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Enhancing the Role of Engineering in Climate Change Mitigation and Sustainable Development in ASEAN Region

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Foreword

Strengthening the response to the threat of climate change has been a major international goal in the last decade. It is the sole aim of the Paris Agreement and a goal in the UN Sustainable Development Goals. The climate change has been a more critical issue in regions with tropical climates such as ASEAN member countries. The International Conference on Climate Change and Sustainability in ASEAN 2019 (CCSE-ASEAN 2019) is an effort to discuss the best response to the climate change that would certainly pose significant threats to sustainable development in Southeast Asia. This conference aims at encouraging rich discussions and continuous collaborations among researchers, engineers, leaders in regional government and industries, and students on enhancing the role of the engineering field with its major innovations in ASEAN countries to mitigate climate change impacts.

CCSE-ASEAN 2019 received 171 submissions of abstracts and full papers. On the basis of a single-blind review process, in which two or three independent reviewers were assigned for each submission, 100 full papers were accepted for oral presentation. The presenters at CCSE-ASEAN 2019 came from several countries including Indonesia, Philippines, Japan, China, and Iraq. The authors presented original scientific reports on varied topics but highly relevant to climate change and sustainability studies.

Based on the recommendation of CCSE ASEAN 2019 Scientific Committee and the authors' consent, the papers presented at CCSE-ASEAN 2019 had been submitted to several publication outlets. Fifty three papers have been published in *AIP Conference Proceedings*. A paper has been published in the *International Journal of Renewable Energy Development* (IJRED). Nine papers have been accepted for publication in *Journal of Energy, Mechanical, Material, and Manufacturing Engineering* (JEMMME). A paper has been accepted for publication in *Jurnal Teknik Sipil dan Perencanaan* (JTSP).

This proceeding is a collection of 26 papers. Application of some emerging technologies, including smart facial and wood types detection, real-time monitoring of volcanoes, and power plants, and rectenna are reported in eight papers. Four papers are on bio-based chemicals discussing coffee residue composites, diesel and coconut oil, and sugar cane fiber. Furthermore, there are two papers on photovoltaic systems, three papers on advanced materials, and a paper on flood detection. Other papers discussed other topics, including ergonomic chairs, honey filter machines, and Sustainable Development Goals. We sincerely thank all authors who have submitted their papers to CCSE-ASEAN 2019 especially to the authors who patiently wait for the publication process.

Our deep gratitude goes to the authors and the reviewers for their dedicated work. We sincerely thank all keynote speakers for their insightful lectures in the plenary session. We would also thank all committee members of CCSE-ASEAN 2019 for their continuous hard work and cooperation, and we thank our sponsors for their support. We do hope that all the participants of CCSE-ASEAN 2019 would gain meaningful inspiration and fruitful collaboration from the conference.

Chair of CCSE-ASEAN 2019

Dr. Eng. Triwahju Hardianto

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Reinforcement Modeling of Building Beams Using Glass Fiber Reinforced Polymer (GFRP) Due to Building Function Changes in Jember

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Abstract. One of effort to increase the space in the building is by adding a floor up. Additions to the upper floors can be done on limited land. However, the addition of the floor causes the ring balk function change becomes the floor beam function. Changing the function of the ring balk becomes floor beam makes the load received by the beam increase. The different types of dead loads and live loads received cause the beam reinforcement is needed. One of the reinforcement methods that can be done is by using Fiber Reinforced Polymer (FRP) material. The advantages of Fiber Reinforced Polymer (FRP) materials are lighter, have high tensile strength, not corrosion, easy to install, and easily formed. In this case, Glass Fiber Reinforced Polymer (GFRP) material is selected. This material is one type of FRP with cheaper price compared to other FRP types. Coating ring balk with GFRP aims to allow the ring balk as a floor beam function without having to destroy it as a whole. So, this case does not interfere with ongoing activities in that building. This study was conducted by modeling a 3 floors into 6 floors building with concrete roof using structure analysis program. The 35/40 ring balk will be function as a main beam on the 4th floor assuming a size of 45/60 with an additional beam of 40/50 to be able to withstand the load given. The results of the maximum moment (Mu = 20845.75 kgm) on the 4th floor main beam are a reference to determine the GFRP needed for reinforcement. Reinforcement is done by coating the beams with 1 mm of GFRP as much as 3 layers on 3 sides of the beam. Based on the analysis carried out it produces øMn (=21893.2861 kgm) > Mu (= 20845.75 kgm). Deflection which calculated composite is 3.63 mm.

