

CREATIVE

INNOVATIVE

PROFESSIONAL



**PELATIHAN KOMPETENSI TAMBAHAN  
PERGURUAN TINGGI LINK AND MATCH  
PENDIDIKAN VOKASI DAN DUNIA KERJA**



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(Ketua Umum IAPPI)

**PEKERJAAN PEMBESIAN DAN  
PERANCAH**



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5. SISTEM PRODUKSI
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7. SISTEM PEMASANGAN DAN PENYAMBUNGAN
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9. PENERAPAN
10. PENUTUP

# 1. PENDAHULUAN

- LATAR BELAKANG
- PERMASALAHAN
- SISTEM PRACETAK TAHAN GEMPA SEBAGAI SOLUSI TEKNOLOGI PEMBANGUNAN RUMAH SUSUN SEDERHANA

# LATAR BELAKANG

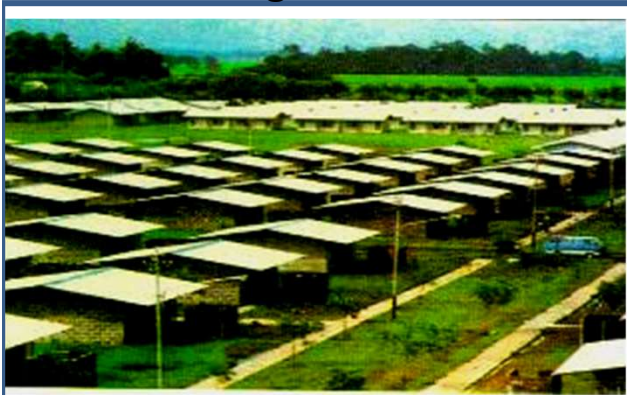
- Jumlah penduduk Indonesia saat ini berkisar 250 juta jiwa, dan dengan perkiraan pertumbuhan penduduk 1% per tahun dan dengan asumsi rata-rata 4 orang per keluarga, maka diperlukan pembangunan perumahan baru sebanyak 60.000 unit per tahun, belum lagi memperhitungkan backlog sekitar 5.8 juta units and perbaikan rumah yang semakin lama juga semakin meningkat
- Kemampuan dari masyarakat berpenghasilan rendah semakin menurun sedangkan harga rumah naik sesuai dengan mekanisme pasar.
- Pada daerah perkotaan makin mahal dan sempitnya tanah mengakibatkan permukiman bergeser ke luar kota atau terciptanya lingkungan kumuh di perkotaan.
- Permukiman yang bergeser ke luar kota menyebabkan okupasi daerah-daerah subur pertanian, banyaknya waktu terbuang dalam transportasi, borosnya penggunaan bahan bakar dan turunnya produktifitas.
- Permukiman kumuh di perkotaan menyebabkan permasalahan lingkungan, kesehatan dan sosial.



meningkatnya kawasan kumuh



permukiman bergeser ke luar kota



Okupansi lahan subur



Pemborosan waktu dan bahan bakar

Solusi : Rumah Susun Sederhana di daerah perkotaan yang strategis dikombinasikan dengan sistem transportasi ma:



# Permasalahan

- Banyak kota-kota besar di Indonesia terletak di daerah gempa dan tanah lunak. Pengalaman selama ini menunjukkan banyak bangunan gedung yang tidak memenuhi persyaratan teknis sehingga mengalami kerusakan parah atau keruntuhan yang sering menimbulkan kerugian harta dan jiwa ketika terkena gempa
- Teknologi pembangunan haruslah tahan gempa, waktu konstruksi cepat, kontrol kualitas yang baik, ekonomis, ramah lingkungan

