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BEHAVIOR OF PRECAST BEAM CONNECTIONS FOR SEISMIC-RESISTANT HOUSES UNDER CYCLIC LOADING

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ABSTRACT

Connections of structural members are very important elements in the design and construction of seismic-resistant buildings. The quality of the connection governs the failure or collapse of a building. Idealization of the design and behavior of Beam Connections (BC) in precast buildings is very crucial in providing a sound and ductile structure. Precast concrete system has several advantages for its construction quality particularly in terms of material due to its manufacturing process with better quality assurance and control in the making process. Other advantages are faster installation, and more practical in construction process.

One of the structural members in a building structure is a beam. The beam is mainly intended to resist the internal bending moments which may cause tension failure and the internal shear forces that can lead to abrupt brittle failure. Hence, this study concentrated on the behavior of beam's precast connection in seismic-resistant houses. The connection was a dry connection. The advantages of using dry connection are very quick and simple in installation without any casting during construction process. The dry connection system uses bolted steel rods to connect between beam members and beam stubs.

Specimen BK 1 (single-story house) produced good ductility. From the experimental testing, this specimen has provided full ductility. On the other hand, Specimen BK 2 (two-story house) produced limited ductility and specimen can be considered to have limited ductility.

Keywords: beam, cyclic loading, dry connections, precast concrete, seismic-resistant houses.

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1. INTRODUCTION

Indonesian territory has a relatively high seismic activity. The impact caused by these earthquakes is the collapse of casualties and the collapse of most buildings, especially residential. Most of the houses that collapsed is a house built without reinforcement structures such as sloof, columns, ring beams of reinforced concrete, materials that do not meet the standards and many houses are built without following the rules and concepts of seismic-resistant design of existing buildings (Wibowo).

To help the homeless victims, the government should immediately provide assistance in the form of houses that can be built quickly so victims can return to normal activities. To overcome this problem, so in this study from the proposed houses seismic-resistant precast concrete.

Precast concrete system has several advantages such as quality and more reliable materials for the manufacturing process with excellent work quality control, faster installation time and the practical, concrete can be exposed directly without the need for finishing first (www.ruk.web.id). Also, do not have to worry that the use of precast elements will be expensive, because considering the precast elements can be mass produced and uniform so that the elements in large quantities can be directly printed and assembled in the field to create house all types in large quantities within brief. Because it can accelerate implementation time, then definitely it will save costs (Yee, 2001).

One of the structural components of buildings is the beam. Beam to resist bending which causes tension failure and shear loads that can lead to brittle failure. Design shear is of great importance in concrete structures due to the tensile strength of concrete is much smaller than the compressive strength. The behavior of reinforced concrete beams in shear is very different state of collapse with the collapse due to bending. The block was immediately destroyed without any prior warning.

In this research will be conducted experimental tests of a dry joint connection system that uses a bolt steel rods, which are used as joints between precast concrete beams. Excess dry joint was to accelerate implementation time, about 25%-40% when compared with in situ concrete joint (Noorhidana, 2002). The beams connection had an important role in determining the performance of structures, especially in the aspect of ductility that is needed in the design of earthquake resistant buildings.

2. RESEARCH SIGNIFICANCE

In this research, the experimental behavior of precast column connection for earthquake-resistant single-story house and two-story house under cyclic loading. The objectives of this research are to observe the behavior of the connection, including crack pattern/damage at the specimens, plastic hinge location, load-displacement relationship and ductility.

3. EXPERIMENTAL PROGRAM

In the test program, the parameters investigated are dimension, longitudinal bars and anchor bolt. Two precast beam connection for single-story house and two-story house were designed and tested.