INTRODUCTION

In the initial planning of a building, structural elements are designed to firmly withstand dead loads and live loads according to the planned analysis. Changing the function of the ringbalk becomes floor beam makes the load received by the beam increase. The type of load received by the beam is certainly greater than the original load. Based on these problems, innovations in reinforcement on beam structural elements can be carried out using lightweight materials such as Glass Fiber Reinforced Polymer (GFRP). According to Parmo and Taufikurrahman (2013), the advantages of Fiber Reinforced Polymer (FRP) materials are lighter, have high tensile strength, are not corrosion, easy to install, and are easily formed. In addition, another advantage of reinforcement using Glass Fiber Reinforced Polymer (GFRP) is to coat the beam and do not need to destroy the beam as a whole. This certainly does not interfere with the ongoing activities in the building. This study aims to determine the modeling of the change in ringbalk function into floor beams on the structure of the building and GFRP needed to reinforce the ringbalk so that it can be the floor beam function.

METHOD

This study uses the Teacher Training and Education Faculty H Building of Jember University, located on Jalan Kalimantan No. 37, Jember. The building is a 3-story building that will be added to the modeling until the ringbalk is not able to withstand the load given. The secondary data obtained includes the compressive strength of concrete (= 20.75 MPa), steel tensile strength (= 320 MPa), the ringbalk dimension (= 35 cm x 40 cm).

Research Flow Chart

Analysis and modeling on the part of the building beam will be presented through the flow diagram on **Figure 1** as follows.

