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Comparative Study Of Changes in SNI 1727 (2013 – 2020) and SNI 1726 (2012 – 2019)

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Abstract: Being one of the largest developing countries, Indonesia has high intensity of infrastructure development. Because of its exact location between the Pacific plate and Eurasian plate, it is necessary to consider the earthquake load in planning a building or other structure. The fundamental period is a function of the lateral stiffness of a building, which will play an important role in carrying lateral loads, such as earthquakes. Earthquake loads experienced by the structure will result in deformation of the building. For building planning in Indonesia, national standards (SNI,) which are continuously adapted to the conditions of the earth and technological developments in construction, are used. This study aims to determine the impact of changes to the standards applied in terms of changes in cross-sectional dimensions, fundamental periods, and building deformation, using modeling in the auxiliary program. Compared with modeling the existing structure in the initial state (model 1), the existing structure with the latest loading (model 2), and the planning results using the latest standard (model 3).Based on the results of the analysis, it was found that the beam dimension changes in the form of an 88% increase in cross-sectional area on the 2nd and 3rd floors of the B9 beam, the largest change in the column cross-sectional dimensions on the K3 column on the 4-7th floor and the K8 column on the 3-7th floor with a large increase of 104%, the change in the fundamental period model 3 increased by 22% from model 1 and increased by 19% from the period model 2, and obtained a change in the form of displacement. X direction in model 3 experienced a maximum increase of 210% against model 1 on the roof floor and in model 3 against model 3 2 increased by 37% on the roof floor for displacement Y direction in model 3 experienced a maximum increase of 192% against model 1 on the roof floor and an increase of 29% against model 2 on the roof.

Keywords: Building Deformation; Fundamental Period; SNI for Earthquake; SNI for Concrete Buildings

1. Introduction

Indonesia as a developing country with a fairly high intensity of development which is directly proportional to the earthquakes that occurred in several regions in Indonesia makes the need for earthquake-resistant building structures very high. Building planning in Indonesia has begun to pay attention to earthquake loads as one of the important factors in planning and analysis. This earthquake load is included as a dynamic load, where the magnitude and direction can change along the time. (Fauziah, 2013).

Planning of concrete structures in Indonesia is regulated by the Indonesian National Standard (SNI) which refers to SNI 2847 “Structural Concrete Requirements for Buildings and Explanations” and building loadings which refer to SNI 1727 “Minimum Load of Buildings and Other Structures”, in addition to planning buildings that can withstand earthquake loads The National Standardization Agency issues SNI 1726 "Earthquake Resistance Planning Procedures for Building and Non-Building Structures".

Standardization used in planning, in this case SNI, is always updated in accordance with earthc surface condition and technological developments in construction. Currently the standard used is the latest release, namely SNI 1727:2020 "Minimum Load for Buildings and Other Structures" which is an update from SNI 1727-2013. And SNI 2847-2019 "Requirements for Structural Concrete for Buildings and Explanations" which is an update of SNI 2847-2013.

Due to the update of the standard used, further analysis will be carried out on the impact of changes to SNI planning and loading. The analysis will be carried out by comparing the current condition of the building structure with the results of the re-planning in accordance with the updated standard.

Earthquakes cause movement in a horizontal or vertical direction, with the magnitude of the vertical motion occurring generally much smaller. Because horizontal motion results in a greater effect, the effect of this motion is usually considered as earthquake load. When the earth under a building structure with a certain mass moves suddenly, the inertia of the mass tends to oppose the movement, there is a shear force between the earth and the mass. (Salmon, 1997)

The Fundamental Period of a building is the duration required for the building to experience a complete back and forth motion, the magnitude of this period for buildings with 1 to 20 floors is generally in the range of 5 seconds to 20 seconds. The magnitude of this period also depends on the mass distribution and stiffness of the building, there are several trends that cause an increase or decrease in the period such as the fundamental period will decrease with the stiffness of the structure, the period will increase with the weight of the structure, high-rise buildings have a larger fundamental period. (Murty, 2012)

The Indonesian National Standard (SNI) 2847-2019 is the revised result of SNI 2847-2019 which is an adoption with modifications from ACI 318M-14 and ACI 318RM-14, these standards are used in planning and implementing concrete structures for buildings, or other structures. (SNI 1729, 2020).

