placed on the structure if three floors are added. However, the working load on the foundation structural elements has exceeded the capacity of the existing foundation to support three floors of additional buildings; the foundation can only support one additional floor. Aside from that, the analysis's findings indicate that the value of the story drift, the fundamental period, and the number of mode shapes required to meet the modal participant mass ratio mandated by building regulations all increase with a building's floor count.

Keywords: Load, Capacity, Story Drift, Fundamental Period, Mode Shape

1. INTRODUCTION

The Lambung Mangkurat University Integrated Laboratory is a two-story building. Increasing the building's floor count will undoubtedly give it a greater area to serve as an additional facility. But the more stories there are, the greater the chance of a structural failure. Damage to a structure's structural components that could lead to the building collapsing is referred to as structural failure.

Due to the addition of floors, a building's current structure must be evaluated in order to determine the building's capacity limitations before adding more floors. The structural integrity of the existing structures' slab, foundations, beams, and columns was assessed.

In addition, in order to prevent structural failure, stability characteristics including story drift, fundamental period, and mode shapes will be taken into account.

The maximum capacity of each structural element and the capacity required to accommodate the increasing amount of stories are the research's findings. It is intended that this study would offer additional information on structural evaluation when it comes to adding stories to the buildings under evaluation and other structures. Additionally, if more floors are being added to the other buildings, we can offer suggestions.

2. THEORETICAL STUDY

Reanalyzing the current structure using the previously acquired shop drawing is how building evaluation is done. ETABS, SpColumn, and other programs like Microsoft Excel, which help simplify structural computations, are used in the analysis. The ETABS program will involve remodeling the current structure to ascertain each structural element's capacity. The results of analysis from this program include the form of moments, vertical forces, and horizontal forces that occur in each structural element, as well as the structural stability characteristics like fundamental periods, story drift, and several structure mode shapes.

Evaluation of Plate, Beam, Column, and Foundation Structural Elements

The evaluation of structural elements is conducted after obtaining the analysis output from the ETABS program. Evaluation is conducted based on references to applicable national standards. The references are:

- 1) SNI 2847-2019 Persyaratan Beton Struktural Bangunan Gedung.
- 2) SNI 1726-2019 Tata Cara Perancangan Ketahanan Gempa untuk Struktur Bangunan Gedung dan non Gedung.
- 3) SNI 1727-2020 Beban Minimum untuk Perancangan Bangunan Gedung dan Struktur lain.
- 4) SNI 03-1727-1989 Pedoman Perencanaan Pembebanan untuk Rumah dan Gedung.

3. METHOD

This research was conducted in the Integrated Laboratory building at Lambung Mangkurat University which is located on Jl. Unlam I, Loktabat Selatan., Banjarbaru Selatan., Banjarbaru City, South Kalimantan 70714.

Building Specification

Concrete strength f'_c : K-300 (24,9 MPa)

Rebar strenght f_y : 420 MPa for rebar $\geq$ D10
280 MPa for rebar $\leq$ D10

Function: Laboratory

Site Class: Hard Soil (SC)

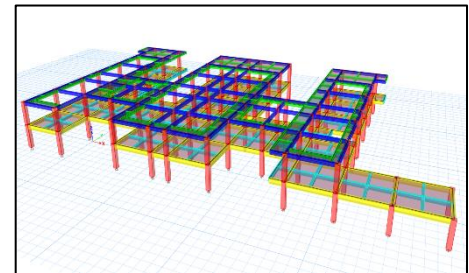
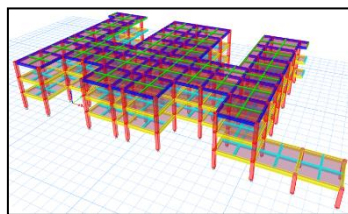


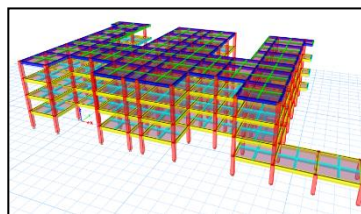
Figure 1. Existing Structure

Building Evaluation Methods

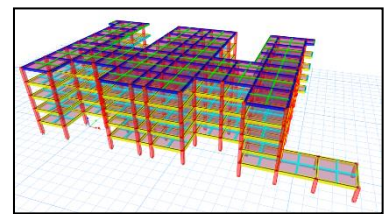
Three separate floor additions will be built utilizing the same structural element dimensions as the original structure but with different load variations. The following image shows the experimental model that will be used:



Variation A1



Variation A2



Variation A3

Figure 2. Model Variations To Be Analyzed

The building was extended by one story (to three floors) for the first experiment (A1), and the load input on the additional floor will serve as a laboratory. The building was extended by two stories for the second experiment (A2); the load input on the new floor served as a reading room on the third floor and offices for the laboratory staff on the fourth. In the meantime, the third experiment (A3) used a room that served as a laboratory classroom and added three floors to the building, with a load input equivalent to each additional story. Figure 3 shows the building structural evaluation procedure as a flowchart.

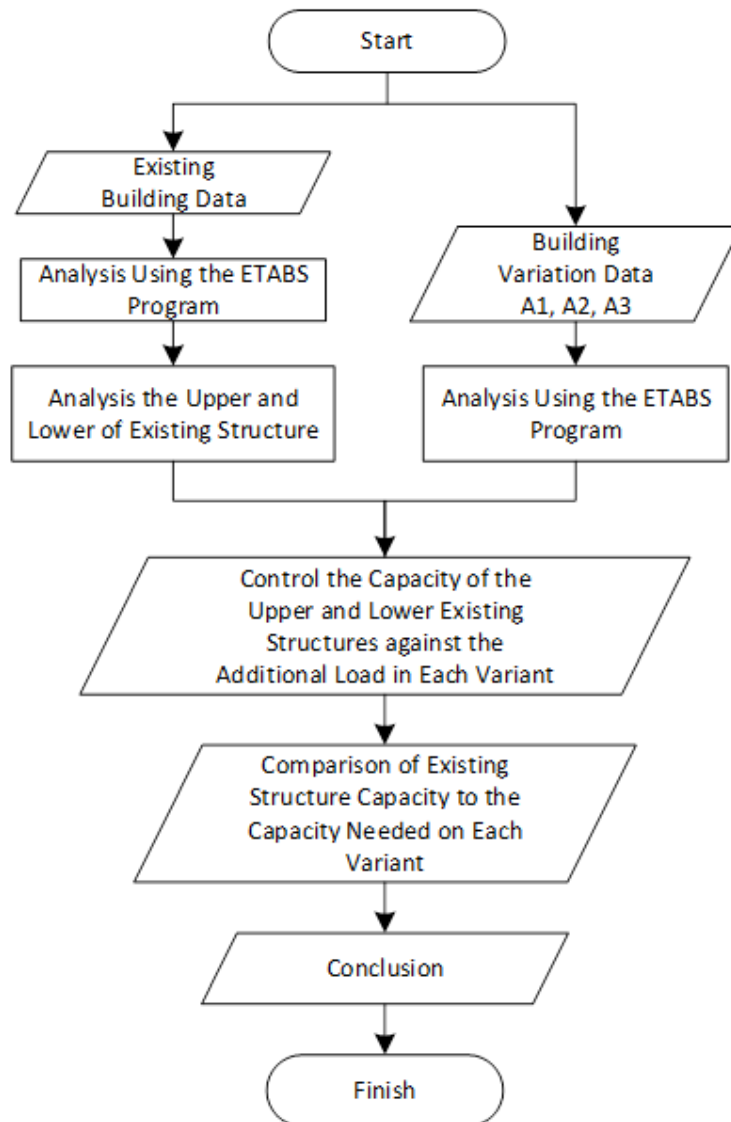


Figure 3. Flowchart of Integrated Laboratory Building Structure Evaluation

4. RESULT AND DISCUSSION

To facilitate comparisons between the existing structure and the increased load of the new level, the building analysis results will be summarized. The fundamental era, mode shape, tale drift, and structural element capacity are the forms in which the comparisons are made. The table below displays the outcomes of the recapitulation:

Recapitulation of Vibration Variations and Vibration Periods of Buildings

The table below provides a summary of the building's mode variants and fundamental periods:

Table 1. Summary of Building Mode Shape and Fundamental Periods

Model	Number of Stories	Fundamental Period (sec)	Modes Needed To Reach 100% Mass Participant
Existing	2	0,452	6
Variation A1	3	0,581	9
Variation A2	4	0,706	12
Variation A3	5	0,829	15

The analysis's results show that both the value of the fundamental period and the number of mode variations needed increase depending on a building's floor count.

