JWS
JOURNAL OF WORLD SCIENCE
https://jws.rivierapublishing.id/index.php/jws
Volume 4 No. 5 Mei 2025
P-ISSN: 2828-8726
E-ISSN: 2828-9307

Building Structure With Seismic Design Categories Use SRPMK

Ade Maulana, Amirul Yusuf, Muchamad Rendy Santie Adhy, Arief Firmanto
Program Studi Teknik Sipil Fakultas Teknik Universitas Swadaya Gunung Jati, Cirebon, Indonesia
Email: ademaulana2199@gmail.com, mrendysantieadhy@gmail.com, amirulyusuf678@gmail.com, arieffirmanto03@gmail.com

ABSTRACT
In planning a multi-storey building, safe and efficient planning is always required, where the structure is expected to be able to withstand existing loads, including earthquake loads, because earthquake loads always greatly affect the behavior of the building and are always a top priority in planning, one of the methods used to withstand earthquake loads is the method of planning the structure of the moment-bearing frame system, which is divided into 3 parts, namely: ordinary moment bearing frame system (SRPMB), medium moment bearing frame system (SRPMM), special moment bearing frame system (SRPMK). The structure that is a priority for planning is a structure that is able to withstand conditions where the earthquake load is extreme or in this case the SRPMK and SRPMM structures which will be designed in such a way that it can withstand the inelastic response due to the earthquake load, in other words, the structure is required to be ductal (flexible) so that it can be categorized as safe if used. As well as referring to SNI 2847-2019 and SNI 1726-2019 regulations. Modeling, analysis, and design of the structure using the help of the ETABS 2020 program. Based on the results of the analysis and planning carried out on the Mall building, the dimensions of the planned structural elements (beams 300 x 500 mm, 300 x 400 mm, 250 x 350 mm, 250 x 400 mm and columns 500 x 500 mm, 400 x 400 mm, 450 x 450 mm, 350 x 350 mm) for SRPMK structures and (beams 250 x 450 mm, 200 x 350 mm, 200 x 300 mm, 200 x 350 mm and columns 450 x 450 mm, 350 x 350 mm, 400 x 450 mm, 300 x 300 mm) have met the cross-sectional criteria for special moment bearing frame systems (SRPMK) and medium motion bearing frame systems (SRPMM), namely Strong Column Weak Beam, are resistant to shear and have met the detailed requirements for a daktail structure.

Keywords: structure, earthquake load, SRPMM, SRPMK, daktail, ETABS

INTRODUCTION

A building is a physical form in the form of a structure made by humans consisting of foundations, columns, beams, walls to a roof that are permanent and made in one place. Buildings can also be called buildings, which are all facilities, infrastructure or infrastructure in human culture in building civilization. Buildings that are erected on the ground will inevitably be affected by the vibrations of the ground itself. This means that the building will definitely be affected by vibrations, both earthquakes and other vibrations.

Cirebon City is located in an earthquake-prone area. We can build buildings in earthquake-prone areas without worrying about the building's resilience to disasters, as stated by Teddy Bone, the driving force of the World Seismic Safety Initiative in Indonesia, "Vertical repetition is better than horizontal repetition". Therefore, to reduce the risk of earthquake disasters, it is necessary to plan earthquake-resistant building structures.

In the event of a minor earthquake, the building must not suffer damage to both non-structural and structural components. In the event of a moderate earthquake, the building may suffer damage to its non-structural components, but the structural components must not be damaged. In the event of a major earthquake, the building can suffer damage to its non-structural components and components, but the occupants of the building can save themselves (Dian Fauziah Rambe, 2009).

A building is a physical form in the form of a structure made by humans consisting of foundations, columns, beams, walls to a roof that are permanent and made in one place. Buildings can also be called buildings, which are all facilities, infrastructure or infrastructure in human culture in building civilization. Buildings that are erected on the ground will inevitably be affected by the vibrations of the ground itself. This means that the building will definitely be affected by vibrations, both earthquakes and other vibrations. Cirebon City is located in an earthquake-prone area. We can build buildings in earthquake-prone areas without worrying about the building's resilience to disasters, as stated by Teddy Bone, the driving force of the World Seismic Safety Initiative in Indonesia, "Vertical repetition is better than horizontal repetition". Therefore, to reduce the risk of earthquake disasters, it is necessary to plan earthquake-resistant building structures. In the event of a minor earthquake, the building must not suffer damage to both non-structural and structural components. In the event of a moderate earthquake, the building may suffer damage to its non-structural components, but the structural components must not be damaged. In the event of a major earthquake, the building can suffer damage to its non-structural components and components, but the occupants of the building can save themselves.

