EACEF-5 The 5th International Conference of Euro Asia Civil Engineering Forum

CERTIFICATE

This is to certify that

Ade Lisantono

has participated in the 5th International Conference of Euro Asia Civil Engineering Forum at Petra Christian University, Surabaya, Indonesia, held on 15-18 September 2015, as

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EACEF-5 Surabaya, Indonesia 15-18 September 2015

Prof. Dr. Djwantoro Hardjito

PETRA CHRISTIAN UNIVERSITY

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Procedia Engineering

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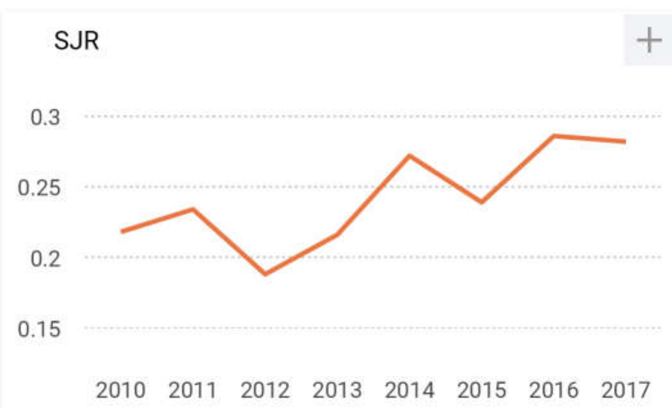

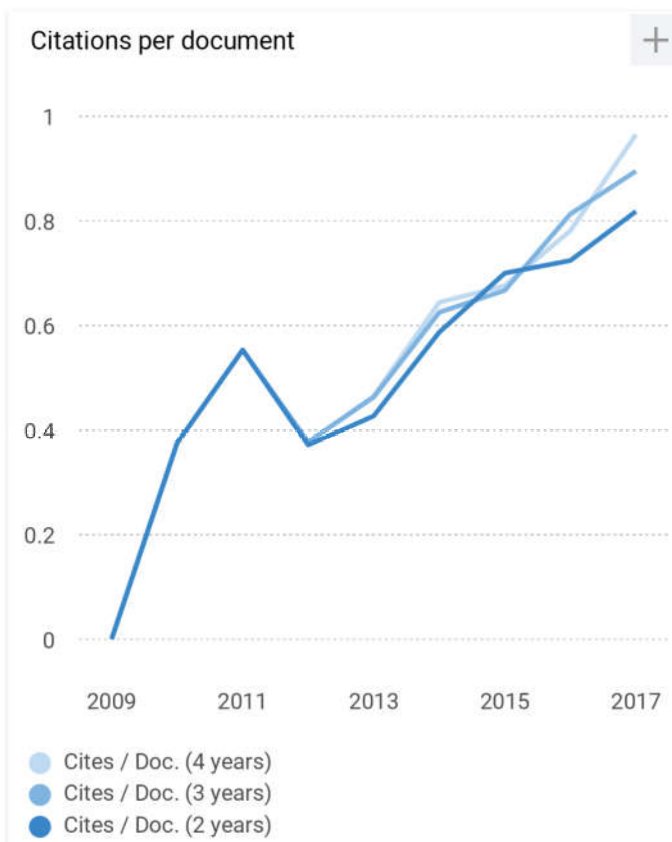

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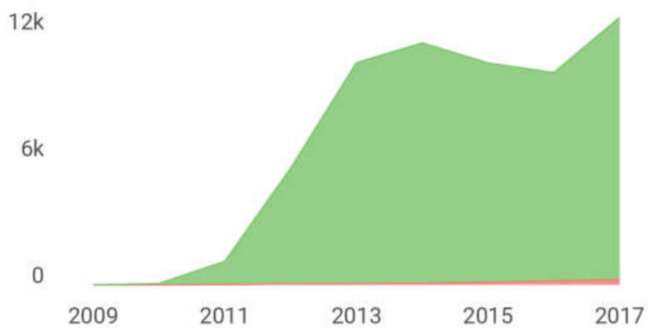

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VENUE AND ACCOMODATION

Petra Christian University
Jalan Siwalankerto 121-131
Surabaya, Indonesia, 60236
http://www.petra.ac.id

The list of accommodation will be made available soon on the conference website.

