THE USE OF PRECAST CONCRETE SYSTEMS IN THE CONSTRUCTION OF LOW-COST APARTMENTS IN INDONESIA

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ABSTRACT

The application of precast concrete structural systems have been attaining vast progress worldwide, particularly in Indonesia in the last few decades. This is due to the fact that the precast structural systems possess several advantages compared to monolithic systems, such as quality control, speedy construction, and suitable application to regularly modular systems. In the middle of 2006, the Indonesia Government launched massive and speedy construction of 1000 low-cost apartment towers nationwide. To cope with the enormous need, Indonesian prominent research workers have been developing several precast concrete structural systems.

The paper deals with the research and the application of precast concrete structural systems in Indonesia. The paper also describes the vast development already achieved to date in the applications of the precast concrete structural systems in the constructions of low-cost apartments in Indonesia. The research and applications of precast concrete structural systems are intended to support accelerated construction of one thousand low-cost apartment tower throughout large cities in Indonesia.

KEYWORDS: precast concrete, low-cost apartment.

1. INTRODUCTION

The applications of precast concrete systems have attained accelerated progress worldwide, due to several aspects, such as good quality control, speedy construction, economy, and sound environment pertaining in the precast concrete practices. In Indonesia, the central Government has launched a national movement in 2003, called Gerakan Nasional Pengembangan Sejuta Rumah (GN-PSR). Since initiation of precast research in 1995, several prominent researchers have scored about 22 concrete precast systems applicable to constructions of medium up to high rise apartment buildings.

Till 2006, medium rise apartments have been built, and since 2003, 50 blocks of apartments are targeted yearly, Beginning middle of 2006, the Government launched construction of 1000 low-cost apartment towers, by the issuance of Presidential decree no. 22 in the year of 2006. It is targeted to build 150 blocks of medium rise apartments yearly and 300 blocks of high rise apartments until the year of 2011. To cope with such enormous needs, intensive research works on high rise apartment has been launched. A prototype of the research result was first applied in Pulogebang, East Jakarta. The paper deals with the development of research and application of precast concrete structural systems, both medium and high rise systems already achieved in Indonesia to date.

2. RESEARCH ON PRECAST CONCRETE SYSTEMS IN INDONESIA

Although the application of precast concrete system to multi-storey apartment buildings can be traced back to the construction of apartment building at Sarijadi, Bandung in 1979, significant research on precast concrete building was initiated by founding an association, namely Indonesian Association of Precast and Prestressed Concrete Engineers in 1999. To date, about 22 precast structural systems have been designed, patented and applied nationwide. See Table 1 for explanation. In 2007, Department of Public Works, the Republic of Indonesia has adopted several standards and manuals in the design, testing, fabrications, and handling of precast concrete structural systems.

Table 1 List of precast concrete structural systems in Indonesia

No.	Product Brand	Year	Patent Holder	License Holder
1	Brecast	1979	UK	Not active
2	Cortina	1981	Meksiko	Not active
3	Waffle Crete System	1995	Waffle Crete International (USA)	PT Nusacipta Etikapura
4	Citra Ratu Bearing Wall	1997	Australia	PT Citra Ratu Mulia
5	Column Slab System	1997	JH Simanjuntak	PT JHS Precast Concrete Industri
6	Beam Column Slab System	1998	PT Adhi Karya	PT Adhimix Precast Indonesia
7	All Load Bearing Wall System	1998	PT Adhi Karya	PT Adhimix Precast Indonesia
8	Jasubakim System	1999	Binsar Hariandja & Sjafei Amri	PT Istaka Karya
9	Bresphaka System	1999	Binsar Hariandja & Sjafei Amri	PT Hutama Karya
10	L Shape Wall System	1999	Brycon Internasional (UK)	Not active
11	T-Cap System	2000	Lutfi Faisal, Arief Sabarudin, Binsar Hariandja, Sjafei Amri	PT Pembangunan Perumahan
12	Less Moment Connection System	2002	Binsar Hariandja,Sjafei Amri, Samsu Trihadi,Moresende,Jendri	PT Paesa Pasindo Engineering
13	Wasppico System	2003	PT Pacific Prestressed Indonesia	PT Waskita Karya
14	WR System	2003	PT Wika Realty	PT Wika Realty
15	Spircon System	2004	Lutfi Faisal	PT Nindya Karya
16	PSA System	2004	Prijasambada, Andy K Manik	PT Limadjabat Jaya
17	Sistem Kolom Multi Lantai (KML)	2005	Edenta Simuraya	PT Ultra Jasa Prima Persada
18	Sistem Priska	2005	Prijasambada & PT Istaka Karya	PT Istaka Karya
19	Sistem C-Plus	2006	Sutadji Yuwasdiki	Puslitbang Permukiman
20	Sistem PPI	2007	PT Pacific Prestress Indonesia	PT Pacifiic Prestress Indonesia
21	Sistem PSA V	2007	Prijasambada	PT Pembangunan Perumahan
22	Sistem PSA VI	2007	Prijasambada	PT Mextron Eka Persada