METHOD

The building to be planned is a reinforced concrete portal structure in the Public Pelyanan Mall building which consists of 6 floors with a height of 24 meters and has a length of 83 meters and a width of 28 meters and a height between floors of 4 meters. The planning location is on the main road of Cirebon city on Cipto Mangunkusumo street.

Based on the following SNI standards:

SNI 2847-2019, namely Procedures for planning structural concrete requirements for buildings and explanations.

SNI 1726-2019, namely Procedures for Earthquake Resilience Planning for Building and Non-Building Structures.

SNI 1727:2013, which is the Minimum Load for the Design of Buildings and Other Structures.

Primary data is obtained from existing data such as drawings of the work plan of the 5-storey lecture building construction project and soil data and material data from the planning location.

Literature Studies

The studies used in this final project are from the results of planning experts and civil engineering experts, literature books related to the study, and standards used in the planning of reinforced concrete buildings.

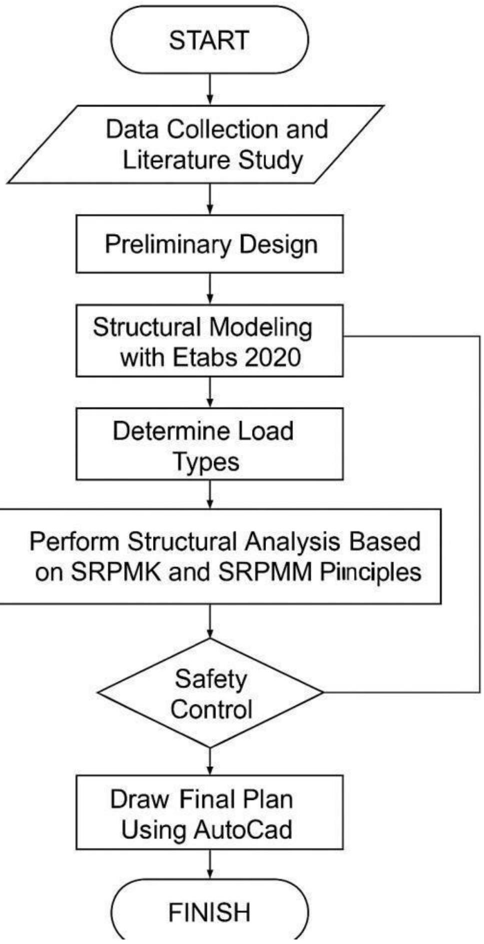

Figure 1. Planning Process Flow Diagram

RESULTS AND DISCUSSION

Structural Fundamental Period Control

The fundamental period of the structure (T), should not exceed the result of the coefficient for the upper limit in the calculated period (Cu) of table 17 and the fundamental period of the approach, (Ta). As an alternative to the implementation of analysis to determine the fundamental period of the structure, (T) is allowed directly using the period of the construction approach (Ta). The fundamental period of approach (Ta) in seconds.

Lower Limit :

Ta (min) = Ct x hx
= 0.0466 x Building Height0.9
= 0.0466 x 240.9
= 0.8139 seconds

Upper Limit

Tmax = Cu x Ta
= 1.4 x 0.8139
= 1,139 seconds

The fundamental period of structure (T) was obtained from the results of the analysis in Etabs of 1.45 seconds. The result exceeds Tmax = Cu. Ta. So that for the fundamental period using Tmax, which is 1.139 seconds.

Mass Passsipation Control

Table 1. SRPMK Mass Participation

Case	Mode	Period Sec	Sum UX	Sum Uy
Capital	1	1.454	0.7917	3.43E-06
Capital	2	1.45	0.7917	0.8051
Capital	3	1.345	0.8049	0.8051
Capital	4	0.48	0.9142	0.8051
Capital	5	0.479	0.9142	0.9155
Capital	6	0.443	0.9156	0.9155
Capital	7	0.269	0.9168	0.9549
Capital	8	0.269	0.9557	0.9561
Capital	9	0.248	0.9561	0.9561
Capital	10	0.181	0.9801	0.9561
Capital	11	0.181	0.9801	0.9805
Capital	12	0.166	0.9803	0.9805
Capital	13	0.139	0.9911	0.9805
Capital	14	0.138	0.9911	0.9913
Capital	15	0.127	0.9911	0.9913
Capital	16	0.114	0.9919	0.9913
Capital	17	0.11	0.9919	1
Capital	18	0.11	0.9999	1