Meanwhile, SNI 1727:2020 "Minimum Design Loads and Related Criteria for Buildings and Other Structures" is the revised result of SNI 1727:2013 which refers to ASCE 7-16, Minimum Design Loads and Associated Criteria for Building and Other Structures. The translation is carried out according to the loading conditions of the building in Indonesia, where the snow load and ice load have not been accommodated in SNI 1727. (SNI 1727, 2020)

2. Method

The study was conducted to determine the impact of changes from SNI on the building structure, the analysis will be carried out by comparing the results of the analysis of three structural models assisted by the SAP2000 program with the following details.

- Model 1, is a modeling of the existing structure with loading based on SNI 1727-2013 and SNI 1726-2012.
- Model 2, is a modeling of the existing structure with loading based on SNI 1727-2020 and SNI 1726-2019.
- Model 3, is a structural modeling of the results of the re-planning using SNI 2847-2019 with loading in accordance with SNI 1727-2020 and SNI 1726-2019.

The data of the existing structure used as an example of modeling in SAP2000 is in accordance with Figure 2, the building is functioned as a 25-storey flat located in Jakarta with materials used in the form of concrete quality 29.05 MPa for beams, 33 MPa, 37 MPa, and 42 MPa for columns, plates and shear walls. With reinforcement quality 420MPa and 280MPa. In SNI 1727-2013 the dead load value is taken from SNI 1727-1989 which is described in Table 1 and dead load is based on SNI 1727-2020 in Table 2 below.

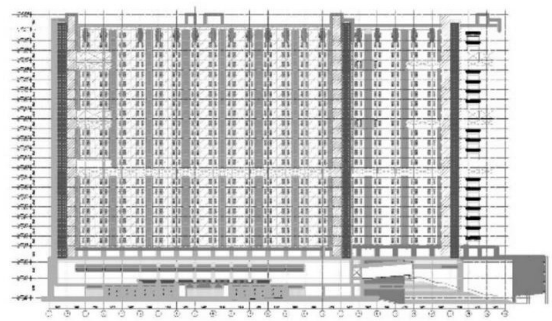

Fig.1. Front View of the Building

Table 1. Dead Load Based on SNI 1727-1989

Load Type	Quantity	Unit
Ceiling Hanger (wood)	7	kg/m^2
Ceiling	11	kg/m^2
Ducting and Plumbing	40	kg/m^2
Space, per cm thickness	21	kg/m^2
Ceramic, per cm thickness	24	kg/m^2
Total	103	kg/m^2

Table 2. Dead Load Based on SNI 1727-2020

Load Type	Quantity	Unit
Ceiling Hanger (metal)	10	kg/m2
Plafond Acoustic	5	kg/m2
Ducting	19	kg/m2
Ceramic with mortar space 25 mm thickness	110	kg/m2
Total	144	kg/m2

The live load in SNI 1727-2013 and SNI 1727-2019 has not changed, the value of live load used in the analysis is described in Table 3 as follows.

Table 3. Live Load

Floor Purposes	Weight (kN/m^2)	
	SNI 1727-2013	SNI 1727-2019
Grocery area	4.79	4.79
All room beside stairs	1.92	1.92
Roof deck	0.96	0.96

The earthquake load used in the analysis will use the response spectrum in accordance with SNI 1726-2012 and SNI 1726-2019 which is shown as follows.