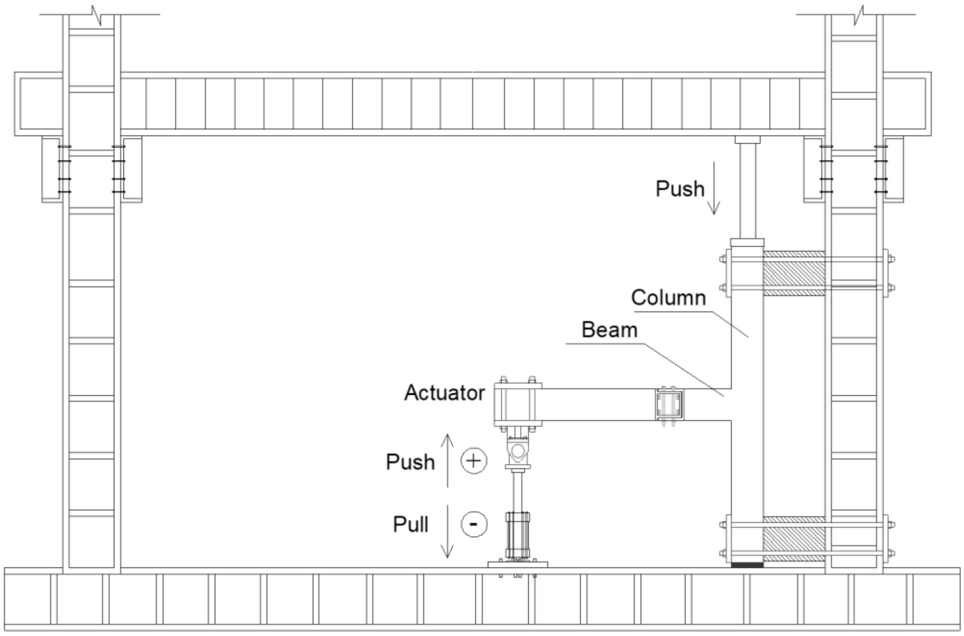


Figure 1. Test Setup for Experimental Study

3.1. Test Setup

Figure 1 shows a schematic view of the setup. Loading frame with axial capacity 1000 KN and lateral capacity of 2000 KN. Data logger recorded measurement from load cell, strain gauges and LVDT. Linier Variable Displacement Transducers (LVDT), to measure displacement occurred at the specimens and at the loading frame during experiment. Strain gauges installed on beam longitudinal rebar, beam transverse rebar, plate and anchor bolt in the concrete.

Quasi static reserved cyclic loading was applied to the specimens in increment, downward for compression and upward for tension, using displacement control system. The displacement sequence for each specimen is given in Figure 2.

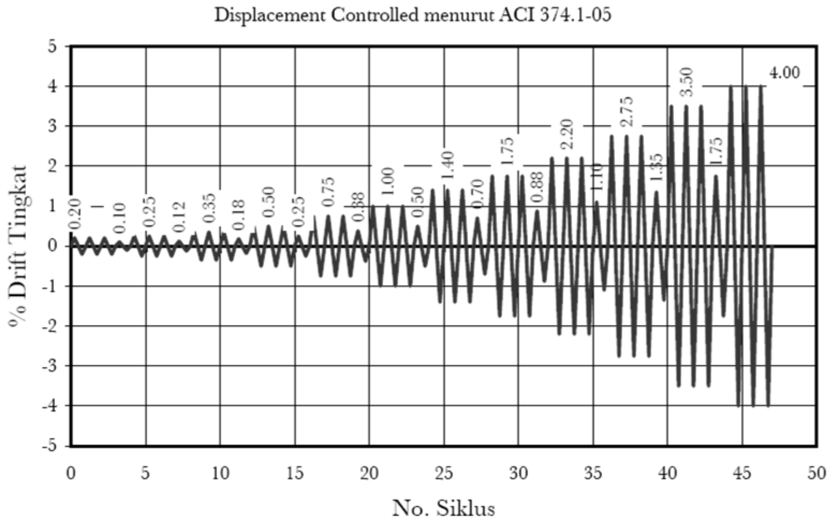


Figure 2. Cyclic Loading

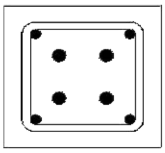
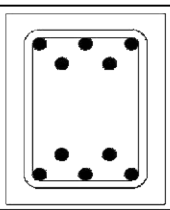
3.2. Specimens

Two specimens were used in this experimental. These specimens differed in beam type and anchor bolt connection. Specimen 1 (BK1) is a beam for single-story house and Specimen 2 (BK2) is a beam for two-story house. The structural dimensions of the specimens are presented in Table 1.