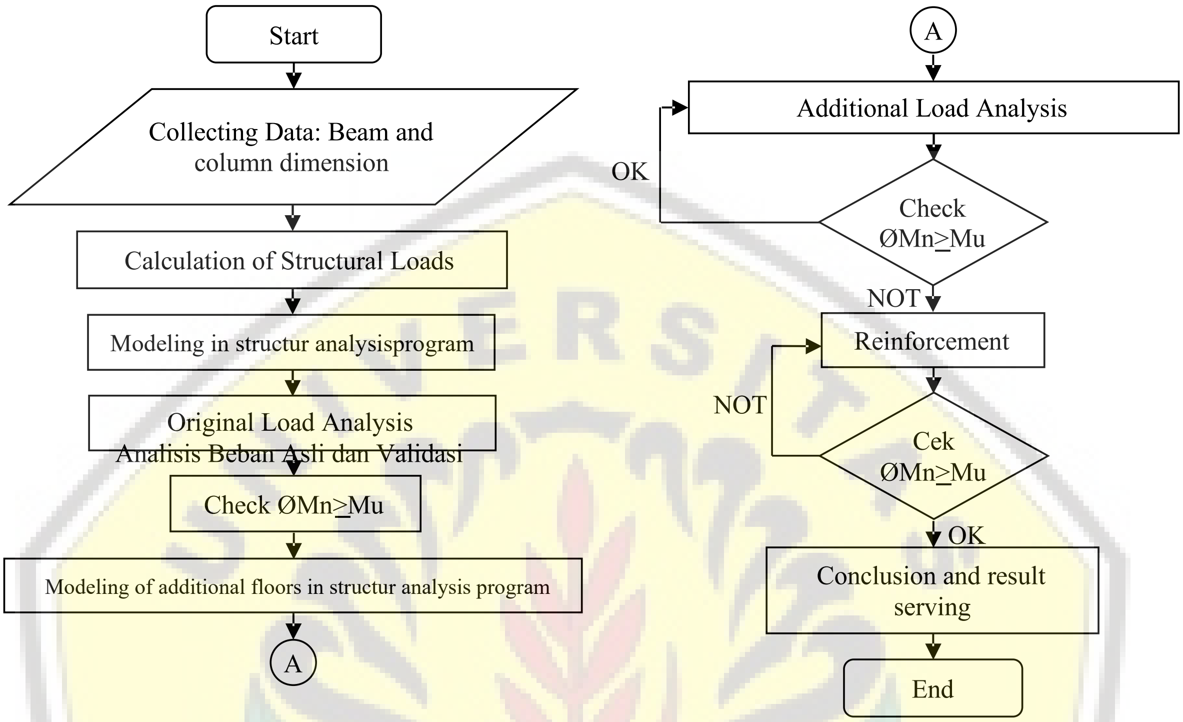

Figure 1. Research Flow Chart

DISCUSSION

Loading on the initial structure of the 3-story building

The loading is carried out using the envelope method, then checking the capacity of the ringbalk structure components using the structure analysis program. In **Figure 2**, the result of checking the capacity of the structure produces green, so the building structure falls into the safe category.

Figure 2. The result of checking the capacity of the ringbalk structure components

New floor beam dimension planning

In order to be able to function as a floor, additional beams need to be done. The beam dimensions on the 4th floor are calculated based on the preliminary design which results in the dimensions of the beam of 40/50, the reference beam of 45/60 and the column of 70/70. The placement of the beam is marked in orange in **Figure 3** below.

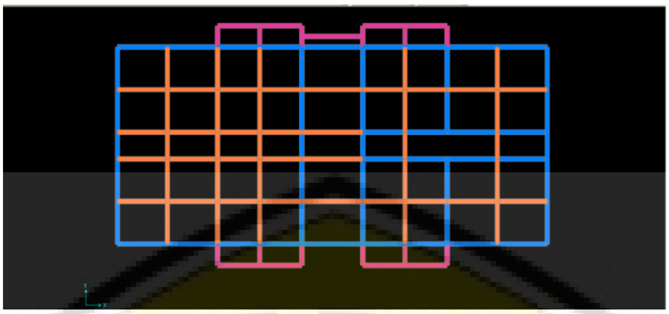

Figure 3. Additional beam

After checking the capacity in structure analysis program, **Figure 4** shows the green color of the 45/60 beam structure and 40/50 additional beam, so that it can be categorized in a decent or safe condition.

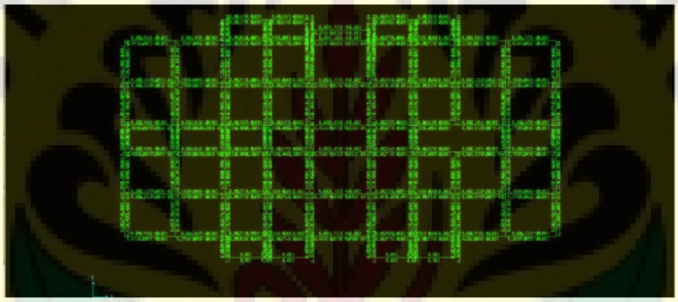

Figure 4. The result of checking the capacity of the 4th floor beam structure components

Table 1. Moment and Shear of the Beam

	Initial Ringbalk of 3-story building	**Main beam of 4th floor as a reference**
Dimension (cm)	35/40	45/60
Moment (kgm)	4560.13	20845.75
Shear (kg)	6356.99	15616.04

Strengthening on Ringbalk Using GFRP

Strengthening using the E-Glass Woven Roving will be carried out on the ringbalk so that it can be function as a 4th floor beam which refers to ACI 440.2R-17.

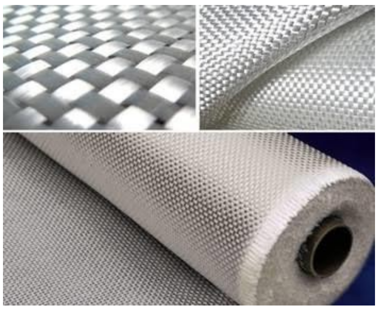

Figure 5. E-Glass Woven Roving [14]

Table 2. Beams Before Reinforcement Data

Parameter	Amount	Unit
Compressive strength of concrete (f'c)	20.75	MPa
Tensile strength of steel (fy)	320	MPa
Width of beam (b)	350	mm
Height of beam (h)	400	mm
Diameter of circular section (D)	16	mm
Concrete coat thick (ts)	25	mm
Enviromental reduction factor (Ce)	0.75	
GFRP ultimate tensile strength (f_{fu}*)	2680	MPa
Strain level of GFRP (ε_{fu}*)	0.045	
Elastic modulus of GFRP (E_f)	72000	MPa
Thick of GFRP (t_f)	1	mm
Elastic modulus of steel (E_s)	200000	MPa
Elastic modulus of concrete (E_c)	21409.519	MPa
Mu of 45/60 beam (planning moment)	20845.75	kgm