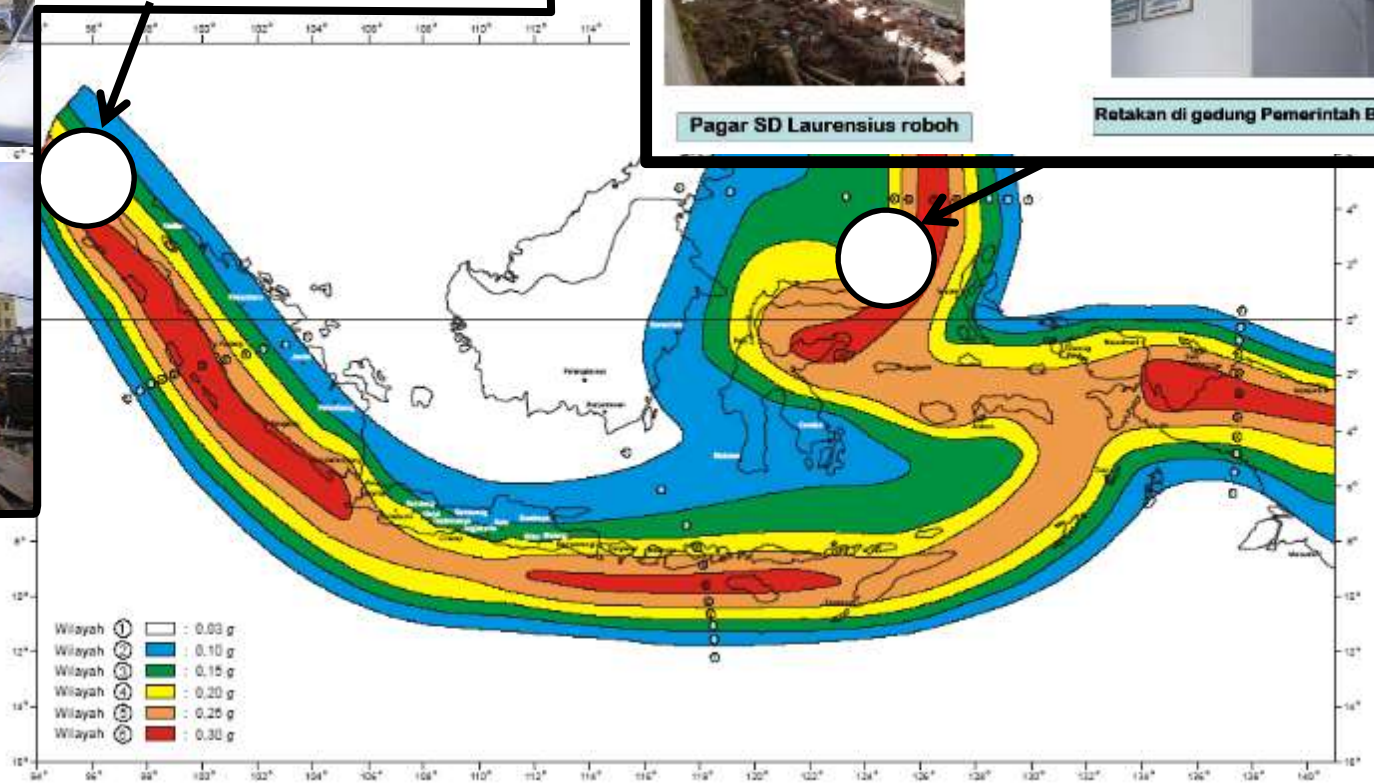




Banyak Kerusakan disebabkan tsunami



Gempa Aceh  
26 Desember 2004  
M = 8.9



Gempa manado 21 Januari 2007

M=6.5  
I = VI MMI

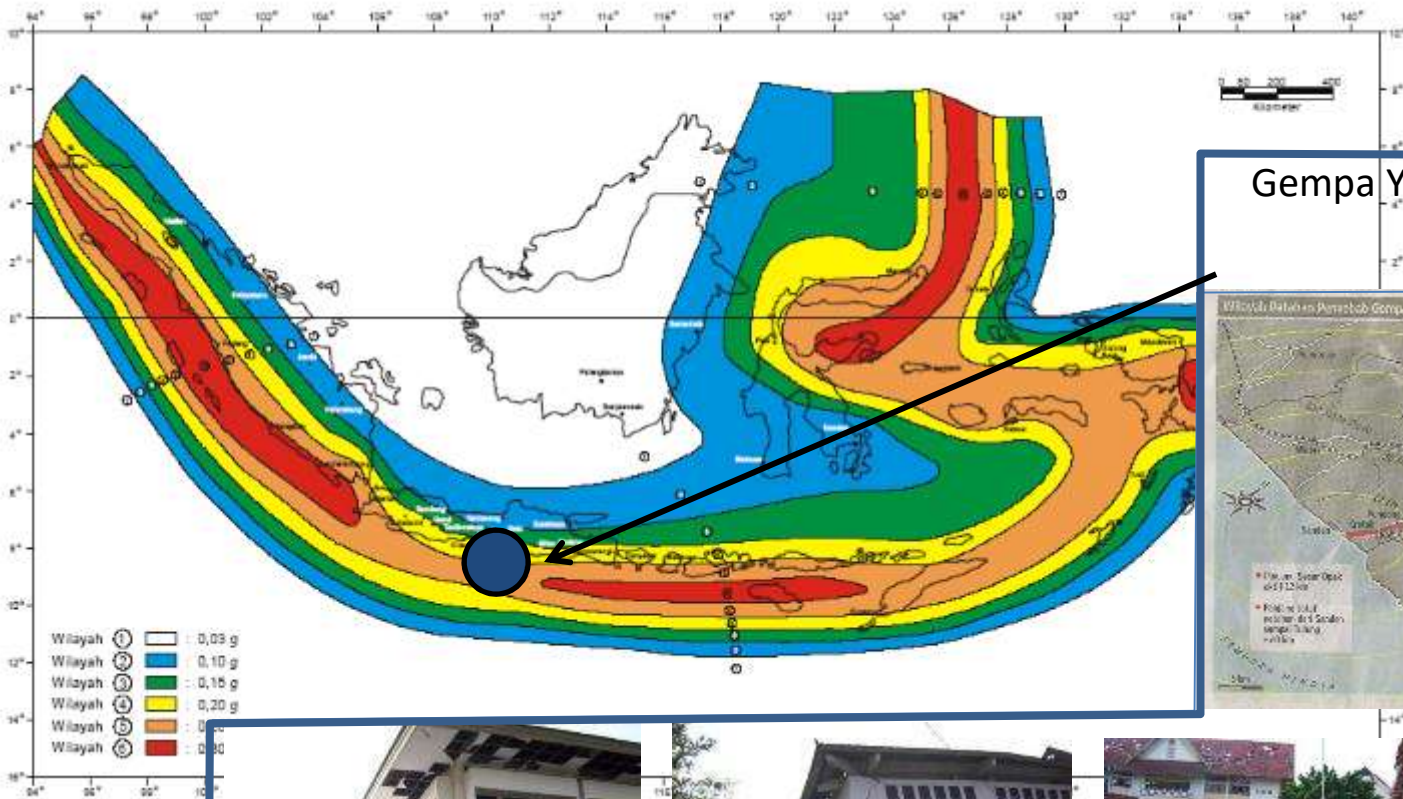
Retakan di salah satu hotel

Retakan di salah satu Dept Store

Pagar SD Laurensius roboh

Retakan di gedung Pemerintah Bitung





## Gempa Yoga 27 Mei 2006 M=6.2



Disebabkan sesar Opak



Keruntuhan akibat efek soft storey pada lantai dasar

Bangunan disampingnya selamat!

Bentuk bangunan yang tidak teratur baik dalam denah dan ketinggian

Kegagalan akibat tidak dipenuhinya persyaratan teknis bangunan

Kesalahan konsep desain bangunan tahan gempa



Kurangnya sengkang di kolom



Tidak terpasang sengkang di







Menyebabkan kegagalan bangunan



Kegagalan akibat soft storey effect

14/03/2007

Kesalahan konsep perencanaan bangunan tahan gempa



Jumlah sengkang yang kurang dan detail yang salah



Detail konstruksi yang salah

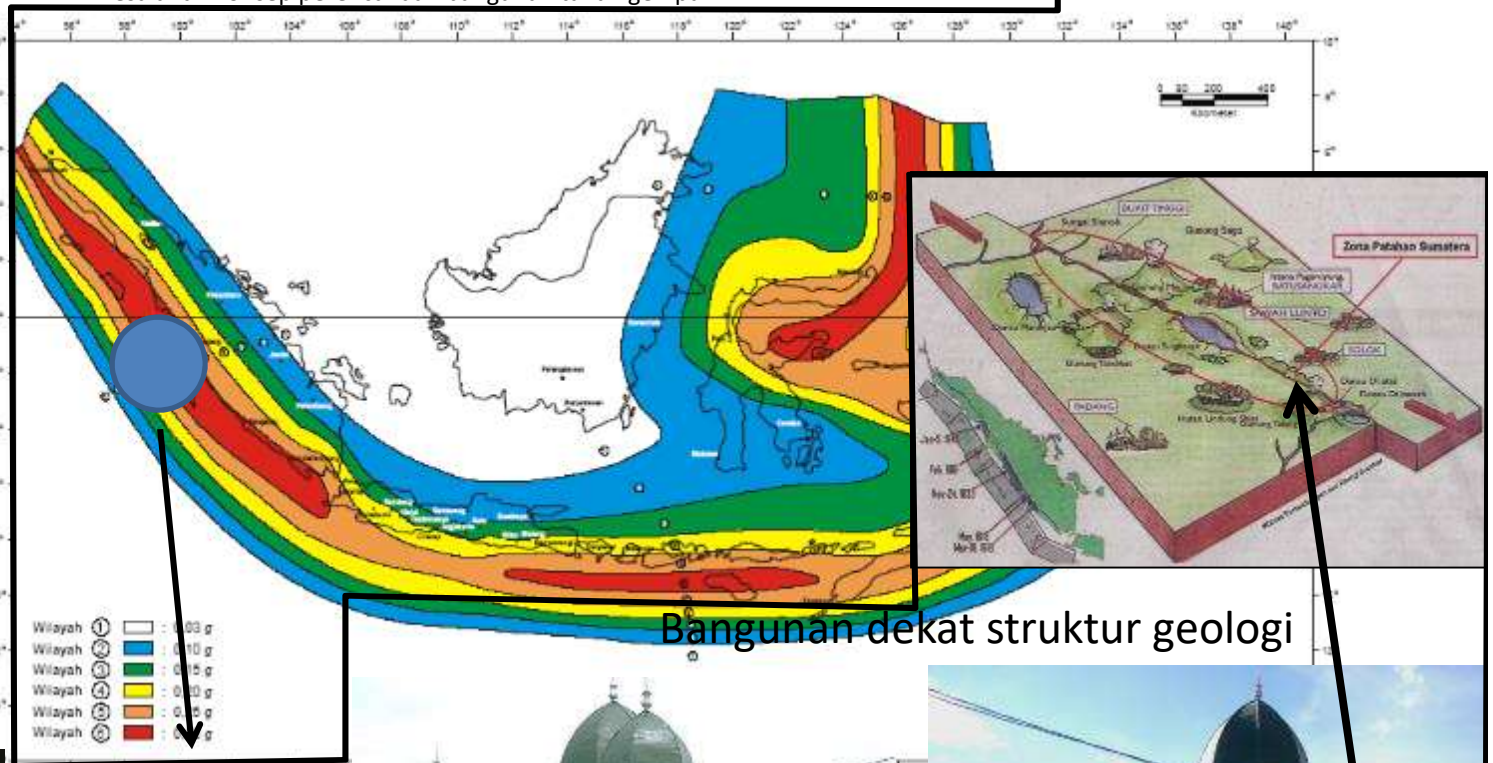
Detail hubungan kolom-pondasi yang salah

13/03/2007



Material konstruksi yang buruk

13/03/2007



Bangunan dekat struktur geologi

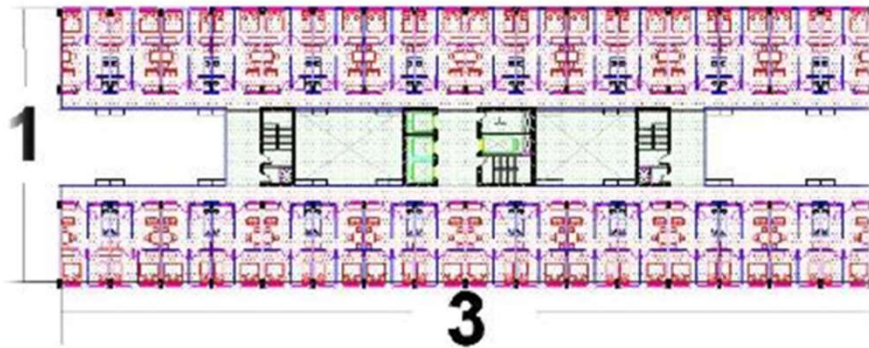
Gempa Sumatera Barat  
6 Mei 2007 (M=6.2) &  
11 September 2007 (M=8.4)



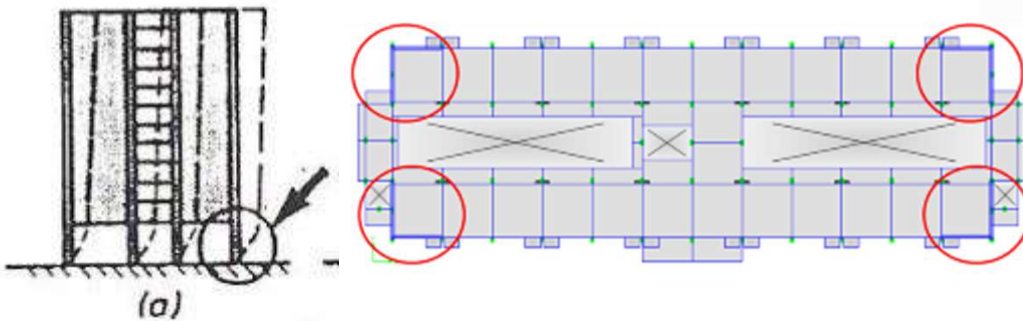


# SOLUSI

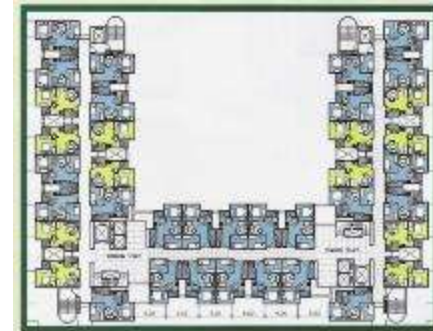
- Solusi untuk mengatasi hal ini adalah teknologi pembangunan dengan menggunakan sistem pracetak tahan gempa
- Sistem pracetak sangat cocok diterapkan pada rumah susun sederhana karena desainnya modular sehingga komponen bangunan dapat dilakukan produksi massal.