3.3. Material Properties

The average compressive strength of at least 13 concrete cylinders is 24.6 MPa. The steel reinforcement, anchor bolt and steel profile used in this study have a modulus of elasticity (E_s) of 200.000 MPa. The steel reinforcement used are plain rebar of ∅8 mm with f_y = 350 MPa, plain rebar of ∅10 mm with f_y = 384 MPa and deform rebar of 13 mm with f_y = 416 MPa. The steel plate use 10 mm with f_y = 340 MPa. The anchor bolt use 13 mm with f_y = 594 MPa.

Table 1 : Details of test specimens

Specimen	Configuration	Axial Force	Dimension	Concrete Cover	Long. reinforcement	Trans. reinforcement	Anchor Bolt	Plate Thickness
		(kN)	(mm)	(mm)	Size and number	Size and spacing	Size and number	(mm)
BK 1		11.772	150 x 150	25	10 No. 4	8 at 50	13 No. 4	10
BK 2		88.29	150 x 200	25	13 No. 6	8 at 50	13 No. 4	10

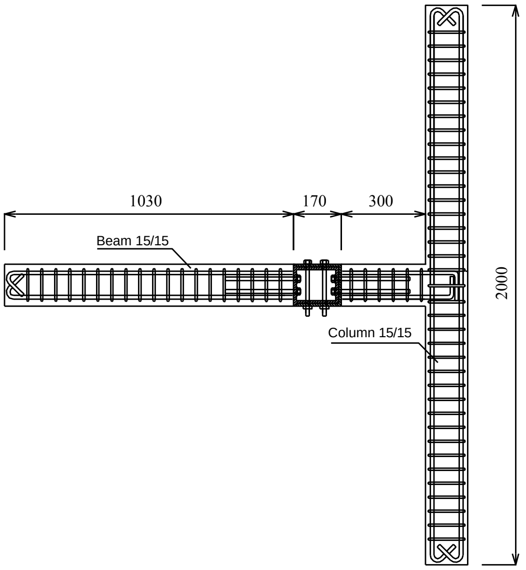


Figure 3. Specimen BK1

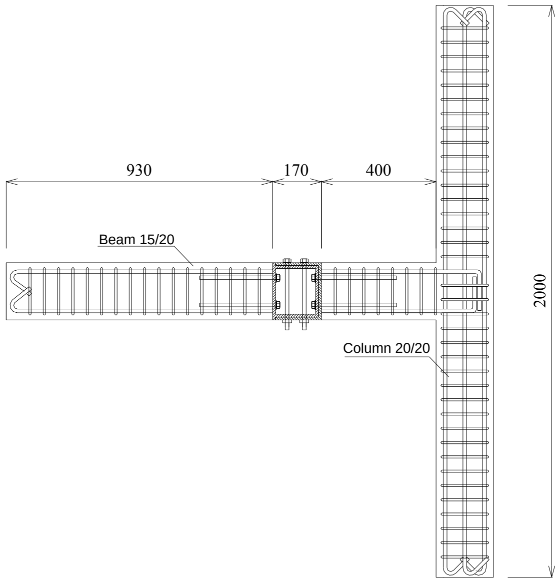


Figure 4. Specimen BK2

4. TEST RESULT

4.1. General behavior

The behavior of the column can be presented by lateral load H versus lateral displacement Δ curve. Typical lateral load-displacement curves are shown in Figs. 7 and 8. In all specimens, first crack occurred around beam column joint.

4.2. Crack pattern

First crack in the specimen BK 1 occurs when push load at 1.33 KN that occurred in the area 1A beam and the first crack of the pull load when the load at 1.51 KN that occurred in the area 1C beam. The crack pattern of specimen BK 1 at the end of the loading can be seen in Figure 5.