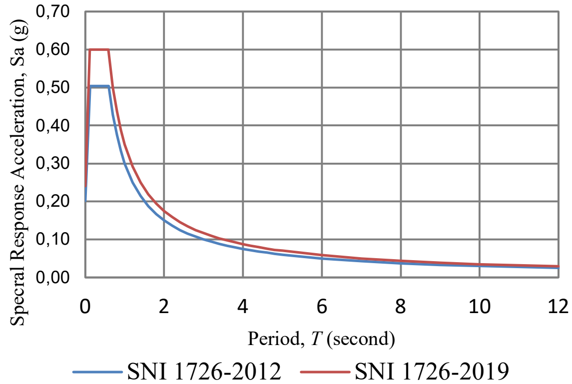

Fig. 2. Respons Spektrum Curve

Analysis was then carried out for the three models using the SAP2000 auxiliary program, in model 2 the beam and column cross sections were controlled according to SNI 2847-2019, if a cross section was obtained that did not meet the requirements according to SNI 2847-2019, then re-planning was carried out in accordance with SNI 2847-2019. The frame system used in this analysis is a special moment resisting frame (SMRF).

After the re-planning is done, it is followed by a comparison of the results of the analysis of the three models to the dimensions of the beam and column cross-section, the fundamental period and the deformation of the building.

3. Results And Discussion

3.1. Existing Structure Analysis with SNI 1727-2013 and SNI 1726-2012

Model 1 which is an existing structure with loading according to SNI 1727-2013 and SNI 1726-2012, the result is a fundamental period of 2.4467 seconds and the deformation is shown by the following displacement values.

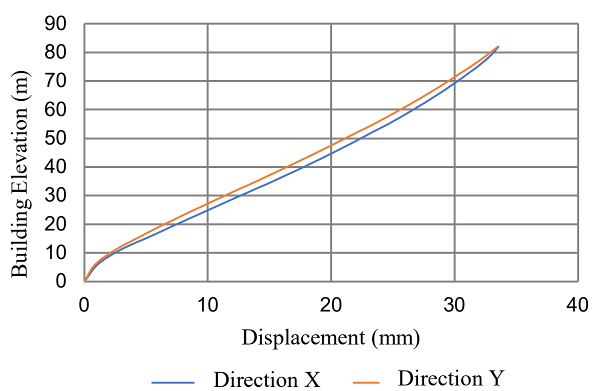

Fig. 3. Displacement Model 1.

Existing Structure Analysis with SNI1727-2020 and SNI 1726-2019 Model 2, which is an existing structure with loading according to SNI 1727-2020 and SNI 1726-2019, obtained the results of a fundamental period of 2.5038 seconds and the deformation shown by the displacement value is as follows.

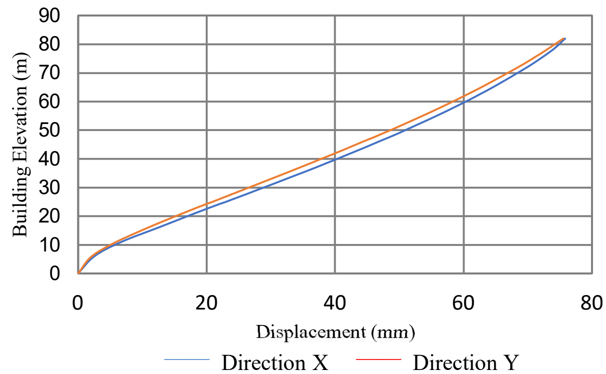

Fig. 4. Displacement Model 2

Based on the analysis of beam and column cross sections obtained beams and columns that do not meet the requirements required in SNI 2847-2019.

Table 4. Recapitulation of Beam Moment Analysis Results Model 2

Storey	Beam	*b* *mm*	*h* *mm*	*ϕMn* *kNm*	*Mu* *kNm*	*Ket.*
Lt. 15 - Roof	B1	400	500	357.59	458.41	Not Ok
Lt. 4 - 14	B1	400	500	478.93	516.35	Not Ok

Table 5. Recapitulation of the Results of Model 2. Beam Shear Analysis

Storey	Beam	*b* *mm*	*h* *mm*	*ϕVn* *kN*	*Vu* *kN*	*Ket.*
Lt. 4 - 14	B1	400	500	319.24	490.28	Not Ok
Lt.3	B1	400	500	235.58	441.03	Not Ok
Lt. 2	B1	400	500	317.97	362.88	Not Ok

Because there are blocks that do not meet moment and shear requirements it is necessary to do re-planning of beams and there are columns that are not meet the following requirements for reinforcement.