(i) Single Loaded Corridor Design



Rasio panjang terhadap lebar dijaga  $< 3$ , dan pada lantai dasar dipasang dinding geser untuk mencegah efek soft storey.



(ii) Double Loaded Corridor Design

# SOLUSI

- Penerapan pertama sistem pracetak pada rumah susun sederhana sebenarnya telah dimulai sejak tahun 1979 di Rumah Susun Sarijadi di Bandung, dan dilanjutkan pada tahun 1980an di beberapa tempat di Jakarta seperti di Klender dan Tanah Abang, Palembang dan Medan



# SOLUSI

- Pada tahun 1995, dicanangkan program pembangunan rusunawa secara massal. Sistem pracetak merupakan pilihan utama dalam metoda konstruksi. Sehubungan dengan program tersebut, dilakukan alih teknologi sistem pracetak di proyek rumah susun sederhana sewa Perumnas di Cengkareng, agar pembangunan rusunawa dapat dilakukan oleh putra-putra bangsa Indonesia sendiri .





# SOLUSI

- Perkembangan penelitian dan pengembangan sistem pracetak yang lebih maju diinisiasi oleh asosiasi profesi Ikatan Ahli Pracetak dan Prategang Indonesia (IAPPI) yang didirikan tanggal 17 Mei 1999 lewat deklarasi yang dikukuhkan oleh Menteri Pekerjaan Umum
- Saat ini ada 22 sistem pracetak yang sudah dikembangkan, dipatenkan dan diterapkan secara luas untuk bangunan bertingkat menengah, dan 8 sistem pracetak untuk bangunan bertingkat tinggi.



# SOLUSI

- Saat ini Departemen Pekerjaan Umum sedang mengadopsi berbagai standar dan manual dalam perencanaan, pengujian, fabrikasi dan pemasangan dari sistem struktur pracetak,



## 2. KLASIFIKASI SISTEM PRACETAK

- Sistem pracetak struktural
  - Sistem rangka penahan momen
    - Komponen kolom
    - Komponen balok
    - Komponen join
    - Komponen pelat
  - Sistem dinding penumpu
    - Komponen dinding
    - Komponen lantai
    - Komponen join
- Sistem pracetak arsitektural
  - Komponen dinding façade
  - Komponen dinding pembatas unit
  - Komponen dinding partisi



## 2. KLASIFIKASI SISTEM PRACETAK



Sistem Rangka  
Penahan Momen

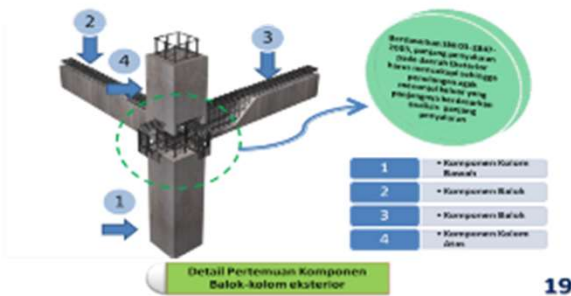
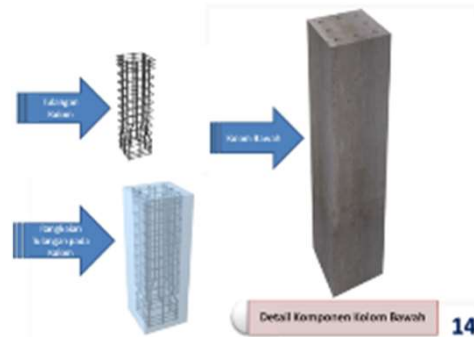


Sistem Dinding Penumpu


### 3. PENGEMBANGAN SISTEM PRACETAK

- Perencanaan sistem dan pendaftaran paten
- Pengujian tahan gempa di laboratorium
- Pembuatan mock-up untuk pengujian kelayakan pelaksanaan sistem di lapangan dan pembentukan tim kerja yang menguasai teknologi pembangunan
- Seminar untuk sosialisasi dan penerimaan publik terhadap sistem yang baru dikembangkan.
- Penerbitan sertifikat dari Pusat Penelitian dan Pengembangan Permukiman Departemen Pekerjaan Umum sebagai bukti pengujian tahan gempa dan sertifikat Ikatan Ahli Pracetak dan Prategang Indonesia untuk bukti pemenuhan pembangunan mock up and seminar.

# Perencanaan dan Pendaftaran Paten



19



US05809712A

**United States Patent** [19] (11) Patent Number: **5,809,712**  
 Simanjuntak (42) Date of Patent: **Sep. 22, 1998**

[54] **SYSTEM FOR JOINING PRECAST CONCRETE COLUMNS AND SLABS** 592128 50159 Nabehachi  
 320139 10174 Nishizaki  
 124034 07121 United Kingdom

[70] Inventor: **Johan Basilio Simanjuntak, Jr.**  
 Darmasraya XII No. 131, Jakarta, Indonesia

[21] Appl. No.: **870486**

[22] Filed: **Jan. 5, 1997**

[10] Foreign Application Priority Data  
 Jan. 6, 1995 [73] Indonesia P 911541

[51] Int. Cl.<sup>6</sup> **E04C 5/06**

[52] U.S. Cl. **52233.7; 52236.8; 52216.9; 52251; 52263; 52283; 52543.1; 52545.1; 52742.14; 52757.12**

[58] Field of Search **52233.7; 216.8; 52235.9; 251; 263; 283; 543.1; 545.1; 742.14; 747.12**

[56] References Cited

U.S. PATENT DOCUMENTS  
 3,502,379 2/1971 Aki-Oya ..... 52236.8 X  
 4,613,325 10/1971 Yoo ..... 52236.8  
 4,240,335 4/1978 Wise ..... 52236.8  
 4,220,970 5/1982 Basak .....

FOREIGN PATENT DOCUMENTS  
 004998 10/1979 Europea Pat. Off.

**ABSTRACT**  
 A precast concrete system is provided that consists of columns and slabs joined together in one point. Each corner of the slab is equipped with a steel pipe mounted on a steel plate that is attached to and covers the top surface of the column. Each column is equipped with high tensile steel reinforcement strands protruding at the top end to penetrate the steel pipes of the four corners of the slab. The steel pipes of the four corners of the slab are attached to the bottom surface of the next column above it, and through the pipes implanted vertically at the lower section of the next column. The implanted pipes are in line with the holes on the base plate. The four steel pipes of four slabs meeting on one column are tied together with high tensile steel wire rope through three holes drilled horizontally at three places of the pipe length upper, middle, and lower sections. The pipes of the slab corners and the gaps between pipes and slabs are filled with a special mortar cement that hardens fast. Then a special mortar cement is injected to the implanted pipes through each pipe's opening on the slab surface of the column.

**7 Claims, 6 Drawing Sheets**

# PENGUJIAN TAHAN GEMPA

- Pengujian tahan gempa dilakukan di Balai Struktur Pusat Penelitian dan Pengembangan Permukiman Departemen Pekerjaan Umum
- Kriteria penerimaan pengujian berdasarkan ACI 374.1-05 *Acceptance Criteria for moment frames based on structural testing* dan *NEHRP 2000 for Acceptance Criteria for bearing wall based on structural testing*
- Pada tahun 2008 Departemen Pekerjaan Umum akan mengeluarkan Standar Nasional Indonesia tentang Metoda Pengujian berdasarkan referensi dan pengalaman yang selama ini telah dilakukan.



# Pengujian tahan gempa



20

Earthquake test of interior precast joint

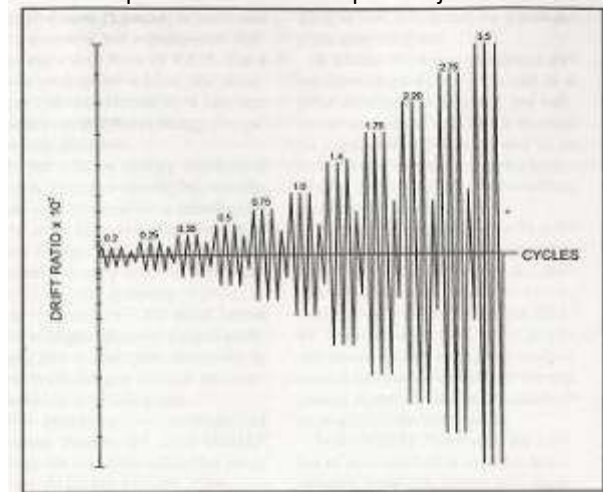


Fig. 5. Cyclic deformation history for validation testing.

Program pembebanan untuk mensimulasi beban gempa. Sambungan sistem harus mampu memenuhi persyaratan sampai simpangan relatif 3.5% untuk dinyatakan sebagai struktur rangka pemikul momen khusus (RPMK).