TENTATIVE PROGRAM

Tuesday, 15 September 2015
Registration and welcome reception

Wednesday, 16 September 2015
Registration, opening speeches, keynote lectures, technical sessions, conference dinner

Thursday, 17 September 2015
Keynote lectures, technical sessions, closing speeches

Friday, 18 September 2015
Technical/social program

CORRESPONDENCE AND INQUIRIES

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ACECC, The Asian Civil Engineering Coordinating Council *)

TECHNICAL/SOCIAL TOUR

The organizing committee is working together with a local tour and travel service to organize social tour (optional), i.e.:

- Sunrise Bromo Mountain Overnight Tour (2D/1N)
- Exotic Bali Tour (3D/2N)
- Wonderful Bromo Bali Tour (4D/3N)
- Spouse Program
- Surabaya City Tour

More detail information on the social program can be obtained from the conference website http://eacef5.petra.ac.id

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First Announcement and Call for Papers

"Civil Engineering Innovation for a Sustainable Future"

EACEF-5

The 5th International Conference of Euro Asia Civil Engineering Forum

Surabaya, Indonesia
15-18 September 2015

UNIVERSITAS KRISTEN PETRA
UPH UNIVERSITAS PELITA HARAPAN
UNIVERSITAS ATMA JAYA YOGYAKARTA

Organized by:
Petra Christian University, Surabaya, Indonesia
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About EACEF and EACEF-5

The International Conference of Euro Asia Civil Engineering Forum (EACEF) is a forum to promote the cooperation and understanding among scholars and engineers from European and Asian countries and other parts of the world, focusing on Civil Engineering expertise. The preceding EACEF conferences have been held successfully in Jakarta (2007), Langkawi (2009), Yogyakarta (2011) and Singapore (2013). The 5th EACEF conference will be organized at Petra Christian University, Surabaya, Indonesia, in 2015. The theme for this conference is **'Civil Engineering Innovation for a Sustainable Future'**, expecting delegates not only from European and Asian countries, but also from other regions, to exchange ideas, findings and expertise, as well as to build up network.

CALL FOR PAPER

The organizing committee invites papers describing original work on innovations and new developments in the following civil engineering sub-disciplines (but not limited to):

- Structural and Construction Engineering
- Geotechnical Engineering
- Green Civil Engineering Materials
- Environmental Engineering (incl. Water & Climate Changes)
- Infrastructure Engineering (incl. Transportation System & Public Facilities)
- Construction Project and Safety Management

Participant(s) who are interested in presenting a paper(s) are invited to submit a maximum 500-word in English (with or without figures). Abstract should be submitted on-line in MS-WORD format to http://eacef5.petra.ac.id. Detailed guidelines for preparing and submitting abstracts and full length papers may be found on the conference website http://eacef5.petra.ac.id. Abstract and full paper will be reviewed by the Scientific Committee. Authors of accepted papers are expected to attend the conference and present the paper(s).

IMPORTANT DATES

Abstract submission	January 17, 2015
Notification of abstract acceptance	February 14, 2015
Full paper submission	May 16, 2015
Full paper notification of acceptance	July 18, 2015
Final paper submission and registration	August 15, 2015
Early bird registration	August 15, 2015
Conference	September 15-18, 2015

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PUBLICATION

After a careful refereeing process, all accepted papers will be published in the following international journal:

Procedia Engineering
(ISSN: 1877-7058)
http://www.journals.elsevier.com/procedia-engineering/
Procedia Engineering is published by **Elsevier,** and indexed by **SCOPUS**.
Selected papers will be offered for publication in the:

Civil Engineering Dimension
(ISSN: 1410-9530 (print), 1979-570x (online),
http://ced.petra.ac.id
CED is indexed by **major databases**.

REGISTRATION

	On/before 15 August 2015	After 15 August 2015
Overseas participant	USD 300	USD 350
Indonesian participant	IDR 1.500.000	IDR 2.000.000
For each additional paper*)	USD 100	USD 100

*) With the same presenter, maximum 1 additional paper.

The registration fee includes seminar kit (hardcopy of abstract, CD proceedings and publication fee in Procedia Engineering), lunches and coffee breaks for two days, welcome reception and conference dinner.

OFFICIAL LANGUAGE

The official language of the conference is English.