Table 3. Calculation of beam bending after strengthening by GFRP

Parameter	Amount	Unit
Area of circular section (As)	1408	mm^2
Distance of circular section center to the concrete side (d')	33	mm
Effective height of beam (d)	367	mm
Ratio of nonprestressed reinforcement (ρs)	0.011	
Width of GFRP (Wf)	350	mm
Amount of GFRP layer (n)	3	lapis
Cross-sectional area of GFRP (Af)	1050	mm^2
Design ultimate tensile strength of GFRP (ffu = Ce x ffu*)	2010	MPa
Design rupture strength of GFRP (Ɛfu = Ce x Ɛfu*)	0.034	
GFRP reinforcement ratio (ρf)	0.008	
Stiffness with GFRP (k)	0,4	
Ratio of area of circular section to beam cross-sectional area (ρg)	0.01006	
β_1 (f'c $\leq$ 30 MPa)	0.85	
M_{DL}	134946600	Nmm
Icr	613199433.7	mm^4
Strain level at installation of GFRP (ε_{bi})	0.0026	
Debonding strain of GFRP (ε_{fd})	0.004	
Effective strain level of GFRP (ε_{fe})	0.0033	

Strain level of concrete (ε_c)	0.003	
Strain level of steel (ε_s)	0.0052	
Stress in steel reinforcement (fs)	320	MPa
Effective stress in GFRP (ffe)	237.9721	MPa
Maximum strain of concrete corresponding to f'c (ε'c)	0.0016	
Stress factor β_1	0.924	
Stress factor α_1	0.7746	
Depth of neutral axis (c)	134.7566	mm
Flexural component strength Mns	137304321.1	Nmm
Flexural component strength Mnf	84391690.46	Nmm
Net tensile strain (εt)	0.0016	
ψf (*3-side "U-wrap"*)	0.85	

The flexural strength produced by reinforcing beams uses the GFRP as follows.

$$\begin{aligned} øM_n &= ø\,[M_{ns} + \psi_f \times M_{nf}] + ø\,M_{n\ \text{initial of ringbalk}} \\ &= 0.65\,[137304321.1 + 0.85 \times 84391690.46] + 0.75\,(110744858) \\ &= 218932861 \text{ Nmm} \\ &= 21893.2861 \text{ kgm} \geq M_u = 20845.75 \text{ kgm} \end{aligned} \quad (1)$$

The deflection that occurred in the beam after reinforced using GFRP was equal to 3.63 mm < permit deflection (= 11.111 mm). While the shear strength produced is øVn (= 6196337.584 kg) > Vu (= 15616.04 kg).

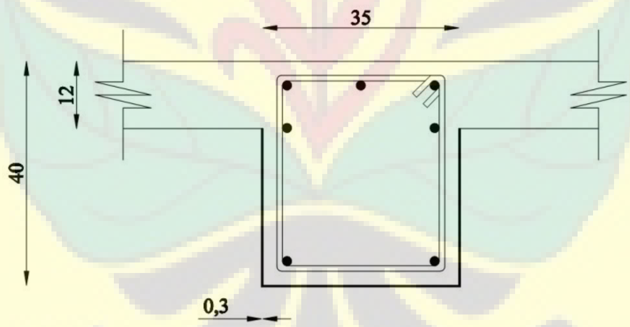

Figure 7. Beam sketch that have been coated by GFRP

CONCLUSION

Based on the results of Reinforcement Modeling of Building Beams Using Glass Fiber Reinforced Polymer (GFRP) Due to Building Function Changes in Jember, it can be conclude as follows.