# Pengujian tahan gempa



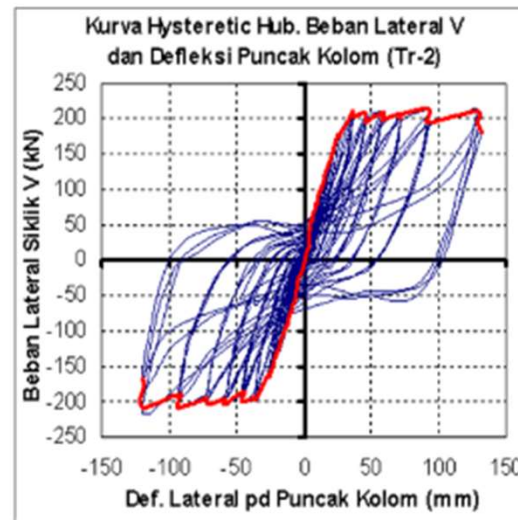
Pengujian Sistem Dinding Penumpu

# PENGUJIAN TAHAN GEMPA

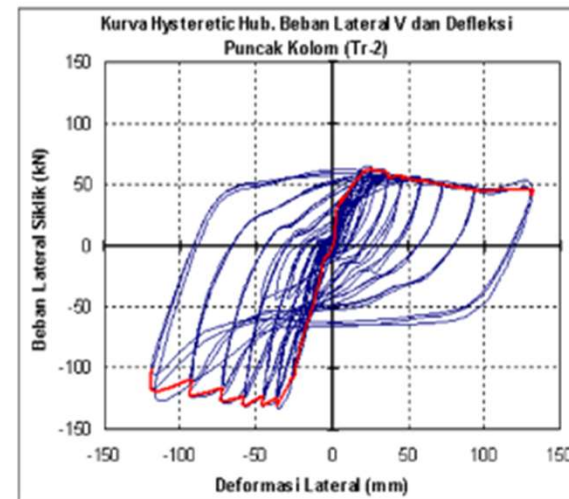
Data riwayat pembebanan  
Beban -  
Perpindahan →

Hasil  
Pengujian  
adalah

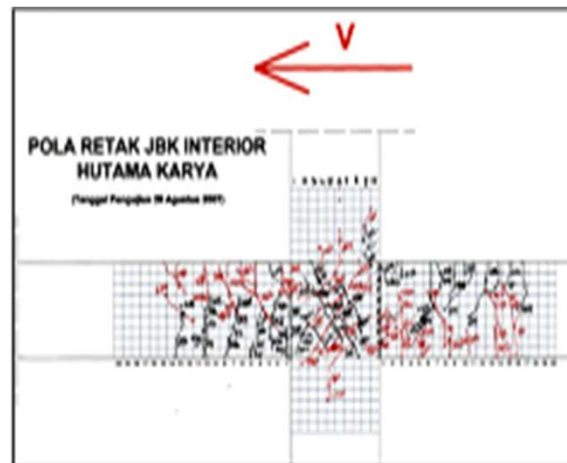
Pola retak yang  
harus  
menunjukkan sifat  
kolom kuat balok  
lemah



Kurva hysteresis beban-deformasi lateral benda uji *joint* balok-kolom interior

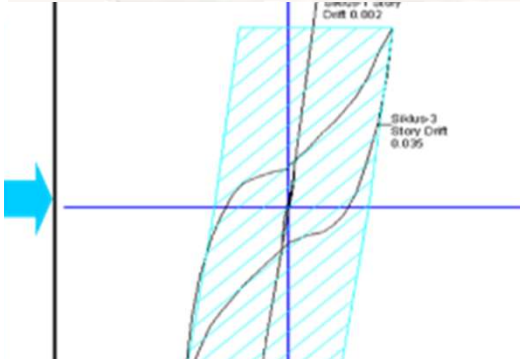
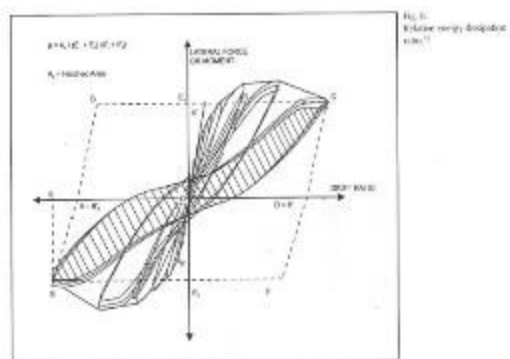
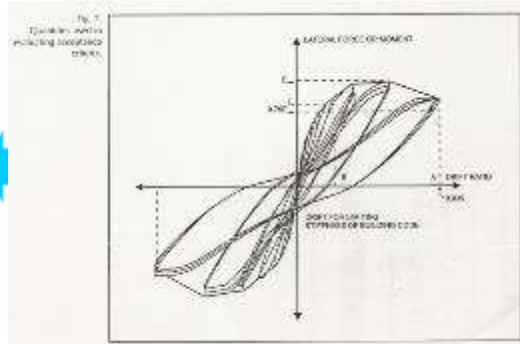
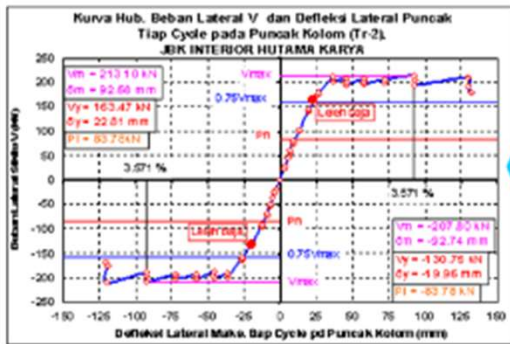


Kurva hysteresis beban-deformasi lateral benda uji *joint* balok-kolom eksterior



# PENGUJIAN LABORATORIUM

Kriteria kekuatan :  $E_{3.5\%}$  (kapasitas pada siklus ketiga simpangan 3.5%)  $>$  75%  $E_{max}$  (kapasitas maksimum)



Kriteria energi disipasi :  $W_{3.5\%}$  (Energi disipasi simpangan 3.5%)  $>$  0.125  $W_{ideal}$  (Energi disipasi ideal)

Jika syarat-syarat ini dipenuhi maka sistem pracetak tersebut dikategorikan Sistem Rangka Penahan Momen Khusus dengan faktor reduksi gaya  $R = 8.5$  sesuai dengan Peraturan Gempa Indonesia SNI 03-1726-2002

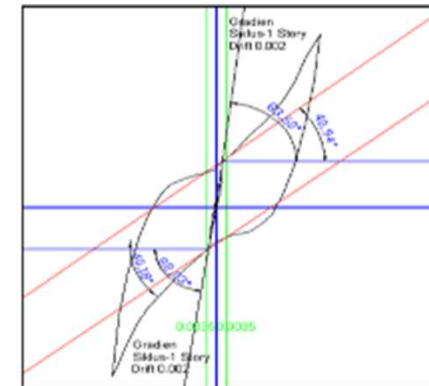
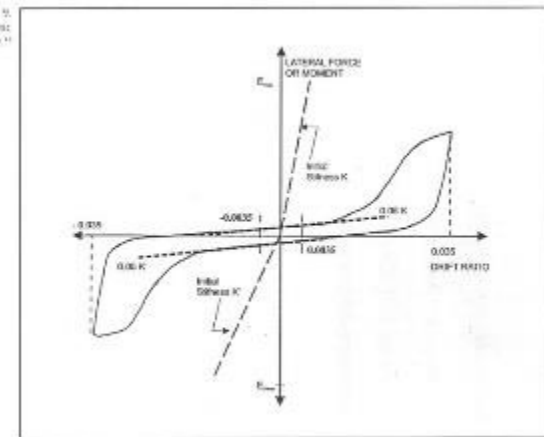


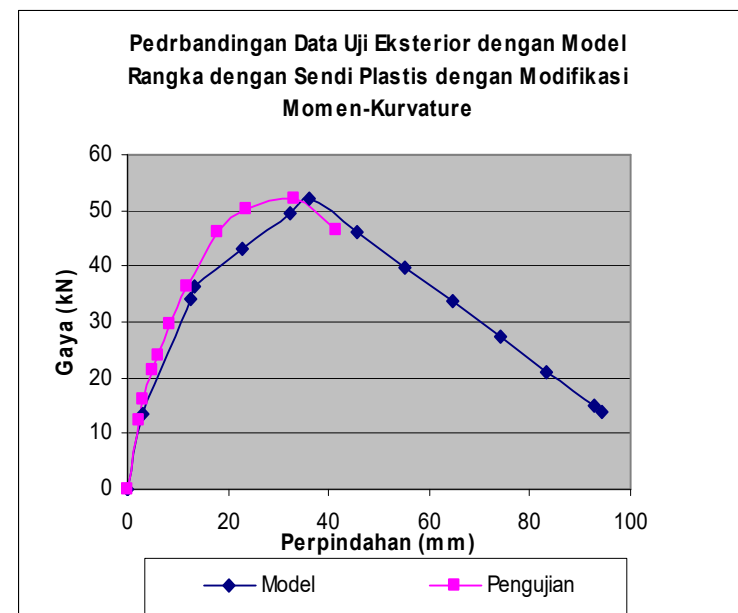
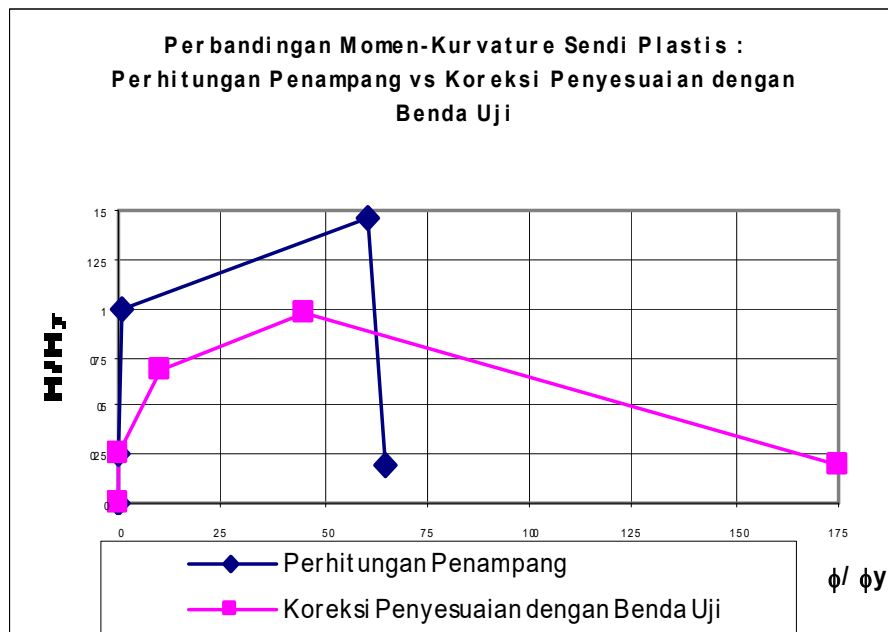
Fig. 21. Typical hysteretic behavior.