Table 6. Recapitulation of Flexural Reinforcement Analysis Results

Column	Lt.	b *mm*	h *mm*	*ρ*	*ρmin*	*Ket*
K4	5-7	700	700	0.97%	1%	Not Ok
	8-15	700	700	0.97%	1%	Not Ok
K4.1	8-15	700	700	0.97%	1%	Not Ok
K8	6-7	700	700	0.97%	1%	Not Ok
	8-15	700	700	0.97%	1%	Not Ok

Got some columns that do not meet minimum reinforcement requirements for flexural reinforcement which is required by SNI 2847-2019. Because there are beams and columns that do not meet the requirements so that a re-planning of the column elements is carried out and beams.

3.2. Structural Analysis of Planning Results with SNI 1727- 2020 and SNI 2847-2019

Based on the analysis results obtained cross-sectional dimensions new ones that were re-planned in accordance with SNI 1727- 2020 and SNI 2847-2019. So that the dimensions cross section of the beam described in Table 7 as following.

Table 7. Recapitulation of Planning Result Block Dimensions

Storey	Beam	Dimension		Lt.	Storey	Dimension	
		b	***h***			***b***	***h***
		mm	***mm***			***mm***	***mm***
Lt.15 - roof	B1	400	600	Lt.3	B1C	400	600
	B1A	400	600		B2	400	600
	B1B	400	600		B3	400	750
	B1C	400	600		B4	300	500
	BC1	400	500		B5	300	500
	BC2	400	500		B7	400	600
	BC3	400	600		B8	400	700
	BC4	400	600		B9	250	400
Lt. 4 -14	B1	400	600	Lt.2	B1	400	600
	B1A	400	600		B1A	400	600
	B1B	400	600		B1B	400	600
	B1C	400	600		B2	400	600
	BC1	400	500		B3	400	750
	BC2	400	600		B4	300	500
	BC3	400	600		B5	300	500
Lt.3	B1	400	600		B7	400	600
	B1A	400	600		B8	400	700
	B1B	400	600		B9	300	500

Based on the calculation results, the results obtained recapitulation of the column cross-section described in Table 8 as follows.

Tabel 8. Recapitulation of Column Dimension Planning

Column	Lt.	Dimension		Column	Lt.	Dimension	
		b	***h***			***b***	***h***
		m	***m***			***m***	***m***
K1	1	1	1.8	K4.1	4	0.8	0.8
	2	1	1.8		5	0.8	0.8
	3	1	1.5		6-7	0.8	0.8
	4-7	0.75	1.4		8-15	0.7	0.7
	8	0.6	1.4		16-25	0.6	0.7
	9-15	0.6	1.2	K5	1-3	0.8	1.4
	16-21	0.5	1		4-7	0.8	1.4
	22-25	0.5	1		8-15	0.6	1.3
K2	1-2	1	1.5		16-25	0.6	0.9
	3	1	1.5	K5.1	1	0.8	1.4
	4-5	0.6	1.4		2-3	0.8	1.4

Column	Lt.	Dimension		Column	Lt.	Dimension	
		b	*h*			*b*	*h*
		m	*m*			*m*	*m*
	6-7	0.6	1.4		4-7	0.8	1.4
	8-15	0.6	1.3		8-15	0.6	1.3
	16-25	0.6	0.9		16-25	0.6	0.9
K3	1-3	1	1	K6	1	0.8	
	4-7	1	1	K6.1	1	0.8	
	8-25	0.7	0.7		2-3	0.8	
K4	1	0.8	0.8	K8	1	1.2	1.2
	2-3	0.8	0.8		2	1.2	1.2
	4	0.8	0.8		3	1.2	1.2
	5-7	0.8	0.8		4	1.2	1.2
	8-15	0.7	0.7		5	1.2	1.2
	16-25	0.6	0.7		6-7	1.2	1.2
K4.1	1	0.8	0.8		8-15	1.2	1.2
	2-3	0.8	0.8		16-25	1.2	1.2

Based on the cross-sectional dimensions that have been obtained obtained for Model 3 which is the result re-planning using SNI 2847-2019 with assignment based on SNI 1727-2020 and SNI 1726-2019 obtained period values fundamental of 2.9797 seconds, with a large displacement as follows.