1) This study was conducted by modeling 3 floors into 6 floors building with concrete roof using structure analysis program. The 35/40 ringbalk will function as a main beam on the 4th floor assuming a size of 45/60 with an additional beam of 40/50 to be able to withstand the load given. The results of the maximum moment (Mu = 20845.75 kgm) on the 4th floor main beam are a reference to determine the GFRP needed for reinforcement.
2) Strengthening is done by coating the beams with 1 mm of GFRP as much as 3 layers on 3 sides of the beam. Based on the analysis carried out it produces øMn (=21893.2861 kgm) ≥ Mu (= 20845.75 kgm).

SUGGESTION

Based on the evaluations of Reinforcement Modeling of Building Beams Using Glass Fiber Reinforced Polymer (GFRP) Due to Building Function Changes in Jember, there are several suggestions that need to be considered, namely:

1) To apply reinforcement to other components of the building structures, such as columns and plates.
2) To analyze the type of collapse due to the connection that occurs between the beam and the addition of GFRP
3) To strengthen building structures with laboratory tests.
4) To analyze the connections that occur between beams.

REFERENCES

1. ACI Committe 440. (2017). *ACI 440.2R-17: Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures*. American Concrete Institute, Farmington Hills
2. Badan Standardisasi Nasional. (2012). *SNI 1726 – 2012: Tata Cara Perencanaan Ketahanan Gempa untuk Struktur Bangunan Gedung dan Non-Gedung*. Badan Standardisasi Nasional, Jakarta
3. Badan Standardisasi Nasional. (2013). *SNI 1727 – 2013: Bebam Minimum untuk Perancangan Bangunan Gedung dan Struktur Lain*. Badan Standardisasi Nasional, Jakarta
4. Badan Standardisasi Nasional. (2013). *SNI 2847 – 2013: Persyaratan Beton Struktural untuk Bangunan Gedung*. Badan Standardisasi Nasional, Jakarta
5. Boen, T. (2009). *Cara Memperbaiki Bangunan Sederhana yang Rusak Akibat Gempa Bumi*. *Australia–Indonesia Facility for Disaster Reduction*, Jakarta
6. Ginardi, I. P. (2014). "Perbandingan Kekuatan Lentur Balok Beton Bertulang dengan Menggunakan Perkuatan CFRP dan GFRP". Jurnal Mahasiswa Jurusan Teknik Sipil 1 (2), 1-8.
7. Hermanto, E. dan F. Kistiyani. (2006). "Kegagalan Bangunan dari Sisi Industri Konstruksi". Media Komunikasi Teknik Sipil 14 (1), 51-52.
8. Kaontole, J. T., M. D. J. Sumajouw, dan R. S. Windah. (2015). "Evaluasi Kapasitas Kolom Beton Bertulang yang Diperkuat dengan Metode *Concrete Jacketing*". Jurnal Sipil Statik 3 (3), 167-174.
9. Kiswono, B. dan E. Jayanto. (2017). "Studi Perbaikan Balok Beton Bertulang Menggunakan Glass Fiber Reinforced Polymer (GFRP) untuk Meningkatkan Kekuatan Tarik pada Bending Momen". Agregat 2 (2), 159-165.
10. Nugraini, S. (2017). Skripsi: Analisis Pemodelan Kegagalan Struktur dan *Retrofitting* pada Bagian Kolom Gedung 8 Lantai. Program Studi S1 Teknik Sipil Universitas Jember, Jember.
11. Nurlina, S., H. Suseno, M. T. Hidayat, dan I. M. Y. Pratama. (2016). "Perbandingan Daktilitas Balok Beton Bertulang dengan Menggunakan Perkuatan CFRP dan GFRP". Rekayasa Sipil 10 (1), 62-68.
12. Parmo dan Taufikurrahman. (2013). "Perbaikan Kekuatan dan Daktilitas Balok Beton Bertulang Menggunakan *Glass Fiber Reinforced Polymer* (GFRP) *Strips*". Jurnal Ilmu-Ilmu Teknik 10 (3), 63-70.
13. Sudarsana, K. dan A. A. Gede Sutapa. (2007). "Perkuatan Kolom Bulat Beton Bertulang dengan Lapis *Glass Fiber Reinforced Polymer* (GFRP)". Jurnal Ilmiah Teknik Sipil 11 (1), 1-9.
14. Jiahe Taizo Glass Fiber Co, Ltd. Woven Roving http://www.jhblxw.com.cn/eng/product/18_54