Kekakuan sekan saat simpangan 3.5%  $K_{3.5\%} >$  0.05  $K_{initial}$  Kekakuan awal

# PENGUJIAN LABORATORIUM

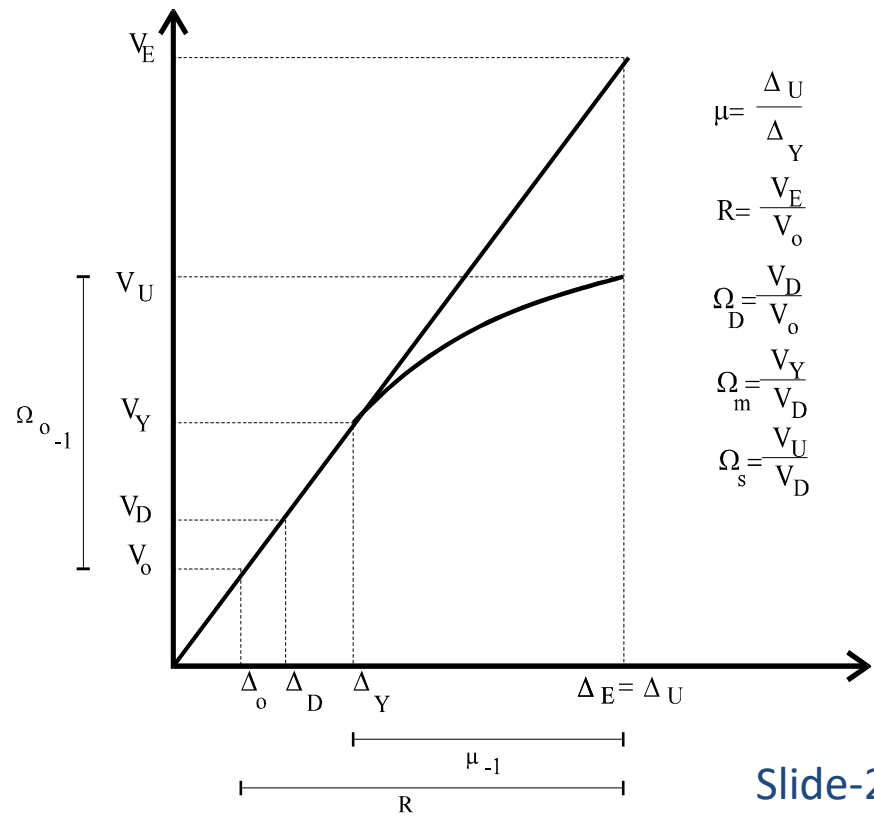
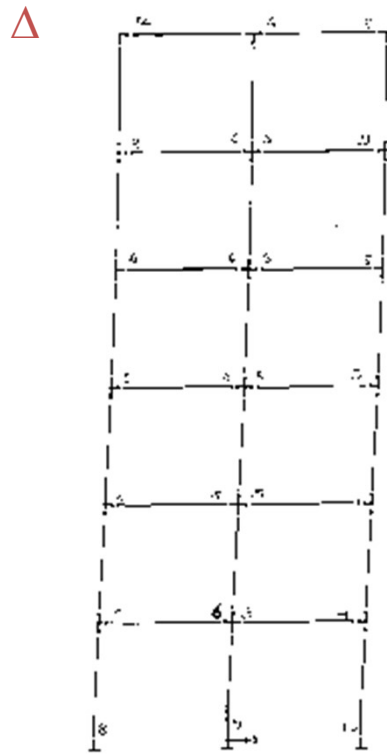
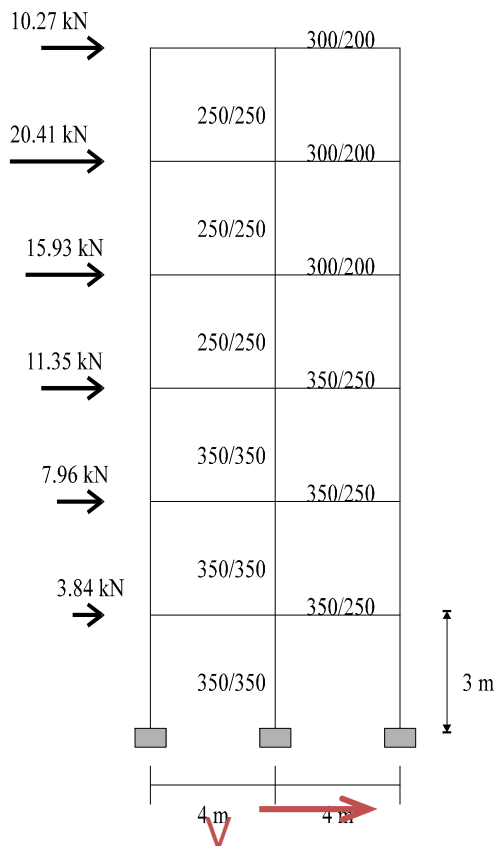
- Jika sistem hanya memenuhi persyaratan sampai simpangan 2.5%, maka sistem dikategorikan sebagai struktur rangka pemikul momen menengah dengan faktor reduksi gaya  $R = 6$ . Penentuan harga  $R$  dapat dilakukan secara khusus dengan cara berikut



1. Modifikasi perilaku sendi plastis sistem pracetak berdasarkan data penguujian

# PENGUJIAN LABORATORIUM

## 2. Analisis pushover berdasarkan data sendi plastis yang dimodifikasi



$$\mu = \frac{\Delta_U}{\Delta_Y}$$

$$R = \frac{V_E}{V_o}$$

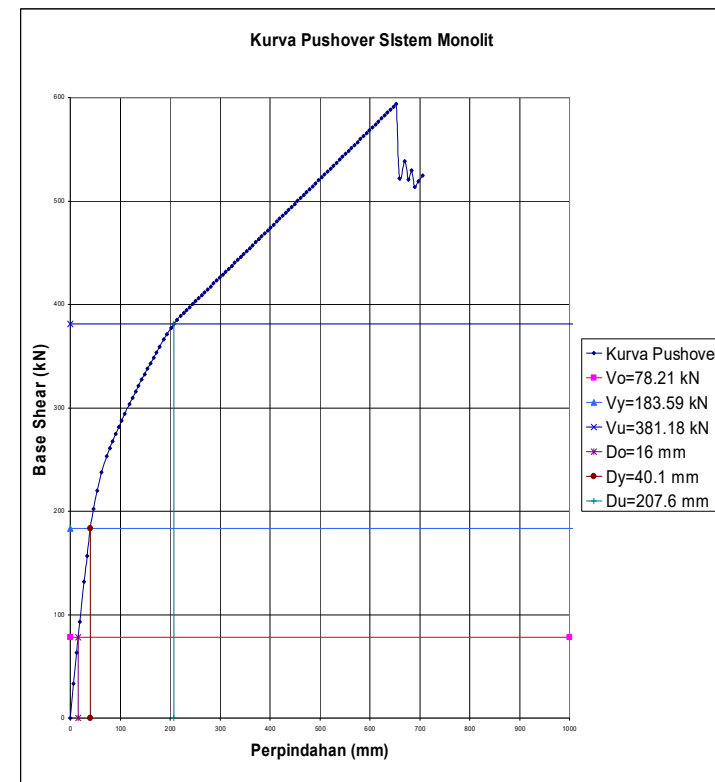
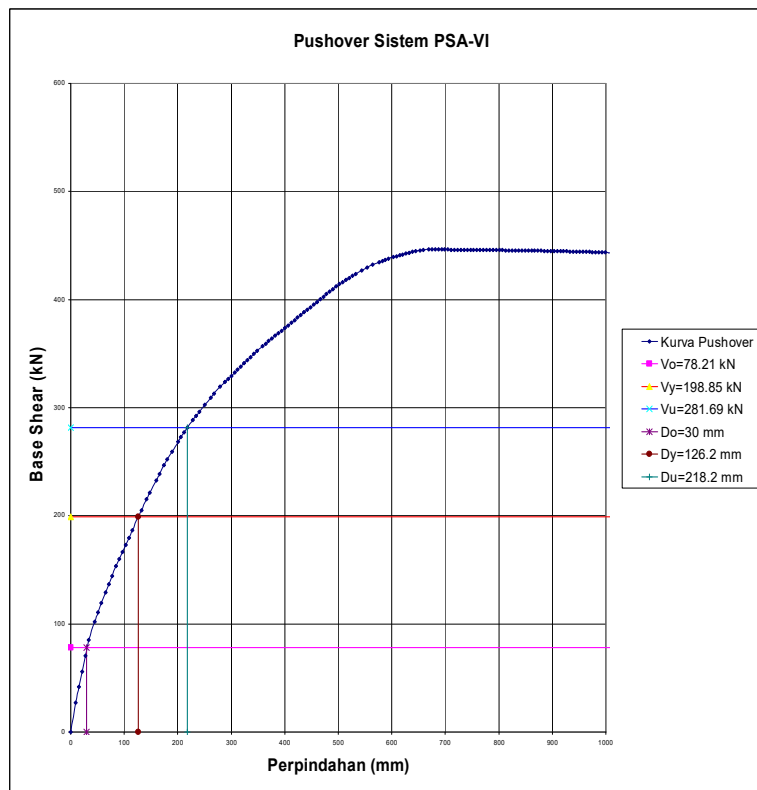
$$\Omega_D = \frac{V_D}{V_o}$$