Minimum requirements a precast concrete system has to be fulfilled in order to be applicable in construction field are, among others, the design and patenting, laboratory testing, and mock-up. A seminar will be conducted so as to determine the acceptability of the newly developed system, followed by the issuance of a certificate sanctioned by the Department of Public Works. Concerning the laboratory testing, several aspects pertaining to the newly structural precast systems, are investigated, i.e., the strength, failure mechanism, load-displacement hysteretic loop, and some other factors such load reduction factor R [6,8,9]. In the laboratory testing, earthquake

excitation load should be considered, due to the fact that almost large cities in Indonesia are located in medium up to strong earthquake motion [2]. See Figure 1 as explanation.

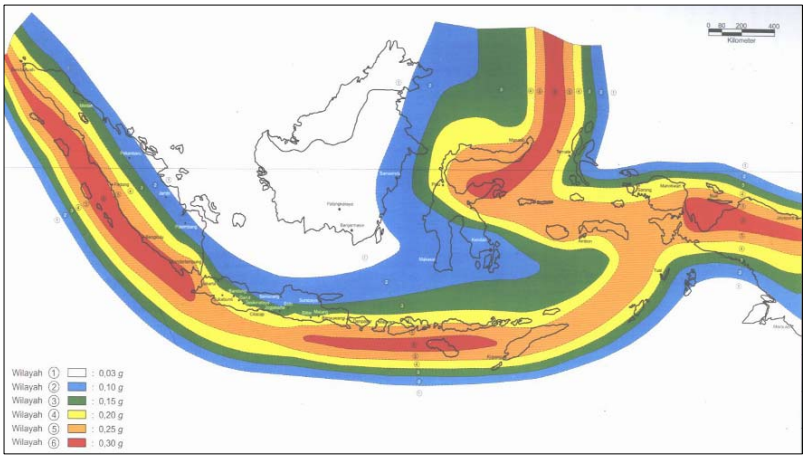


Figure 1: Earthquake zoning map of Indonesia

3. NORMS, STANDARDS, PROCEDURES AND MANUALS

Nowadays, no formal norms, standards, specifications nor manuals concerning precast concrete available for practices in Indonesia. For the time being, practices in the design and field applications are carried out referring to local and foreign standards such as Indonesian concrete code SNI 03-2847-2002, PCI, ACI, AASHTO or UBC codes [1,2,3,4,5,7,10].

Today, National Bureau for Standard (Badan Standard Nasional, BSN) and Research and Development Bureau (Badan Penelitian dan Pengembangan, Balitbang) Department of Public Works undergo programs to establish norms, standards, specifications and manuals concerning precast concrete practices.