EACEF-5

The 5th International Conference of Euro Asia Civil Engineering Forum

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Preface

Antoni, Ima Muljati, Djwantoro Hardjito

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The 5th International Conference of Euro Asia Civil Engineering Forum (EACEF-5)

Experimental investigation of reinforced concrete column embedded with the angle steel shapes

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Abstract

Column is an important structural element in a building, because it carries some loads from the beams and the floors connecting to the column. Sometimes it needs to strengthen the existing column for some reasons. For example the load capacity of the column must be increased due to the compressive strength of the concrete column does not comply with the specified requirement. Investigation of the reinforced concrete column with angle steel shapes embedded at the corner of the column is limited. Therefore, it needs to investigate before developing the analysis for practical purpose design. This research conducts the experimental program of the reinforced concrete column with equal-leg angle steel shapes embedded at corner of the column. Eight specimens were tested in this experimental program. Four columns were subjected to the concentrically load and the others were subjected to eccentrically load. The specimens which embedded with angle steel shapes have various stiffeners spacing of 50 mm; 100 mm, and 150 mm. The column has length of 750 mm with sectional dimension of (75 mm x 75 mm). The column has four longitudinal reinforcements of 8 mm and stirrup of 5 mm. The equal-leg angle steel shape has size of (22.1 mm x 22.1 mm x 2 mm). The results of the experimental program show that compare to the reference specimen, the increment load of concentrically loaded column embedded with angle steel shape with stiffener spacing 50 mm, 100 mm, and 150 mm were 210.4447 %, 235.5426 %, and 185.6640 %, respectively. While the increment load of eccentrically loaded column embedded with angle steel shape with stiffener spacing 50 mm, 100 mm, and 150 mm were 85.5607 %, 34.6697 %, and 42.9479 %, respectively

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Keywords: reinforced concrete column; equal-leg angle steel shapes; stiffeners spacing; capacity of column; concentric and eccentric load.

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1. Introduction

Column is a structural element of building that transfers loads from roof, slab, beam and others non structural element to the foundation of the building. It can be said that column is a very important element in structural building. So, it must be careful in designing column of high rise building. In a construction of high rise building made of concrete, sometimes the compressive strength of concrete does not comply with specified strength. Insufficient concrete strength can be occurred due to lack of quality control in making of concrete in the construction building. When an element of structure has insufficient strength, it needs to strengthen for safety reason.

There are some methods to strengthen the existing reinforced concrete columns. One of the methods is adding the existing column with an angle steel shape. Generally, the angle steel shape usually used for tension or compression members in roof structure. Now, the angle steel shape was used not only for roof structure members, but also for others element of structures. Research on the reinforced concrete columns embedded with angle steel shape were limited. Basuki [1] conducted a research on utility of angle steel shape as a compression member or column with the couple plat subjected to concentric load. His research showed that the closer spacing of the couple plat on the column, the stiffer the column. However, if the spacing of the couple plat on the column was un-uniform spacing, the column strength will decrease. Suwanto [2] conducted the research on composites column where the angle steel shape used as the reinforcement. His research showed that the angle steel shape can increase the column strength up to 13.85 % compare to the reinforced concrete column which has the same area reinforcement bars with angle steel shape.

Basuki [1] and Suwanto [2] conducted the research on utility of angle steel shape for structural element and reinforcement of the column, not for retrofitting an existing column. Therefore, it needs to conduct an experimental program of reinforced concrete column embedded with angle steel shape at the corner of the column.

2. Experimental program

Eight specimens were tested in this experimental program. Four columns were subjected to the concentrically load and four columns were subjected to eccentrically load. The column has length of 750 mm with the sectional dimension of (75 mm x 75 mm). The reinforced concrete column has four longitudinal reinforcements bar of 8 mm and stirrup of 5 mm with spacing of 50 mm. The equal-leg angle steel shape has size of (22.1mm x 22.1mm x 2mm) which was installed at the corner of the reinforced concrete column as a composite column (see Fig. 1) with couple plates as stiffeners (see Fig. 2). The couple plates as a stiffener were welded at the angle steel shapes with various spacing of 50 mm; 100 mm, and 150 mm (see Fig. 2). The average compressive strength of concrete f_c' at 28 days = 32.29 MPa, the average yield stress of longitudinal bar f_y = 266.8 MPa. While the average yield stress of angle steel shape f_y = 247.01 MPa.