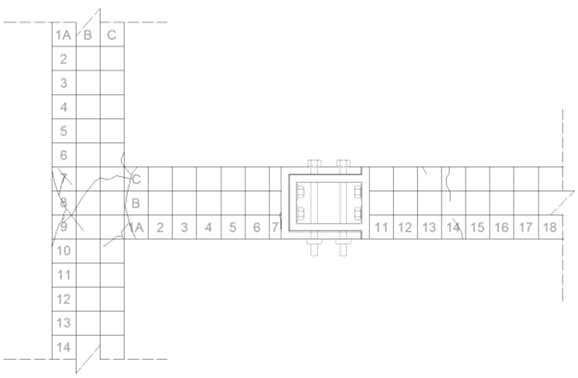


Figure 5. Crack pattern for BK 1

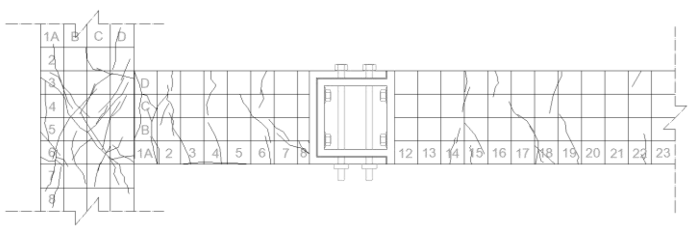


Figure 6. Crack pattern for BK 2

First crack in the specimen BK 2 occurs when pull load at 2.53 KN that occurred in the area 2D beam and the first crack of the push load when the load at 3.96 KN that occurred in the area 2A beam. The crack pattern of specimen BK 2 at the end of the loading can be seen in Fig. 6.

4.3. Load-displacement relationship

Maximum load for specimen BK 1 while push load is 4.18 KN occurred at Δ = 71.22 mm (drift 5.28%) and maximum load while pull load is 3.4 KN occurred at Δ = 71.22 mm (drift 5.28%)

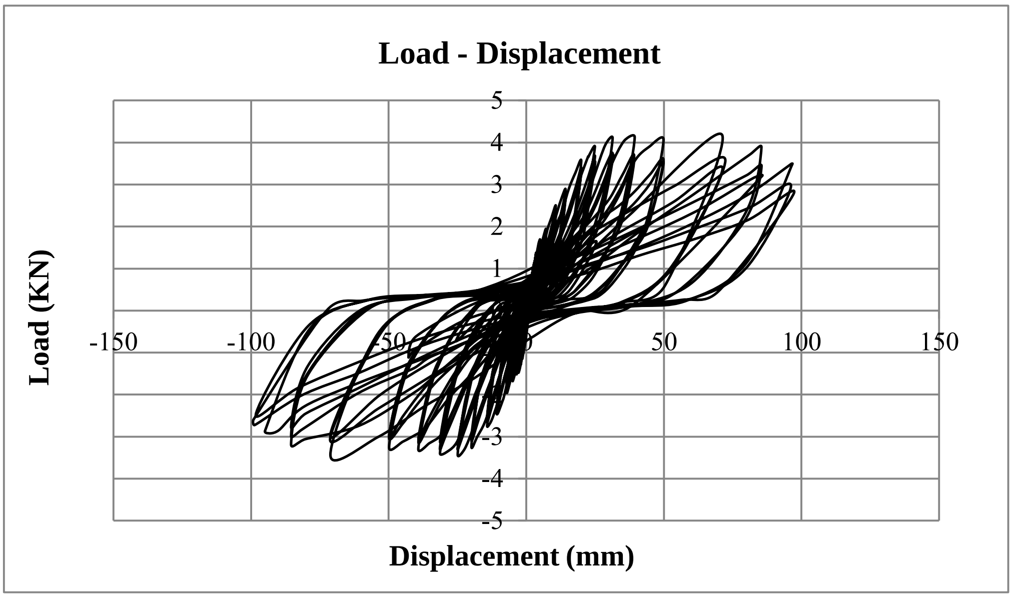


Figure 7. Hysteretic Curve Load-Displacement relationship specimen BK 1

Maximum load for specimen BK 2 while push load is 15.96 KN occurred at Δ = 72.62 mm (drift 5.38%) and maximum load while pull load is 12.77 KN occurred at Δ = 91.44 mm (drift 6.77 %)