Table 2. SRPMM Mass Participation

Case	Mode	Period Sec	Sum UX	Sum Uy
Capital	1	1.784	0.7861	0
Capital	2	1.755	0.7861	0.7998
Capital	3	1.64	0.7986	0.7998
Capital	4	0.582	0.9092	0.7998
Capital	5	0.575	0.9092	0.9113
Capital	6	0.535	0.9105	0.9113
Capital	7	0.321	0.9526	0.9113
Capital	8	0.318	0.9526	0.9534
Capital	9	0.295	0.953	0.9534
Capital	10	0.212	0.9782	0.9534
Capital	11	0.21	0.9782	0.9788
Capital	12	0.194	0.9784	0.9788
Capital	13	0.16	0.9901	0.9788
Capital	14	0.159	0.9901	0.9904
Capital	15	0.146	0.9902	0.9904
Capital	16	0.125	0.9978	0.9904
Capital	17	0.124	0.9978	1
Capital	18	0.123	0.9999	1

Crossover Control Between Floors

In SNI 1726-2019 Article 7.12.1.1 it is stated that for seismic force bearing systems consisting of only a moment frame on a structure designed for seismic design categories D, E, or F, the deviation between design levels (Δ) must not exceed Δa/ρ υ for all levels. ρ must be determined according to 0.

Table 3. SRPMK Inter-Floor Deviation Control

ΔX						
Floor	**h (mm)**	**Drift Δs Interlevel (mm)**	**Cd**	**Drift Δm Interlevel (mm)**	**Condition Drift Δa (mm)**	**Information**
6	4000	1.959	5,5	10.775	61.538	OK
5	4000	3.593	5,5	19.762	61.538	OK
4	4000	5.053	5,5	27.792	61.538	OK
3	4000	5.434	5,5	29.887	61.538	OK
2	4000	5.748	5,5	31.614	61.538	OK
1	4000	3.683	5,5	20.257	61.538	OK
ΔY						
Floor	**h (mm)**	Drift **Δs Interlevel (mm)**	**Cd**	Drift **Δm Interlevel (mm)**	Condition **Drift Δa (mm)**	**Information**
6	4000	1.975	5,5	10.863	61,538	OK
5	4000	3.593	5,5	19.762	61,538	OK
4	4000	5.055	5,5	27.803	61,538	OK
3	4000	5.438	5,5	29.909	61,538	OK
2	4000	5.760	5,5	31.680	61,538	OK
1	4000	3.695	5,5	20.232	61,538	OK

Table 4. SRPMM Inter-Floor Deviation Control

ΔX						
Floor	**h (mm)**	**Δs Interlevel (mm)**	**Cd**	**Drift Δm Interlevel (mm)**	**Condition of Drift Δm Interlevel (mm)**	**Information**
6	4000	4.080	4,5	18.360	61.538	OK
5	4000	7.196	4,5	32.382	61.538	OK
4	4000	9.946	4,5	44.757	61.538	OK
3	4000	10.670	4,5	48.015	61.538	OK
2	4000	11.147	4,5	50.162	61.538	OK
1	4000	6.874	4,5	30.933	61.538	OK

ΔY						
Floor	**h (mm)**	**Drift Δs Interlevel (mm)**	**Cd**	**Drift Δm Interlevel (mm)**	**Condition of Drift Δa Interlevel (mm)**	**Information**
6	4000	4.028	4,5	18.126	61.538	OK
5	4000	7.097	4,5	31.937	61.538	OK

4	4000	9.823	4,5	44.204	61.538	OK
3	4000	10.536	4,5	47.412	61.538	OK
2	4000	11.052	4,5	49.734	61.538	OK
1	4000	6.867	4,5	30.902	61.538	OK

Beam Planning Results

From the planning carried out, the results of the beam planning were obtained as follows:

Table 5. SRPMK Beam Repetition

Information	**Primary Beam 1**	**Primary Beam 2**	**Primary Beam 3**	**Secondary Beam**
Landscape	5000 mm	4000 mm	3000 mm	5000 mm
Dimensions	300 x 500	300 x 400	250 x 350	250 x 400
Longitudinal Bending/ Reinforcement	**Primary Beam 1**	**Primary Beam 2**	**Primary Beam 3**	**Secondary Beam**
Long. Upper Support	4 D22	3 D22	3 D19	3 D19
Long. Middle Support	2 D16	2 D16	2 D16	2 D16
Long. Lower Support	4 D22	3 D22	3 D19	3 D19
Long. Upper Field	3 D22	2 D22	2 D19	2 D19
Long. Middle Field	2 D16	2 D16	2 D16	2 D16
Long. Lower Field	3 D22	2 D22	2 D19	2 D19
Transverse / Sliding Reinforcement	**Primary Beam 1**	**Primary Beam 2**	**Primary Beam 3**	**Secondary Beam**
Transversal Support	3D13-100	2D13-80	2D13-70	2D13-80
Transversal Field	2D13-150	2D13-120	2D13-100	2D13-110