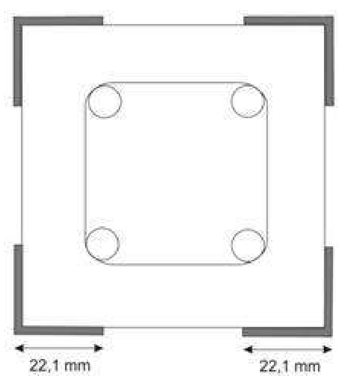


Fig. 1. Position of angle steel shapes

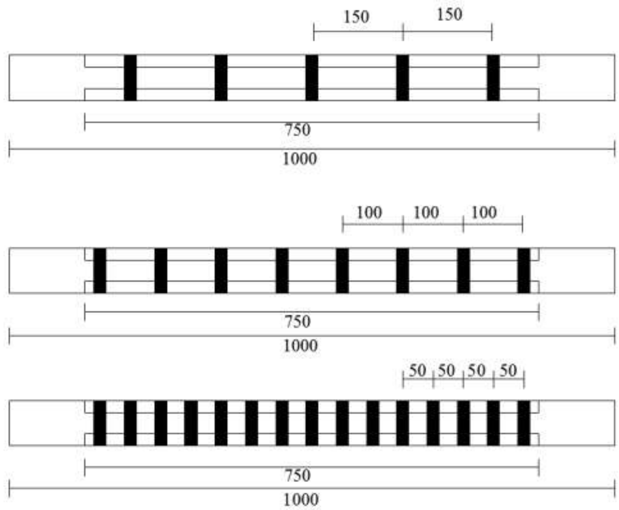
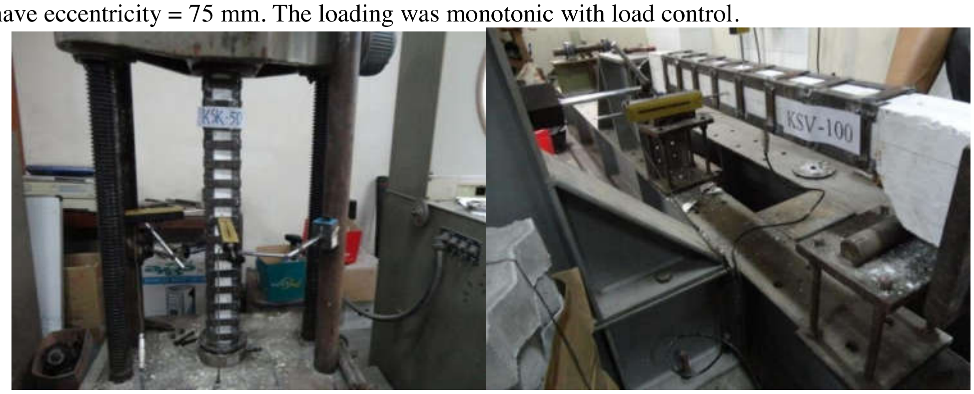


Fig. 2. Various spacing of the stiffeners (in mm)

The concentrically loaded column were tested using Universal Testing Machine as shown in Fig. 3(a). While the eccentrically loaded column were tested using hydraulic jack which was setup at the loading frame as shown in Fig. 3(b) and have eccentricity = 75 mm. The loading was monotonic with load control.



(a) (b)

Fig. 3. (a) Setup of concentrically loaded column; (b) Setup of eccentrically loaded column.

Linear Variable Differential Transformers (LVDT) was used to measure deflection at the mid span of the specimen. The deflections were measured with respect to both principal axes. Measured data both deflection and load were read through a computer driven data acquisition system by data logger. The surface of the column was whitewashed first and then square grids of 50 mm were drawn to facilitate the observation of crack propagation.

3. Results and Discussions

3.1. E Concentrically loaded column

There were four specimens of concentrically loaded column. The first specimen, KN, was reinforced concrete column without adding angle steel shape as the reference specimen. The second specimen, KSK-50, was reinforced concrete column embedded with angle steel shape and stiffener spacing of 50 mm. The third specimen, KSK-100, was reinforced concrete column embedded with angle steel shape and stiffener spacing of 100 mm. The fourth specimen, KSK-150, was reinforced concrete column embedded with angle steel shape and stiffener spacing of 150 mm.

Comparing the maximum load among the concentrically loaded column specimens can be seen in Table 1.

Table 1. Maximum load of concentrically loaded column specimens [3].

Specimen	Maximum load (kg-f)
KN	6603.2388
KSK-50	20499.4020
KSK-100	22156.6780
KSK-150	18863.0780

Table 1 shows that compare to the reference specimen (KN), the increment load of specimen KSK-50, KSK-100, and KSK-150 were 210.4447 %, 235.5426 %, and 185.6640 %, respectively. Among KSK-50, KSK-100 and KSK-150, it can be seen that the specimen of KSK-100 gave the highest increment load. As Basuki [1] stated that the closer spacing of the couple plates on the column, the stiffer the column. It means that it would gave better confinement if the spacing of couple plates as close as possible. So KSK-50 would gave better strength than KSK-100. However, in this research KSK-100 gave a little bit higher strength than KSK-50, it might be due to the compressive strength of concrete of KSK-100 was a little bit higher than KSK-50.