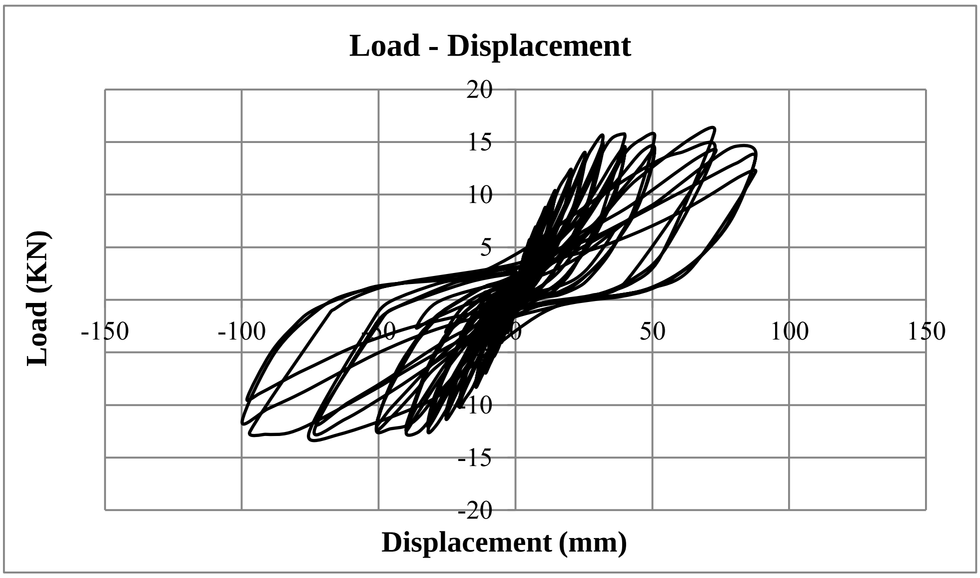


Figure 8. Hysteretic Curve Load-Displacement relationship specimen BK 2

4.4. Displacement Ductility

Deflection value of reinforcement is taken as the first yielding of reinforcement experienced when the load 2.86 KN for pushing load with deflection value of Δy = 14.28 mm and 2.43 KN of pulling load with a deflection value of Δy = 10.78 mm. For ultimate displacement while push load is taken from 80 % of peak push load that is 3.34 KN with displacement Δu = 96.58 mm, the obtained value displacement ductility amounted Δμ = 6.76. For ultimate displacement while pull load is taken from 80 % of peak pull load that is 2.74 KN with displacement Δu = 98.23 mm, the obtained value displacement ductility amounted Δμ = 9.11. (shown in Figure 9)