$$\Omega_m = \frac{V_Y}{V_D}$$

$$\Omega_s = \frac{V_U}{V_D}$$

# PENGUJIAN LABORATORIUM

3. Membandingkan perilaku pushover sistem pracetak dengan sistem monolit yang setara





# PENGUJIAN LABORATORIUM

## 4. HASIL PENGUJIAN

### Model portal pracetak:

|                             |   |            |
|-----------------------------|---|------------|
| $\mu_{\text{pracetak}}$     | = | 4.11       |
| $R_{\text{pracetak}}$       | = | 6.84       |
| $f_{1\text{pracetak}}$      | = | 1.39       |
| $f_{\text{pracetak}}$       | = | 2.29       |
| $k_{\text{pracetak yield}}$ | = | 3.16 kN/mm |

### Model portal monolit:

|                            |   |            |
|----------------------------|---|------------|
| $\mu_{\text{monolit}}$     | = | 6.59       |
| $R_{\text{monolit}}$       | = | 8.18       |
| $f_{1\text{monolit}}$      | = | 1.20       |
| $f_{\text{monolit}}$       | = | 2.26       |
| $k_{\text{monolit yield}}$ | = | 5.12 kN/mm |

Perbandingan kinerja portal pracetak terhadap portal monolit:

|                    |   |                    |
|--------------------|---|--------------------|
| $\mu$              | = | 3.31               |
| $R$                | = | 5.29 (SNI-03-1726) |
| $R$                | = | 7.11 (Pushover)    |
| $f_1$              | = | 1.30               |
| $f$                | = | 2.84               |
| $k_{\text{yield}}$ | = | 60.76 %            |

# SERTIFIKAT UJI TAHAN GEMPA



DEPARTEMEN PEKERJAAN UMUM  
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PUSAT PENELITIAN DAN PENGEMBANGAN PERMUKIMAN  
Jln. Panyauangan Cileunyi Wetan Kab. Bandung 40393 PO Box: 812 Bandung 40008  
Telp. 022 - 7798393; Fax. 022 - 7798392 ( 4 saluran ); E-mail: kapuskim@bdg.centrin.net.id; pkimlit-b@kbw.go.id

## SERTIFIKAT PENGUJIAN

Berdasarkan hasil pengujian terhadap benda uji *joint* balok-kolom pracetak system PT. HUTAMA KARYA yang dilakukan sejak Bulan Juli sampai dengan Bulan September 2007 di Pusat Penelitian dan Pengembangan Permukiman, Badan Penelitian dan Pengembangan, Departemen Pekerjaan Umum, maka dengan ini dinyatakan bahwa:

### SISTEM SAMBUNGAN BALOK & KOLOM HK PRECAST

*P. T. Hutama Karya.*

dapat diterapkan pada bangunan gedung bertingkat sistem portal rangka terbuka sampai 10 lantai dengan parameter: Daktilitas ( $\mu$ ) = 2,24; Faktor Reduksi Gempa (R) antara 5,29 sampai dengan 7,11.

Sertifikat ini hanya berlaku jika pelaksanaannya sesuai dengan spesifikasi model uji yang diuji di laboratorium seperti yang tertuang dalam "Laporan Akhir Pengujian Struktur *Joint* Balok Kolom Pracetak System PT. Hutama Karya".



Bandung, 22 September 2007  
Kepala,

*[Signature]*  
Terangna Ginting, Dipl. EST.  
NIP. : 110015314



# PEMBUATAN MOCK UP



**MOCK UP  
HK PRECAST**

**PROYEK RUMAH  
SAKIT ORTHOPEDI,  
SOLO JAWA TENGAH**



# SERTIFIKAT IAPPI



## IKATAN AHLI PRACETAK DAN PRATEGANG INDONESIA INDONESIA ASSOCIATION OF PRECAST AND PRESTRESSED ENGINEER

SEKRETARIAT : Jl. Pangeran Antasari No. 23, Cilandak Barat, Jakarta Selatan

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Website : [www.iappi-indonesia.org](http://www.iappi-indonesia.org) Email : [iappi\\_ind@yahoo.com](mailto:iappi_ind@yahoo.com)

### SERTIFIKAT SISTEM STRUKTUR PRACETAK

NO. 24/SERTIFIKAT-SISTEM/IAPPI/11/2008

Berdasarkan hasil sidang Tim Verifikasi yang dilakukan pada tanggal 17 Nopember 2008 di Jakarta, yaitu kajian terhadap rancangan, hasil pengujian dan bangunan contoh Sistem Struktur Beton Pracetak "SISTEM PRECON HBS" oleh PT Dantosan Precon Perkasa, serta sesuai dengan Sertifikat Pengujian oleh Pusat Penelitian dan Pengembangan Permukiman, Badan Penelitian dan Pengembangan, Departemen Pekerjaan Umum pada 24 April 2008, maka dengan ini menyatakan bahwa :

### Sistem Struktur Beton Pracetak "SISTEM PRECON HBS" PT Dantosan Precon Perkasa

Telah memenuhi persyaratan teknis untuk perencanaan struktur bangunan tahan gempa berkategori daktilitas penuh sesuai SNI 03-1726-2002 dan penggunaannya sebagai komponen rumah susun dan bangunan gedung lainnya. Sertifikat ini hanya berlaku bila pelaksanaannya sesuai dengan spesifikasi yang diajukan dalam pembuatan sertifikat ini.

Ditetapkan di Jakarta  
Tanggal 17 Nopember 2008

Sekretaris Umum

DR Ir. Hari Nugraha Nurjaman, MT



Ketua Umum

Ir. H. R. Sidjabat, MPC I

# 4. PELAKSANAAN SISTEM PRACETAK

- Pelaksanaan sistem pracetak akan lebih cepat dibandingkan dengan sistem konvensional karena
  - Ada kegiatan yang dapat dilakukan secara paralel, yaitu pada saat pelaksanaan struktur bawah, kegiatan produksi komponen struktur atas dapat dilakukan
  - Pekerjaan arsitektur dan utilitas dapat segera dilakukan setelah satu lantai struktur selesai dipasang, karena komponen pracetak sudah mempunyai kekuatan cukup. Pada struktur konvensional, pekerjaan arsitektur dan utilitas baru bisa dimulai setelah 3 s/d 4 lantai struktur karena perancah sementara baru dapat sepenuhnya dilepas setelah beton mempunyai kekuatan yang cukup.



## 4. PELAKSANAAN SISTEM PRACETAK



- saat pelaksanaan struktur bawah, kegiatan produksi komponen struktur atas dapat dilakukan

# 4. PELAKSANAAN SISTEM PRACETAK



Precast : setelah 1 lantai struktur selesai, pekerjaan arsitektur segera dapat dilakukan