The crack propagation of the concentrically loaded column can be seen in Fig. 4(a). The first crack will be occurred at the near both supports. After that, the crack propagated to the mid span of the specimen until the specimen was failure. Local buckling of the angle steel shape also occurred at the near support as shown in the Fig. 4(b).

(a) (b)

Fig. 4. (a) Crack propagation of concentrically loaded column; (b) Local buckling of angle steel shape of concentrically loaded column.

3.2. Eccentrically loaded column

Four specimens of eccentrically loaded columns were tested in this experimental program. The first specimen, KN, was reinforced concrete column without adding angle steel shape as the reference specimen. The second specimen, KSV-50, was reinforced concrete column embedded with angle steel shape and stiffener spacing of 50 mm. The third specimen, KSV-100, was reinforced concrete column embedded with angle steel shape and stiffener spacing of 100 mm. The fourth specimen, KSV-150, was reinforced concrete column embedded with angle steel shape and stiffener spacing of 150 mm.

The maximum load and deflection of each specimen can be seen in Table 2.

Table 2. Maximum load and deflection of eccentrically loaded column specimens [4].

Specimen	Maximum load (kg-f)	Deflection (mm)
KN	1714.010	8.3192
KSV-50	3180.529	8.4002
KSV-100	2308.252	7.0146
KSV-150	2450.141	11.3284

Table 2 shows that compare to the reference specimen (KN), the increment load of specimen KSV-50, KSV-100, and KSV-150 were 85.5607 %, 34.6697 %, and 42.9479 %, respectively. Among KSV-50, KSV-100 and KSV-150, it can be seen that the specimen of KSV-50 gave the highest increment load. This can be explained that KSK-50 had the closest spacing of couple plates. It means that the KSK-50 had better confinement compare to others, therefore it gave higher capacity. The relationship of load and deflection of specimen KSV-50 can be seen in Fig. 5.

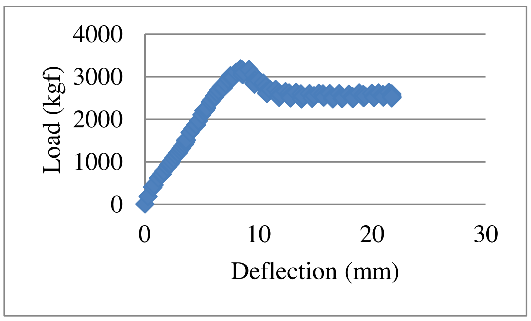


Fig. 5. Load-deflection relationship of specimen KSV-50.

Fig. 5 shows that the curve was increasing almost linearly until reaching the maximum load, after that the curve was decreasing nonlinearly with increasing deflection, and proceeded with a section of horizontal curve prior to collapse. The crack propagation of the eccentrically loaded column can be seen in Fig. 6(a) and (b). Generally, the first crack was occurred at the outer tension fiber of column near to the support. As the load increased, the crack propagated to across the column up to compression fiber, then failure.

(a) (b)

Fig. 6. (a) Crack pattern of the specimen KSV-50; (b) Crack pattern of the specimen KSV-150.

4. Conclusions

Based on the obtained experimental results, the following conclusions can be drawn:

1. Angle steel shapes embedded to the reinforced concrete column with plate stiffeners can increase the strength, both for concentrically loaded column as well as eccentrically loaded column.
2. Compare to the reference column, the increment load of concentrically loaded column embedded with angle steel shape with stiffener spacing 50 mm, 100 mm, and 150 mm were 210.4447 %, 235.5426 %, and 185.6640 %, respectively.
3. Compare to the reference column, the increment load of eccentrically loaded column embedded with angle steel shape with stiffener spacing 50 mm, 100 mm, and 150 mm were 85.5607 %, 34.6697 %, and 42.9479 %, respectively.
4. The relationship of load-deflection curve was increasing almost linearly until reaching the maximum load, after that the curve was decreasing nonlinearly with increasing deflection, and proceeded with a section of horizontal curve prior to collapse.
5. The concentrically loaded column embedded with angle steel shape was failure initiated with crack at the near support together with local buckling of the angle steel shape. While eccentrically loaded column embedded with angle steel shape was failure initiated with crack at the outer fiber near to the support, then it propagated across the column up to compression fiber.

Acknowledgements

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