4. DESIGN OF MULTI-STOREY PRECAST CONCRETE STRUCTURAL SYSTEMS

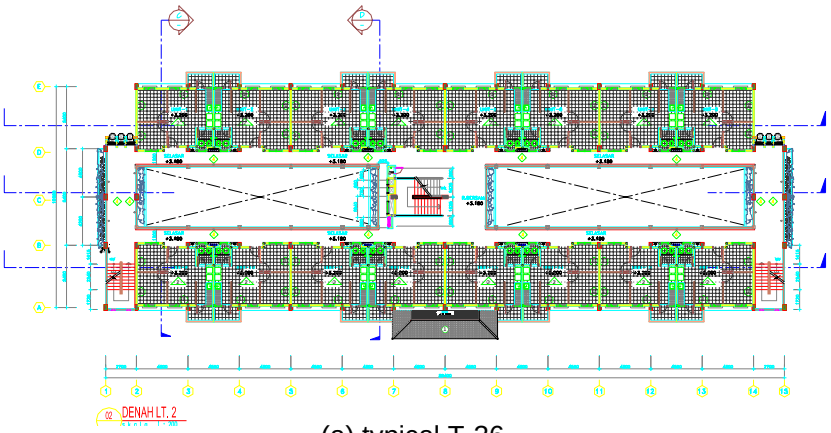
Generally, following engineering practices, design of a multi-storey low-cost apartment is carried out by considering soil condition, dead and live loading, earthquake zoning of the location of construction to determine earthquake excitation load. As far as earthquake loading is concerned, load reduction factors for light, moderate and strong earthquake are taken as R = 5.5, 8.5 and 8.5 respectively [2].

To minimize shape effect, floor plant is managed to be more symmetrical, with aspect ratio not to exceed 3.0. Should ground floor is construed to be an open storey, extra lateral bracing should be provided. See Figure 2 and Figure 3 as explanation.

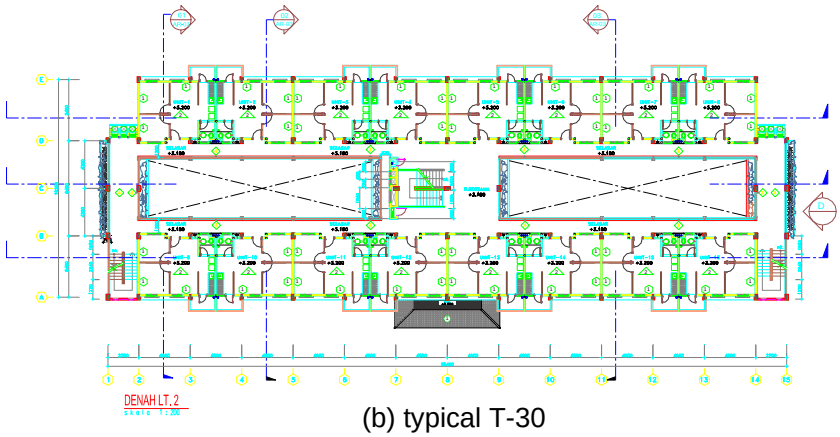
5. APPLICATIONS OF PRECAST CONCRETE SYSTEMS IN INDONESIA

As already mentioned before, the applications of precast concrete structural systems were initiated in 1979 in the construction of Sarijadi low-cost medium rise apartment in Bandung, West Java. The use of waffle-crete system (American patent) in the project of Cengkareng apartment in 1995, as shown in Figure 4 and 5, has ever since ignited the motivation of Indonesian engineers to design and discover several precast concrete structural systems already tabulated in Table 1. It should be brought to mind that with the total population of Indonesia about 250 millions, and an estimated 1.0 percent rate of annual birth and an assumption of 4 persons per family,

about 600,000 units of housing are needed to construct annually, not to mention the back-log and restorations that has ever been accruing annually.



(a) typical T-36



(b) typical T-30

Figure 2: Typical symmetrical floor plan

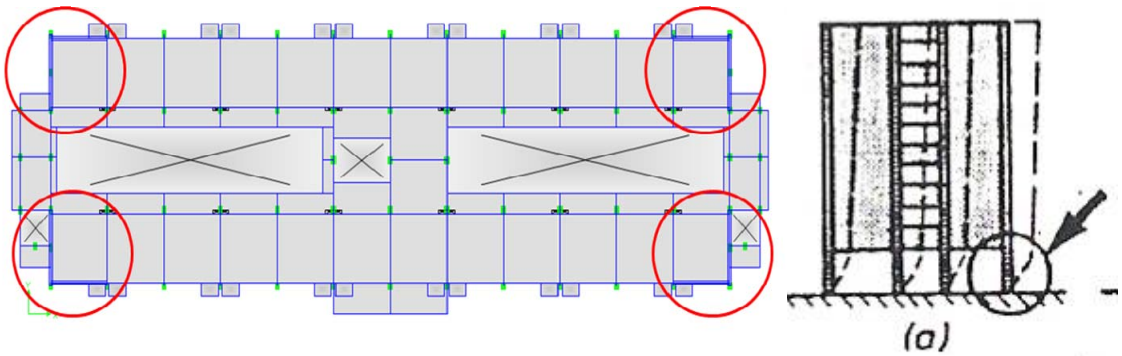


Figure 3: Lateral bracing for soft storey

Figure 4: Cengkareng low-cost apartment, inspected by the late President Soeharto in 1995