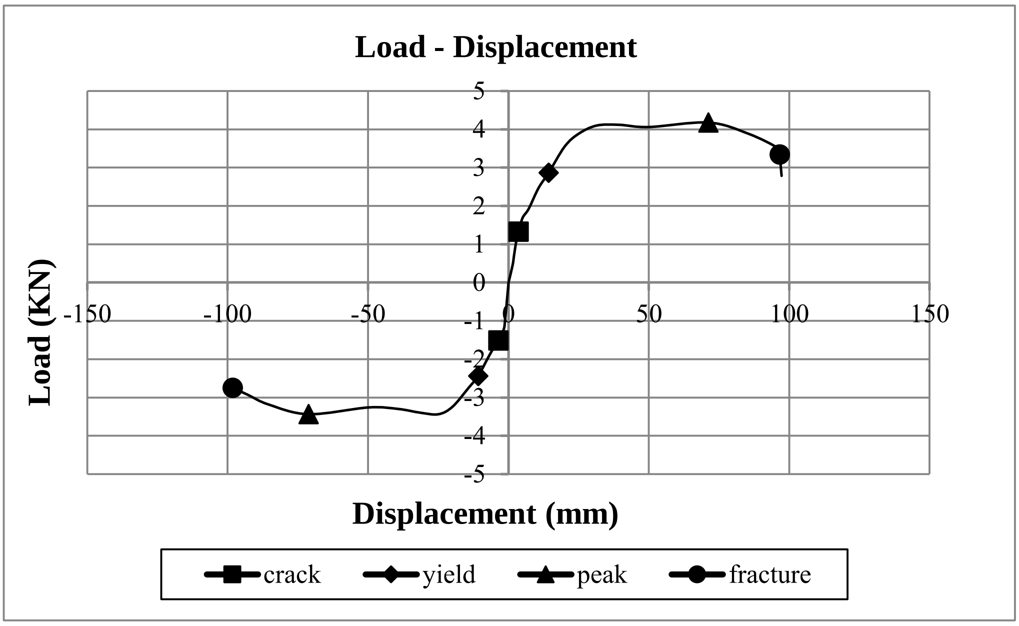


Figure 9. Cyclic Maximum Load-Displacement relationship specimen BK 1

Deflection value of reinforcement is taken as the first yielding of reinforcement experienced when the load 13.85 KN for push load with deflection value of Δy = 25.44 mm and 12.478 KN of pull load with a deflection value of Δy = 31.98 mm. For ultimate displacement while push load is taken from 80 % of peak push load that is 12.77 KN with displacement Δu = 87.58 mm, the obtained value displacement ductility amounted Δμ = 3.44. For ultimate displacement while pull load is taken from 80 % of peak pull load that is 10.22 KN with displacement Δu = 98.79 mm, the obtained value displacement ductility amounted Δμ = 3.02. (shown in Figure 10)

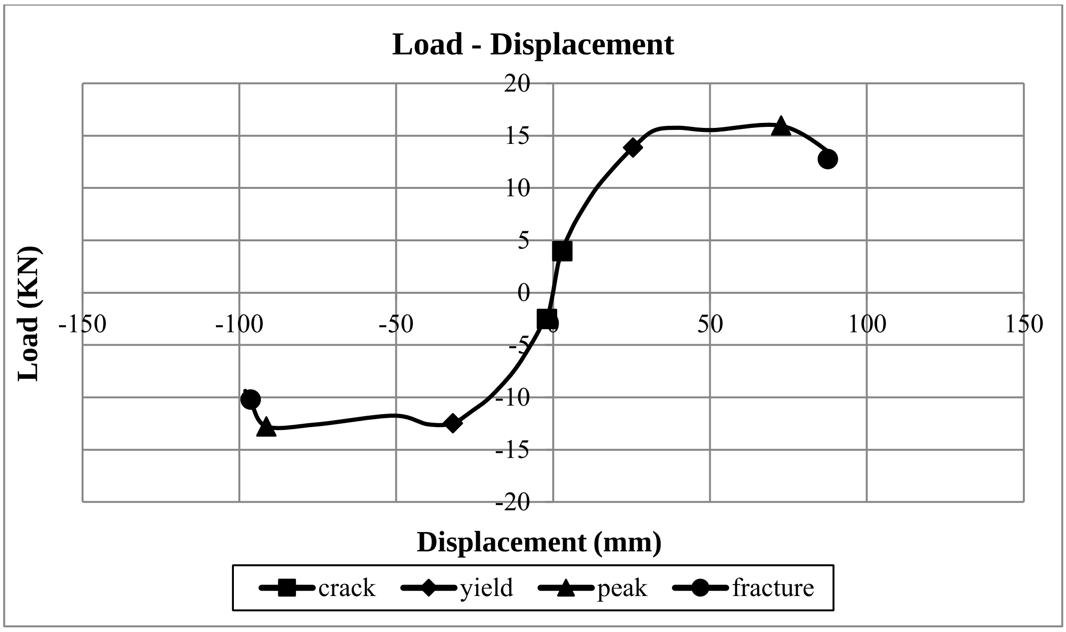


Figure 10. Cyclic Maximum Load-Displacement relationship specimen BK 2

5. CONCLUSIONS

Based on the experimental result, the following conclusions can be made for specimens BK 1 (single-story house). For push load displacement ductility amounted $\Delta\mu$ = 6.76, for pull load displacement ductility amounted $\Delta\mu$ = 9.11. From the test, it can be concluded that the connection to have full ductility. However, for specimens BK 2 (two-story house), it produced limited ductility. For push load displacement ductility amounted $\Delta\mu$ = 3.44 and pull load displacement ductility amounted $\Delta\mu$ = 3.02. The specimen can be considered to have limited ductility. For all specimens, first crack occur around the beam-column joint.