Table 6. SRPMM Beam Repetition Recapitulation

Information	**Primary Beam 1**	**Primary Beam 2**	**Primary Beam 3**	**Secondary Beam**
Landscape	5000 mm	4000 mm	3000 mm	5000 mm
Dimensions	250 x 450	200 x 350	200 x 300	200 x 350
Longitudinal Bending/ Reinforcement	**Primary Beam 1**	**Primary Beam 2**	**Primary Beam 3**	**Secondary Beam**
Long. Upper Support	3 D19	2 D19	2 D19	3 D16
Long. Middle Support	2 D16	2 D16	2 D13	2 D13
Long. Lower Support	3 D19	2 D19	2 D19	3 D16
Long. Upper Field	3 D19	2 D19	2 D19	2 D16
Long. Middle Field	2 D16	2 D16	2 D13	2 D13
Long. Lower Field	3 D19	2 D19	2 D19	2 D16
Transverse / Sliding Reinforcement	**Primary Beam 1**	**Primary Beam 2**	**Primary Beam 3**	**Secondary Beam**
Transversal Focus	2D13-95	2D13-70	2D10-40	2D10-90
Transverse Field	2D13-120	2D13-90	2D10-80	2D10-100

Column Planning Results

From the planning carried out, the results of the planning column were obtained as follows:

Table 7. Recapitulation of SRPMK Column Repetition

Information	**Primary Column 1**	**Primary Column 2**	**Primary Column 3**	**Primary Column 4**
Height	4000 mm	4000 mm	4000 mm	4000 mm
Dimensions	500 x 500	400 x 400	450 x 450	350 x 350
Longitudinal / Bending Reinforcement	**Primary Column 1**	**Primary Column 2**	**Primary Column 3**	**Primary Column 4**
Longitudinal Reinforcement	12 D25	12 D22	12 D22	12 D19
Transverse / Sliding Reinforcement	**Primary Column 1**	**Primary Column 2**	**Primary Column 3**	**Primary Column 4**
Supprot Transverse Reinforcement				
Weak Axis	3D16-100	3D16-100	3D16-100	3D16-80
Strong Axis	3D16-100	3D16-100	3D16-100	3D16-80
Field Transverse Reinforcement				
Weak Axis	2D16-120	2D16-130	2D16-130	2D16-100
Strong Axis	2D16-120	2D16-130	2D16-130	2D16-100

Table 8. Recapitulation of SRPMM Column Repetition

Information	**Primary Column 1**	**Primary Column 2**	**Primary Column 3**	**Primary Column 4**
Height	4000 mm	4000 mm	4000 mm	4000 mm
Dimensions	450 x 450	350 x 350	400 x 400	300 x 300
Longitudinal / Bending Reinforcement	**Primary Column 1**	**Primary Column 2**	**Primary Column 3**	**Primary Column**
Longitudinal reinforcement	16 D22	12 D22	16 D19	12 D19
Transverse / Sliding Reinforcement	**Primary Column 1**	**Primary Column 2**	**Primary Column 3**	**Primary Column 4**
Support Reinforcement Focus				
Weak Axis	3D16-100	3D16-85	3D16-80	3D16-75
Strong Axis	3D16-100	3D16-85	3D16-80	3D16-75
Field Transverse Reinforcement				
Weak Axis	2D16-130	2D16-120	2D16-110	2D16-100
Strong Axis	2D16-130	2D16-120	2D16-110	2D16-100