VS

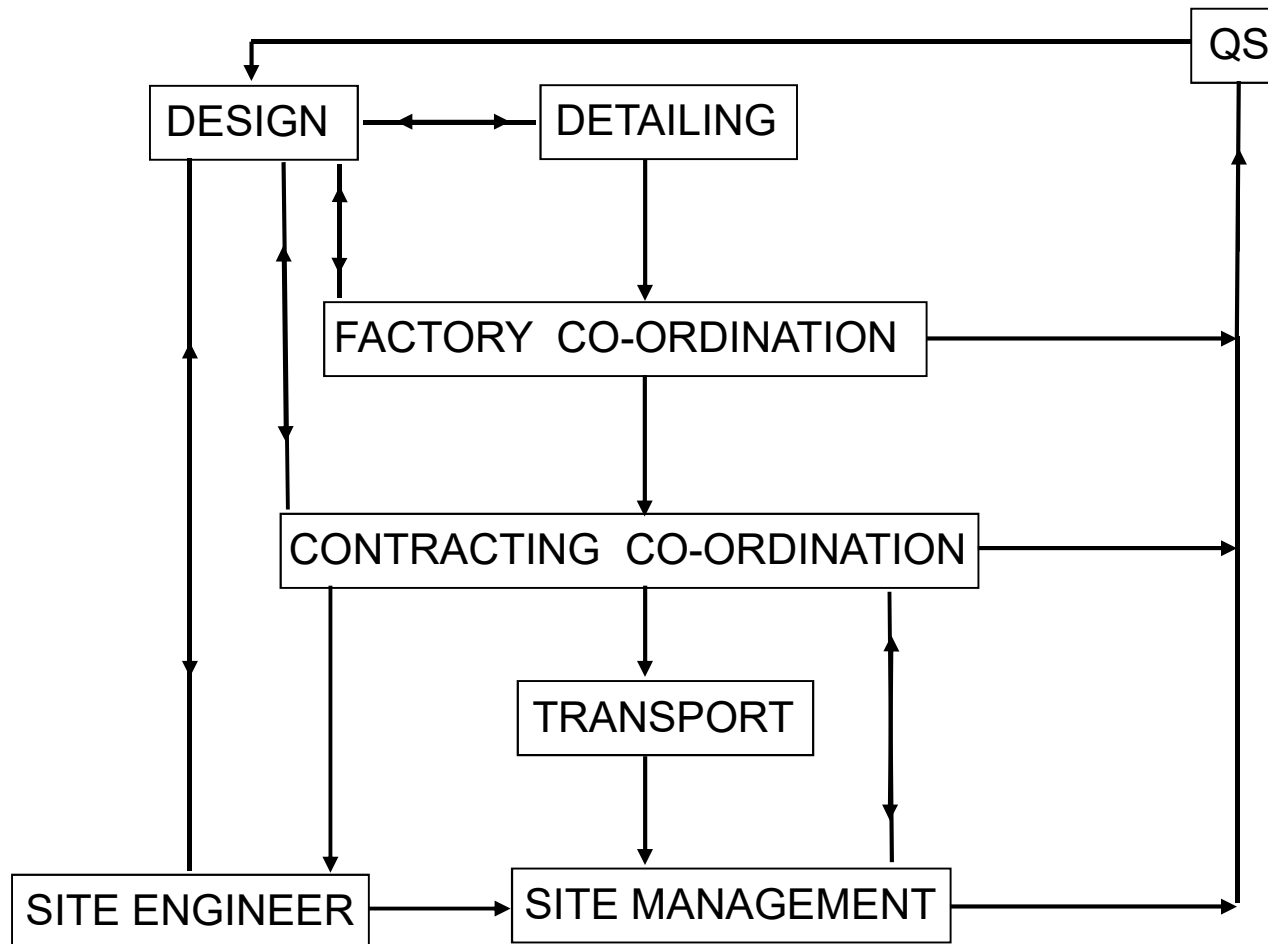


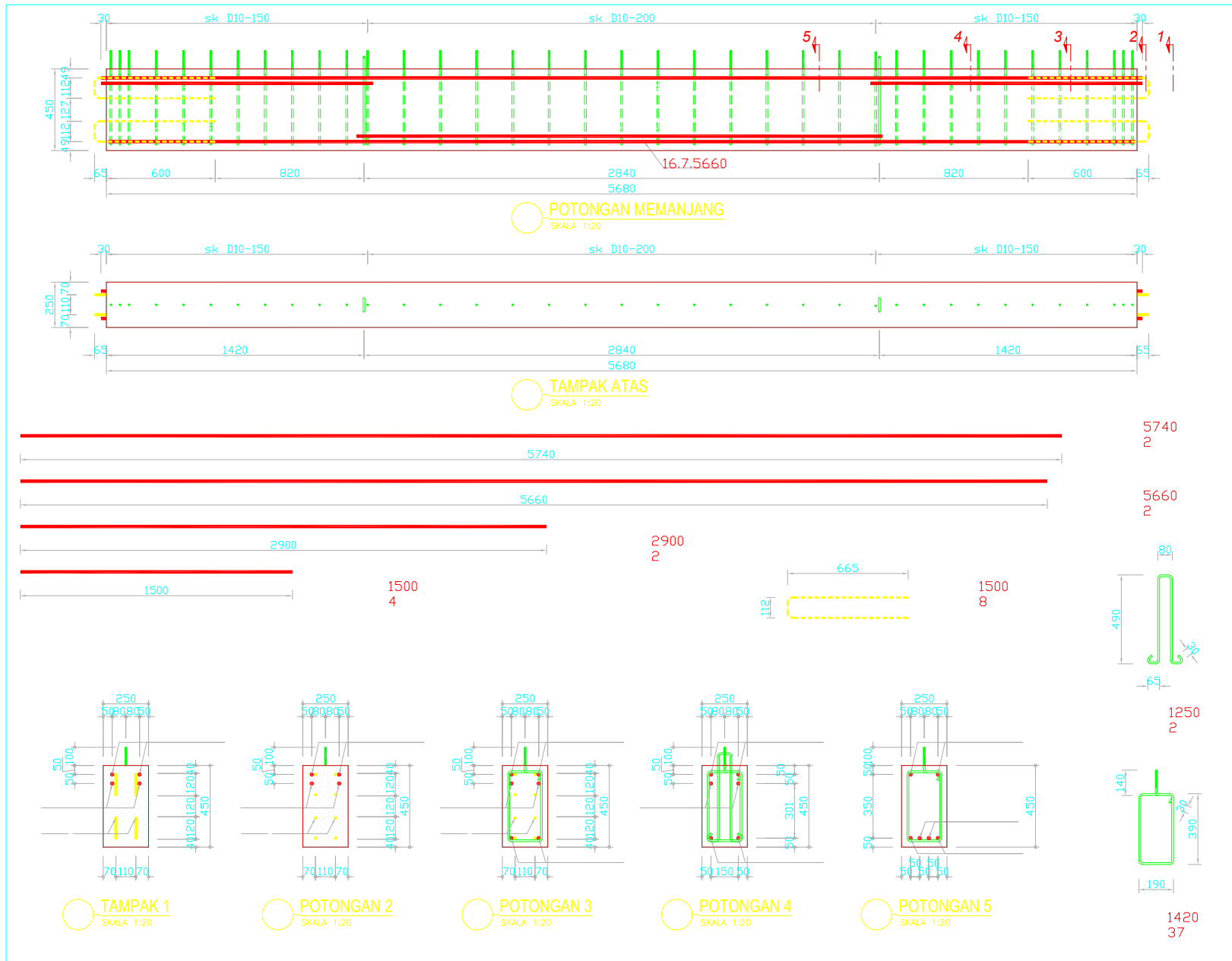
Pekerjaan arsitektur baru dapat dilakukan setelah 3 – 4 lantai struktur selesai dicor

## 4.PELAKSANAAN SISTEM PRACETAK

- Pelaksanaan sistem pracetak didahului dengan beberapa pekerjaan persiapan.
  - Penyiapan gambar kerja produksi komponen
  - Penyiapan layout pelaksanaan pekerjaan di lapangan.
  - Penyiapan project planning dan controlling menyangkut material, peralatan dan tenaga kerja.

## ALUR TANGGUNG JAWAB DALAM ORGANISASI PRODUSEN PRACETAK





Shop drawing sebagai dasar pembuatan komponen



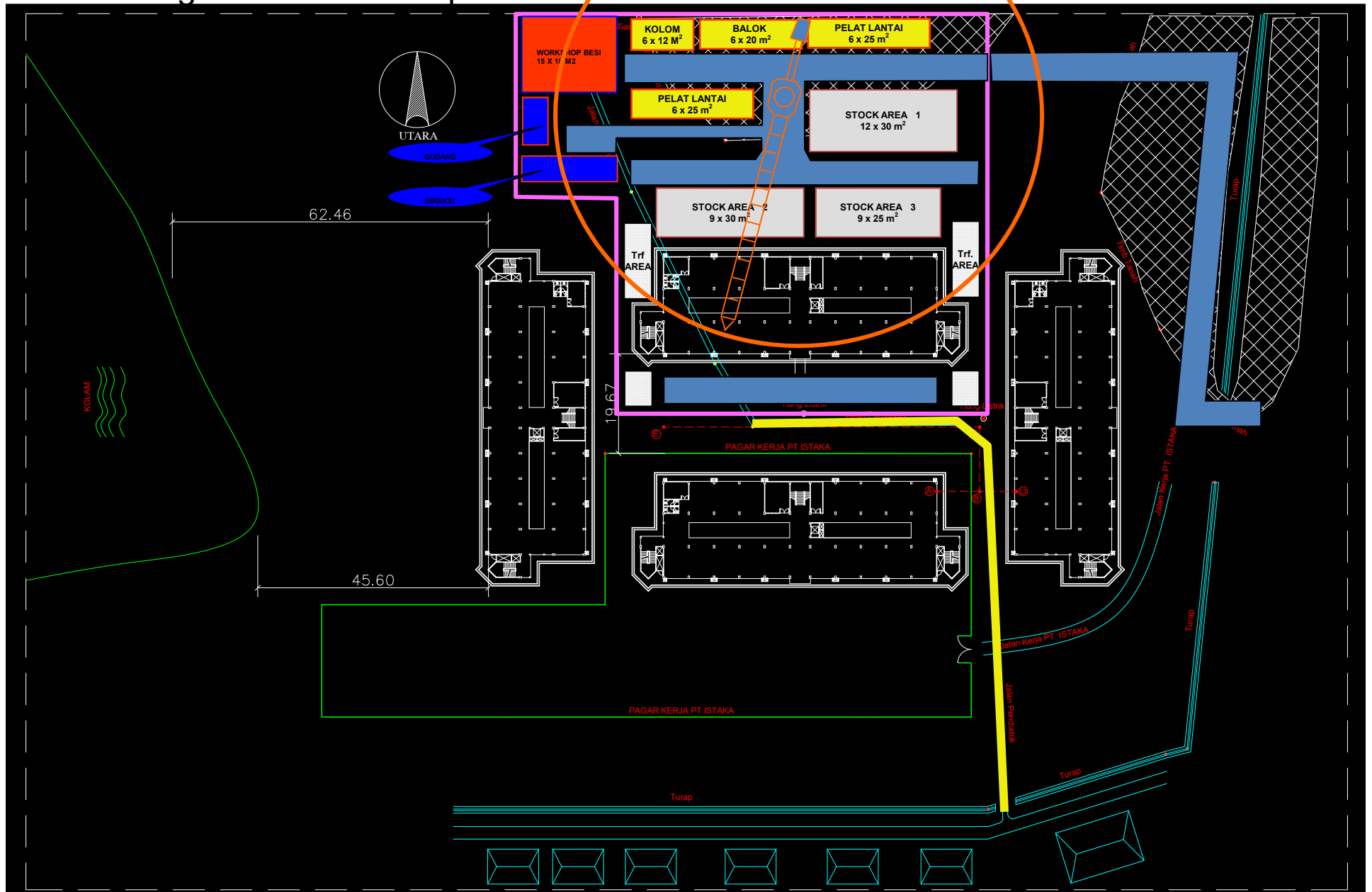
## Rekapitulasi Komponen Pre-Cast PSA System