Recapitulation of Story Drift that Occur

The following picture below provides a summary of the story drift that happened between floors:

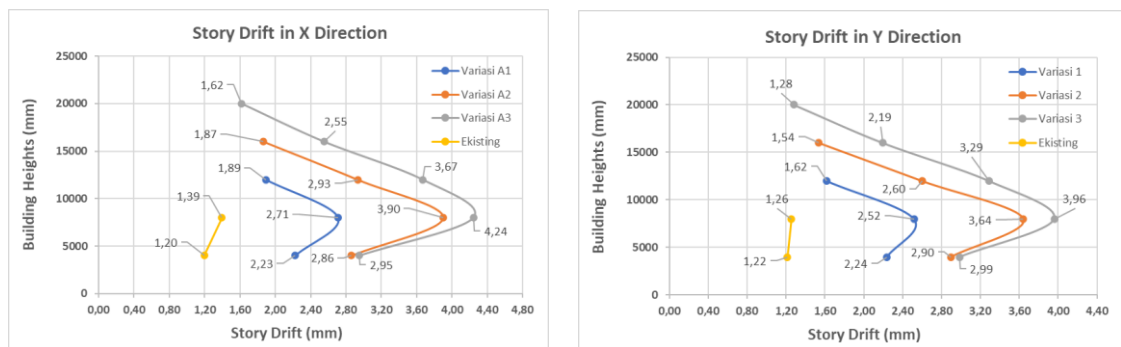


Figure 4. Summary of Building Story Drift Occurring in the X and Y Directions

The results of the evaluation indicate the story drift value rises according to a building's floor count.

Recapitulation of Capacity and Requirements for Plate, Beam, and Column Structural Elements

The following table below provides a summary of the requirements and capacity for structural elements that include slab, beam, and column:

Table 2. Summary of Building Elements Capacity and Requirements Needed for Slab, Beam, and Column