CONCLUSION

Based on the findings of this study, the construction of a public service mall at the analyzed site is not recommended using the SRPMM. This is due to the fact that the calculated Sds and Sd1 values place the site within Seismic Design Category (KDS) D. According to Table 12 of SNI 1726:2019, the application of the SRPMM within KDS D is categorized as 'Not Permitted' (TI). In contrast, the use of the Special Moment Resisting Frame (SRPMK) system within the same category is classified as 'Not Limited' (TB). Therefore, for the site under investigation, the SRPMK system is recommended as the appropriate structural system for the proposed development. Based on the results of the reinforced concrete structure design, it can be concluded that the beam dimensions used in the SRPMK and SRPMM systems include main beams with varying sizes such as 300 x 500 mm for Main Beam 1 in SRPMK and 250 x 450 mm in SRPMM. For the columns, the dimensions used in SRPMK include Main Column 1 with a size of 500 x 500 mm, and in SRPMM, Main Column 1 has dimensions of 450 x 450 mm. In the Special Moment Bearing Frame (SRPMK) system, the structure meets the strong column weak beam requirements based on several conditions, such as the bending strength of the column satisfying $\Sigma Mnc \geq 1.2\ \Sigma Mnb$ to reduce the possibility of failure in columns that are part of the seismic force-resisting system. Additionally, the reinforcement of the beam with existing dimensions has undergone loading, and the beam and column components are able to withstand shear forces where the nominal shear capacity is greater than the shear force acting on the component. The structure is also designed to be more ductile, with tighter reinforcement placed in areas that are prone to fatigue, such as the beam-column connection, to prevent shear collapse. The structure qualifies for the vibration period (T) as it does not exceed the upper limit of the foundation period (Ta upper limit), and the control of the level deviation between floors in the design should ensure that the inter-floor displacement (Δ) does not exceed $\Delta a/\rho\ \upsilon$ for all levels, ensuring safety in the inter-floor design.

REFERENCES

National Standards Agency. 2019. Minimum Load for Building Design and Other Structures, SNI 03-1727-2013. BSN, Bandung.

National Standards Agency. 2019. Earthquake Resilience Planning Procedures for Building and Non-Building Structures, SNI 1726:2019. Jakarta.

National Standards Agency. 2019. Procedures for Planning Concrete Structures for Buildings and Explanation, SNI 2847:2019. Jakarta.

National Standards Agency. 2017. Concrete Rebar Steel Explainer, SNI 2847:2019. Jakarta.

Karisoh, P. H., Dapas, S. O., Pandaleke, R. E., 2018. Structural Planning of Reinforced Concrete Buildings with Special Moment Bearing Frame System., Static Civil Journal Vol.6 No.6 June 2018 (361-372) ISSN: 2337-6732, Sam Ratulangi University. Manado.

Fadilah, H. M., & Walujodjati, E. (2020). Comparison of Earthquake Load of Multi-Storey Buildings Using Static Equivalent Analysis and Dynamic Time History Analysis in Garut Regency. Journal of Construction, 18(1), 20–30. https://doi.org/10.33364/konstruksi/v.18-1.780

Dewayanti, O., Kumaat, E. J., Dapas, S. O., Windah, R. S., 2013. Calculation of Intersection of Multi-Storey Building Structures (Comparative Study of Radial and Grid Directional Bending Models), Static Civil Journal Vol.1 No.11, October 2013 (689-695) ISSN: 2337-6732, Sam Ratulangi University. Manado.

Laily, R., Sumajouw, M. D. J., Wallah, S. E., 2019. Planning of a 4-Story Reinforced Concrete Construction Training Center Building in Manado City. Journal of Static Civil Studies, Vol.7, No.8, August 2019. Sam Ratulangi University. Manado.

Prismastanto, N. (2019). Method of Analysis of Various Response Spectrums in Multi-Storey Building Structures. MoDuluS: World Communication Media of the Civil Sciences, 1(1), 25.https://doi.org/10.32585/modulus.v1i1.378

E. R. Boyoh, R. S. Windah, and S. O. Dapas, "Planning a 12-Story Reinforced Concrete Construction Hotel on Jln. Ahmad Yani, Manado City," J. Static Civil Studies, vol. 7, no. 8, pp. 913–922, 2019

W. Maulana, The Use of the Application of 12-Storey Building Design Etabs (Reinforced Concrete Building Structure Based on SNI 1729-2019), Depok: Civil Arch, 2019.

Riza, M.M. 2010. Building Structure Planning Application with Etabs. Azza Reka.

Close, L. Suyadi. Widyawati, R. 2016. Analysis of the Design of the Whiz Hotel Building Method of the Special Moment Bearing Frame System. JRSDD. Vol.1, No. 1. Pages 481-490.

Cahaya Saputra, et. al. 2022. Planning of Hotel Building Structure in Padang City, West Sumatra. E-Repository of Hatta University. Diploma Thesis, http://repo.bunghatta.ac.id/view/creators/Ca haya=3ASaputra=3A=3A.html.

Tajunnisa, Y. Chadafi, M. Rahmadhaniawan, V. 2014. Comparison of Performance Evaluation of Earthquake-Resistant Buildings between the MACC and MACC Methods. Journal of Applications. Vol 12. No. 1.