The initiation of low-cost housing program that carried out at Sarijadi in 1979, was accelerated beginning in 1995. Subsequently, in 2003, low-cost apartment program was initiated by the Directorate of Housing and Settlement, Department of Public Works. Several institutions such as Batam Authority, Pelindo, DKI, Perumnas, Jamsostek, took part in this national housing program.

Kalicode, Yogyakarta

Sleman, Yogyakarta

Sam Ratulangi Univ., Manado

Andalas Univ., Padang

Figure 5: Several apartments that survived strong earthquake in 2004-2008

As far as the low-cost housing program launched by the Directorate of Housing and Human Settlement is concerned, several pilot projects have already completed in 2003-2004, as shown in Table 2 until Table 5. In the era of the new Government (2004-2009), the housing program is administered and carried out by two institutions, i.e., Department of Public Works and State Ministry of Public Housing. The Department of Public Works is held responsible for the restoration of slum settlement region, while State Ministry of Public Housing is held responsible for the construction of low-cost apartments for government employees and workers.

Table 2: Apartment built by Dept. of Public Works, 2003-2004

No	Location	Type	Units	Storey	DED	Constructor
1	Batam I	T27	80	5	2003	2003-2004
2	Batam II	T27	80	5	2003	2003-2004
3	Medan	T27	80	5	2003	2004
4	Jakarta I	T36	80	5	2004	2004-2005
5	Jakarta II	T30	100	6	2004	2004-2005
6	Jakarta III	T30	100	6	2004	2004-2005
7	Jakarta IV	T30	100	6	2004	2004-2005
8	Depok	T21	96	5	2004	2004-2005
9	Tangerang	T21	96	5	2002	2002-2004
10	Karawang	T27	80	5	2003	2004
11	Bekasi	T21	96	5	2004	2004-2005
12	Bogor	T27	80	5	2003	2004
13	Cimahi I	T21	96	5	2003	2003-2004
14	Cimahi II	T21	96	5	2003	2003-2004
15	Surakarta	T21	96	5	2003	2003-2004
16	Jogjakarta	T21	96	4	2003	2003-2004
17	Sleman	T21	96	4	2004	2004-2005
18	Gresik	T21	96	4	2003	2003-2004
19	Surabaya I	T21	96	4	2003	2003-2004
20	Surabaya II	T21	96	4	2003	2003-2004
21	Surabaya III	T21	96	4	2003	2003-2004
22	Surabaya IV	T21	96	4	2003	2003-2004
23	Makasar	T30	80	5	2003	2003-2004

Table 3: Apartment built by Dept. of Public Works, 2005-2005

No.	Location	Storey	Block	Type	System	Contractor
1	Tanjung Balai	5	1	96 unit T 21	Spircon	PT Nindya Karya
2	Pematang Siantar	5	1	96 unit T 21	Adhi BCS	PT Adhimix Precast Indonesia
3	Palembang	5	1	96 unit T 21	Adhi BCS	PT Adhimix Precast Indonesia
4	Marunda - DKI	6	2	100 unit T30	Kolom Multi Lantai	PT Ultra Jasa Persada Prima
						PT Limajabat Jaya JO
5	Parung Panjang Bogor	5	3	96 unit T 21	Priska & PSA	PT Istaka Karya
6	Bogor	5	1	96 unit T 21	LMC	PT Paesa Pasindo Engineering
7	Bandung	5	1	96 unit T 21	PSA	PT Limadjabat Jaya
8	Semarang-Kaligawe/Undip	4	2	96 unit T 21	Waffle Crete	PT Nusacipta Etikapura
9	Yogyakarta-UGM	4	1	96 unit T 21	JHS Column Slab	PT Nusacipta Etikapura
10	Sidoardjo	4	1	96 unit T 21	JHS BCS	PT JHS PCI
11	Surabaya	4	2	96 unit T 21	Adhi BCS	PT Adhi Karya
12	Entikong	5	1	96 unit T 21	PSA-PAESA	PT Paesa Purna JO
13	Nunukan	4	1	96 unit T 21	PSA	PT BKK Surya Konstruksi-
						PT Limajabat Jaya JO
14	Mariso-Makasar	5	3	96 unit T 21	PSA-PAESA	PT Paesa Pasindo Engineering
15	Jayapura	5	2	96 unit T 21	Bresphaka	PT Hutama Karya