Structure Elements	Parameters	Existing Capacity	Requirements				Unit
			Existing	Variation 1	Variation 2	Variation 3	
Kolom	Lentur	5246,27	1214,87	2005,48	2723,87	3367,32	kN
	Geser	267723,22	99443,90	114823,80	126648,90	128778,90	N
Balok MB-1	Tumpuan (-)	551,93	-286,65	-289,22	-306,38	-307,13	kN
	Tumpuan (+)	292,71	237,74	288,28	291,79	289,80	
	Lapangan (-)	292,71	-202,68	-288,41	-292,65	-283,69	
	Lapangan (+)	551,93	306,25	302,02	302,73	302,86	
	Geser Tump.	804855,42	325339,04	325781,44	325613,04	325483,34	N
	Geser Lap.	864335,86	206041,90	251404,50	251276,30	251243,60	mm ²
	Luas Torsi Long	4819,99	3227,85	3460,04	3554,71	3549,47	
	Luas Torsi Geser	4819,99	3165,66	3519,78	3541,57	3503,10	
Balok MB-2	Tumpuan (-)	278,51	-245,36	-132,88	-132,40	-132,14	kN
	Tumpuan (+)	169,48	162,42	85,09	85,38	85,48	
	Lapangan (-)	169,48	-147,37	-85,12	-138,83	-138,37	
	Lapangan (+)	278,51	115,96	52,51	86,23	86,36	
	Geser Tump.	444687,73	209390,29	124267,69	129459,69	136414,69	N
	Geser Lap.	365247,46	150706,80	62901,60	71788,50	81678,60	mm ²
	Luas Torsi Long	3685,87	3117,14	1837,17	1835,81	1822,79	
	Luas Torsi Geser	3685,87	2196,57	1321,81	1861,60	1847,72	
Balok RB-1	Tumpuan (-)	311,40	-245,36	-103,41	-100,68	-97,45	kN
	Tumpuan (+)	169,48	93,50	94,07	94,20	94,49	
	Lapangan (-)	169,48	-100,99	-97,94	-101,80	-105,88	
	Lapangan (+)	311,40	94,58	95,06	95,08	95,23	
	Geser Tump.	619700,62	203557,86	138957,56	157852,86	158158,86	N
	Geser Lap.	603568,28	149161,90	95435,10	95927,40	96440,50	mm ²
	Luas Torsi Long	3969,40	2736,88	1809,72	1792,61	1773,22	
	Luas Torsi Geser	3969,40	1793,55	1778,31	1801,68	1827,26	
Balok RB-2	Tumpuan (-)	74,57	-42,88	-42,78	-42,52	-42,25	kN
	Tumpuan (+)	74,57	12,15	29,64	29,56	29,49	
	Lapangan (-)	74,57	-32,28	-25,17	-42,52	-42,25	
	Lapangan (+)	74,57	33,46	17,72	33,99	34,27	
	Geser Tump.	235148,29	49524,36	46712,96	46600,76	49672,36	N
	Geser Lap.	217585,30	29595,20	20017,70	35759,10	37862,60	
	Luas Torsi Long	1608,50	602,52	833,67	725,45	724,91	mm ²
	Luas Torsi Geser	1608,50	680,49	618,68	757,73	759,66	
Plat 12cm	Lentur X (+)	13,82	8,09	8,06	8,08	8,08	kN
	Lentur X (-)	13,82	-11,69	-11,73	-11,72	-11,72	
	Lentur Y (+)	11,84	8,95	8,89	8,89	8,89	
	Lentur Y (-)	11,84	-11,60	-11,60	-11,56	-11,53	
	Geser	63,62	18,32	18,31	18,28	18,26	
Plat 10cm	Lentur X (+)	9,86	3,91	3,85	3,78	3,80	kN
	Lentur X (-)	9,86	-6,05	-6,04	-6,06	-6,08	
	Lentur Y (+)	7,88	3,67	3,65	3,66	3,65	
	Lentur Y (-)	7,88	-7,30	-7,26	-7,21	-7,16	
	Geser	46,66	8,13	8,12	8,12	8,12	

The analysis's findings indicate that even if the structure is increased to five stories, structural components like slabs, beams, and columns are still capable of supporting the load.

Recapitulation of Capacity and Foundation Needs

The group-bearing capacity is the calculated foundation capacity. See the table below for a summary of foundation requirements and capacity:

Table 3. Summary of Building Capacity and Foundation Requirements

Parameters	Existing Capacity	Requirements			
		Existing	Variation 1	Variation 2	Variation 3
Group Bearing Capacity	142,47 kN	93,87 kN	133,11 kN	204,1 kN	252,49 kN
Punching Shear 2 Way	2802036 N	448,54 N	660,03 N	1042740 N	1303620 N
Punching Shear 1 Way	398912 N	177390 N	261180 N	412600 N	515800 N
Rebar Needed - X Dir	5699,1 mm ²	1930,5 mm ²	2998,79 mm ²	4648,31 mm ²	5727,15 mm ²
Rebar Needed - Y Dir	5699,1 mm ²	2168,16 mm ²	3264,48 mm ²	5139,7 mm ²	6166,05 mm ²

The foundation had a one-way punch shear failure due to its inability to withstand the structure's weight, as indicated by the analytical results in model variants 2 and 3. Furthermore, variation 3's pile cap lacks significant rebar reinforcement in the Y direction.

5. CONCLUSION

Although the foundation can only support loads up to three stories in the first variation model, it becomes overstressed in the second and third variations, and in the second and third variations, it experiences punching shear failure. The column capacity can still support additional loads of up to five stories in the third variation model analysis. There is a positive correlation between story drift and the number of floors; the higher the number of floors, or the greater the load, the higher the story drift value. In addition, the fundamental period and the number of floors also increase in proportion; that is, the fundamental period will lengthen as more load (floors) is added. Additionally, a higher load (number of floors) may necessitate a wider range of modes in order to achieve a 100% modal participant ratio throughout the analysis.

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