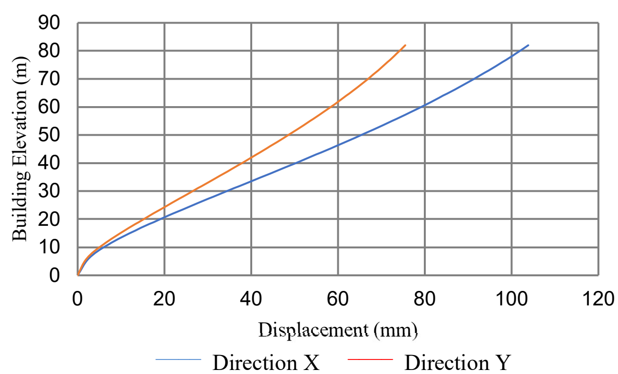

Fig. 5. Displacement Mode Values Comparison of Dimensions of Beams and Columns

3.3. Dimensional Comparison of Beams and Columns

Based on the results of the analysis obtained a comparison of the dimensions of the beam and column cross-section as follows.

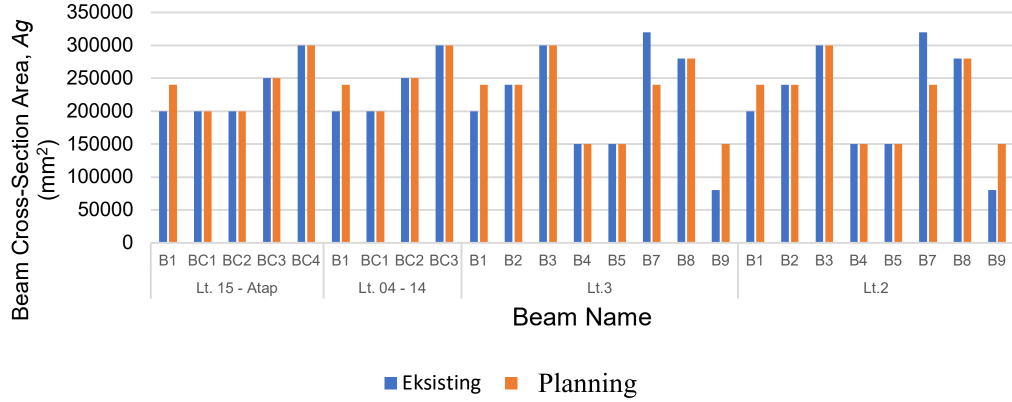

Fig. 6. Comparison of Dimensions of Beams

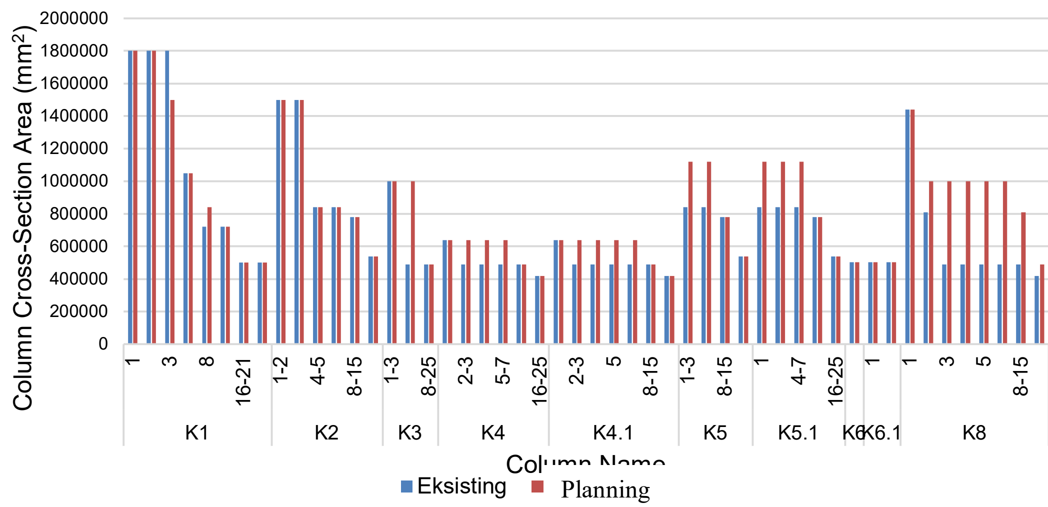

Fig. 7. Comparison of Column Cross-sectional Dimensions

The largest change in the dimensions of the beam cross-section is on the 2nd and 3rd floors of the B9 beam with an increase of 88%, and the largest change in the column cross-sectional dimension is on the K3 column on the 4-7th floor and K8 on the 3-7th floor with a large increase of 104%.

3.4. Comparison of the Fundamental Period

The comparison results obtained for the three models are as follows. It was found that the period of model 3 increased by 22% from model 1 and increased by 19% from model period 2.

Table 9. Comparison of the fundamenta period

Period (second)		
Model 1	**Model 2**	**Model 3**
2.4467	2.50381	2.9797

3.5. Displacement Comparison

To find out how big the difference is due to changes in building deformation, the displacement value is used as an analysis, based on the results of the analysis, the comparison for displacement is shown in graphic form as follows.

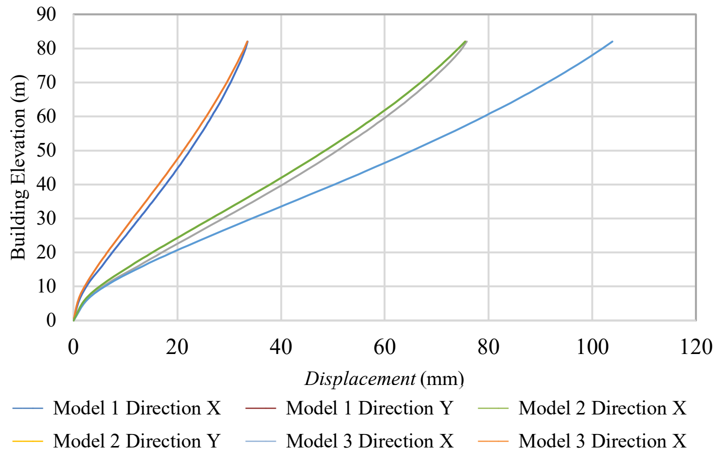

Fig. 8. Displacement Comparasion

Based on the percentage results, it is known that the displacement in the X direction in model 3 has a maximum increase of 210% against model 1 on the roof floor and in model 3 against model 2 it increases by 37% on the roof floor for the displacement in the Y direction of model 3 has a maximum increase of 192 % against model 1 on the roof floor and an increase of 29% against model 2 on the roof floor.

4. Conclusion

Based on the results of the analysis obtained, it can be concluded as follows. The largest change in the dimensions of the beam cross-section is on the 2nd and 3rd floors of the B9 beam with an increase of 88%, and the largest change in the column cross-sectional dimension is on the K3 column on the 4-7th floor and K8 on the 3-7th floor with a large increase of 104%.

The change in the fundamental period of model 3 increased by 22% from model 1 and increased by 19% from the period of model 2. It is found that the displacement change in the X direction in model 3 has a maximum increase of 210% against model 1 on the roof floor and in model 3 against model 2 it increases by 37% on the roof floor for the displacement in the Y direction on model 3, it has a maximum increase of 192% against model 1 on the roof floor and increased by 29% over model 2 on the roof floor.

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