6. ACKNOWLEDGMENTS

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7. REFERENCES

Alfitasari, M., Tavio dan Subakti, A. 2010. “Perilaku dan Perancangan Balok Beton Pracetak untuk Rumah Sederhana Cepat Bangun Tahan Gempa dengan Sistem Rangka Terbuka (Open-Frame)”, Surabaya. Institut Teknologi Sepuluh Nopember.

Abduh, Muhamad. 2007. **Inovasi Teknologi dan Sistem Beton Pracetak di Indonesa : Sebuah Analisa Rantai Nilai**. Seminar dan Pameran HAKI 2007.

Budianto, Tavio dan Iranata, D. 2010. “Perilaku dan Perancangan Sambungan Balok Kolom Pracetak untuk Rumah Sederhana Cepat Bangun Tahan Gempa dengan Sistem Rangka Berdinding Pengisi (Infilled – Frame)”. Surabaya. Institut Teknologi Sepuluh Nopember.

Hoenderkamp, J.C.D., Snijer, Hofmeyer.2005. **Steel Frames with Precast Reinforced Concrete Infill Panels**. Universiteit Eidhoven.

Imran, I., Kamaludin, Hanafiah.1999. Perilaku **Sambungan Antara Elemen Beton Pracetak pada Rangkaian Balok-Kolom Terhadap Beban Lateral Siklik**. Jurusan Teknik Sipil, Institut Teknologi Bandung.

Nawy, E.G, 1986 diterjemahkan oleh Bambang Suryoatmono.1998. **Beton Bertulang Suatu Pendekatan Dasar**. Bandung : PT Refika Aditama.

Noorhidana, V., Saptahari M. Sugiri, Biemo W. Soemardi. 1999. **Analisis Eksperimental Kolom Pracetak *Dry Joint* Akibat Beban Siklik Lateral**.

Park, R. 1990. **Precast Concrete in Seismic-Resisting Building Frames in New Zealand.**

Park, R. 1995. **A Perspective on the Seismic Design of Precast Concrete Structures in New Zealand**. University of Canterbury Christchurch, New Zealand.

Park, R., T. Paulay. 1933. **Reinforced Concrete Structure**. John Wilwy &Sons.

Puslibang Sumber Daya Air. **Peta Zona Gempa Indonesia Sebagai Acuan Dasar Perencanaan dan Perancangan Bangunan**.

SNI 1726-2002. **Standar Perencanaan Ketahanan Gempa Untuk Struktur Bangunan Gedung**.

SNI 2847-2002. **Tata Cara Perhitungan Struktur Beton untuk Bangunan Gedung**.

Trimurtiningrum, R., Tavio dan Subakti, A. 2010. “Perilaku dan Perancanagan Balok Beton Pracetak untuk Rumah Sederhana Cepat Bangun Tahan Gempa dengan Sistem Rangka Berdinding Pengisi (Infilled-Frame)”, Surabaya. Institut Teknologi Sepuluh Nopember.

Wibowo, FX. Nurwadji. **Rumah Tumbuh Satu Lantai Memakai Kanal C Ringan**. Jurusan Teknk Sipil, Univertitas Atma Jaya Yogyakarta.

Yee, A.A. 2001. **Structural and Economic Benefits of Precast/Prestressed Concrete Construction**. PCI Journal July-August.

CERTIFICATE OF ATTENDANCE

ITS Institut Teknologi Sepuluh Nopember

IEEA Indonesian Earthquake Engineering Associ

The 2nd International Conference on Earthquake Engineering and Disaster Mitigation (ICEEDM-II 2011)

"Seismic Risk Reduction and Damage Mitigation for Advancing Earthquake Safety of Structures"

19 - 20 July 2011, Surabaya, Indonesia

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