Table 4: Apartment built by State Ministry of Housing, 2005-2006

No.	Location	Storeys	Blocks	Type	System	Contractor
1	Batam	5	2	96 unit T 21	JHS Column Slab/PSA	PT JHS PCI
2	Medan	4	2	96 unit T 21	Modified-T Cap	PT Pembangunan Perumahan
3	Bandung	5	1	96 unit T 21	PSA	PT Limajabat Jaya
4	Semarang - Undip	4	1	96 unit T 21	Bresphaka	PT Hutama Karya
5	Yogyakarta -UII	4	1	96 unit T 21	Bresphaka	PT Hutama Karya
6	Surabaya	5	2	96 unit T 21	Precon	PT Waskita Karya
7	Nunukan	4	1	96 unit T 21	PSA	PT Jaya Konstruksi
8	Makasar - UMI	4	1	96 unit T 21	WR System	PT Wijaya Karya
9	Manado - UNSRAT	4	1	96 unit T 21	Adhi BCS	PT Adhi Karya

Table 5: Apartment built by the Provincial Government of Jakarta

No.	Location	Storeys	Blocks	Type	System	Contractor
1	Cilincing (1996)	6	4	756 unit T21/28	Waffle Crete	PT Nusacipta Etikapura
2	Sindang,Koja (1999)	6	3	292 unit T 21/T30	Waffle Crete	PT Nusacipta Etikapura
3	Tipar Cakung (2003)	6	10	1000 unit T 30	Modified-T Cap	PT Pembangunan Perumahan
						& PT Jaya Konstruksi
4	Muara Angke (2004)	6	6	600 unit T 36	JHS BCS	PT Raka Utama
5	Kapuk Muara (2005)	6	6	600 unit T 30	JHS BCS/U Shell	PT Jaya Konstruksi
6	Marunda (2005)	6	2	200 unit T 30	U Shell	PT Pembangunan Perumahan
7	Pondok Bambu (2005)	6	2	200 unit T 30	U Shell	PT Pembangunan Perumahan
8	Jatirawasari (2005)	6	2	200 unit T 21/T30	Adhi BCS	PT Bangun Kharisma
9	Pegadungan (2005)	6	2	200 unit T30	Priska	PT Istaka Karya

In private sector, several prominent realtors have already joined the apartment project, especially for middle up to high income people. Other institutions such as P.T. Pelindo, Perum Perumnas, Budha Tzu Chi have also participated in the development of housing facilities.

It is worth mentioning that after earthquake and tsunami disaster, the rehabilitation of housing facilities dictates that strong and yet fast and low-cost housing facilities are badly needed in that region. Similarly, earthquake disaster in Yogyakarta requires low-cost housings. Several applications of precast concrete structure in part have provided such needed facilities.

6. CONCLUSIONS

Applications of precast concrete structural systems for the construction of low-cost apartments have gained vast progress worldwide, and so to speak, in Indonesia as well. This is due to the fact that precast concrete systems have several advantages compared to the conventional cast-in-situ concrete systems. This fact has been utilized by the Government of Indonesia, to implement an accelerated progress in the development of public housing facilities, in particular, low-cost rental and owned apartments.

To support the massive program, the Government of Indonesia has already launched a national moratorium on housing construction, referred to as GN-PSR. About 1000 low-cost apartment towers are expected to build in the period of 2003-2011. This program is backed up by the applications of about 22 precast concrete structural systems that already applied thus far.

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