Proyek : Rusunawa Lokasi Univ. Gajahmada, Kampus Bulak Sumur

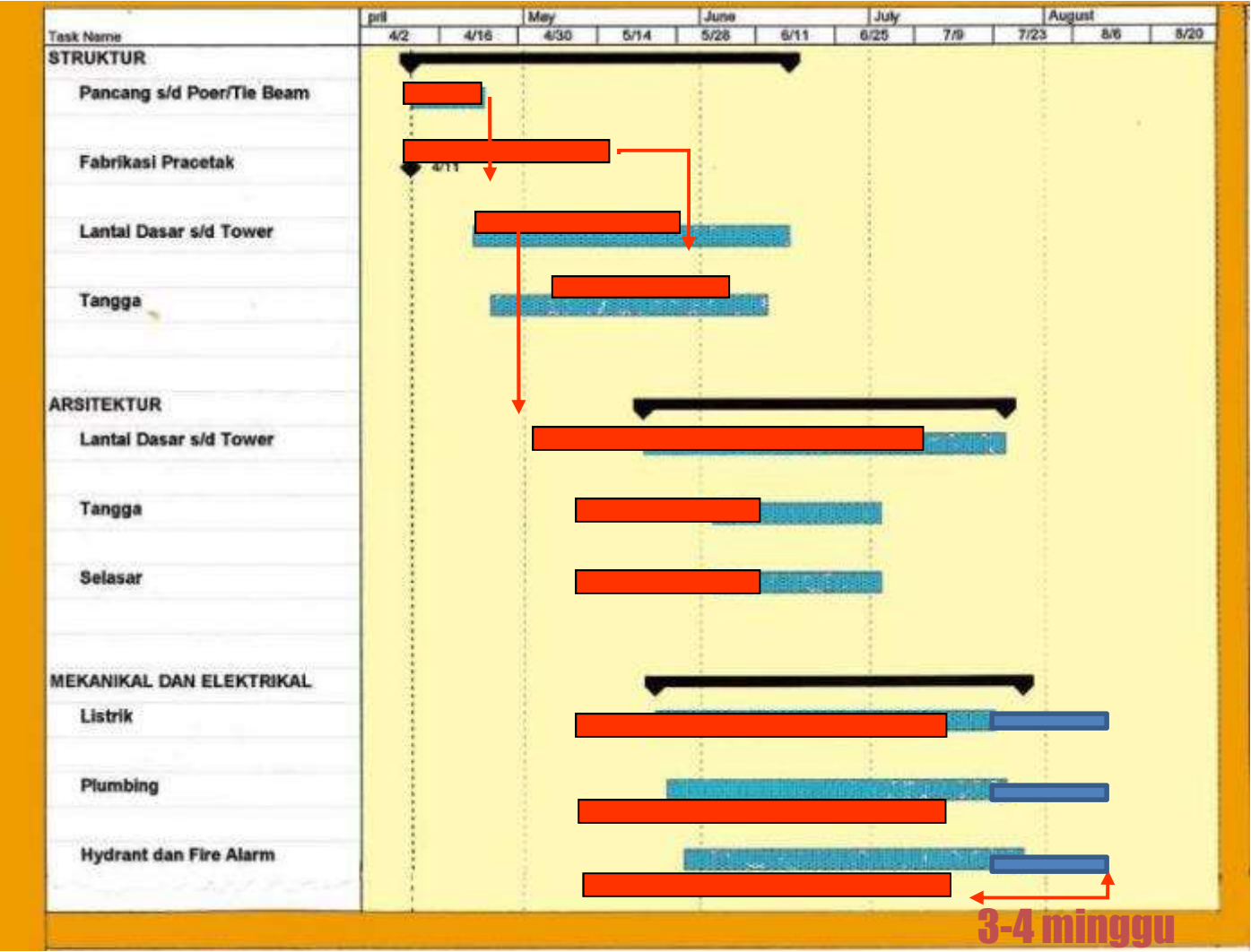
| No. | Struktur               |            |          |          |          | Jumlah            |                         |                        |                         |                  |               | Beton                        |                             | Grouting Kolom               |                             | Grouting Balok               |                             |
|-----|------------------------|------------|----------|----------|----------|-------------------|-------------------------|------------------------|-------------------------|------------------|---------------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|
|     | Jenis                  | Type       | Dimensi  |          |          | Lt. Dasar<br>(bh) | Lt. 1<br>(Satu)<br>(bh) | Lt. 2<br>(Dua)<br>(bh) | Lt. 3<br>(Tiga)<br>(bh) | Lt. Atap<br>(bh) | Total<br>(bh) | / Komp.<br>(m <sup>2</sup> ) | / Type<br>(m <sup>2</sup> ) | / Komp.<br>(m <sup>2</sup> ) | / Type<br>(m <sup>2</sup> ) | / Komp.<br>(m <sup>2</sup> ) | / Type<br>(m <sup>2</sup> ) |
|     |                        |            | P<br>(m) | L<br>(m) | T<br>(m) |                   |                         |                        |                         |                  |               |                              |                             |                              |                             |                              |                             |
|     | <b>Sub Structure</b>   |            |          |          |          |                   |                         |                        |                         |                  |               |                              |                             |                              |                             |                              |                             |
| 1   | T. Pancang             | 1 Triangle |          |          | -        | 170               |                         |                        |                         |                  | 170           |                              |                             |                              |                             |                              |                             |
| 2   | Pile Cap               | 1 PC1.1    | 0.84     | 0.84     | 0.50     | 14                |                         |                        |                         |                  | 14            | 0.35                         | 4.94                        |                              |                             |                              |                             |
|     |                        | 2 PC1.2    | 0.84     | 0.84     | 0.50     | 4                 |                         |                        |                         |                  | 4             | 0.35                         | 1.41                        |                              |                             |                              |                             |
|     |                        | 3 PC1.3    | 0.84     | 0.84     | 0.50     | 24                |                         |                        |                         |                  | 24            | 0.35                         | 8.47                        |                              |                             |                              |                             |
|     |                        | 4 PC2.1    | 1.54     | 0.84     | 0.50     | 58                |                         |                        |                         |                  | 58            | 0.65                         | 37.51                       |                              |                             |                              |                             |
|     |                        | 5 PC2.2    | 1.54     | 0.84     | 0.50     | 4                 |                         |                        |                         |                  | 4             | 0.65                         | 2.59                        |                              |                             |                              |                             |
|     |                        | 6 PC2.1a   | 1.54     | 0.84     | 0.50     | 2                 |                         |                        |                         |                  | 2             | 0.65                         | 1.29                        |                              |                             |                              |                             |
|     |                        |            |          |          |          | 106               | -                       | -                      | -                       | -                | 106           |                              | 56.21                       |                              |                             |                              |                             |
| 3   | Tie Beam               | 1 TB1.A    | 5.16     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.58                         | 1.16                        |                              |                             |                              |                             |
|     |                        | 2 TB1.B    | 5.12     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.58                         | 1.15                        |                              |                             |                              |                             |
|     |                        | 3 TB1.C    | 4.46     | 0.25     | 0.45     | 30                |                         |                        |                         |                  | 30            | 0.50                         | 15.05                       |                              |                             |                              |                             |
|     |                        | 4 TB1.D    | 2.21     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.25                         | 0.50                        |                              |                             |                              |                             |
|     |                        | 5 TB1.E    | 1.86     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.21                         | 0.42                        |                              |                             |                              |                             |
|     |                        | 6 TB1.F    | 2.96     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.33                         | 0.67                        |                              |                             |                              |                             |
|     |                        | 7 TB1.G    | 2.26     | 0.25     | 0.45     | 1                 |                         |                        |                         |                  | 1             | 0.25                         | 0.25                        |                              |                             |                              |                             |
|     |                        | 8 TB1.H    | 3.07     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.35                         | 0.69                        |                              |                             |                              |                             |
|     |                        | 9 TB2.A    | 2.96     | 0.25     | 0.45     | 68                |                         |                        |                         |                  | 68            | 0.33                         | 22.64                       |                              |                             |                              |                             |
|     |                        | 10 TB2.B   | 3.92     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.44                         | 0.88                        |                              |                             |                              |                             |
|     |                        | 11 TB2.C   | 3.92     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.44                         | 0.88                        |                              |                             |                              |                             |
|     |                        | 12 TB2.D   | 3.56     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.40                         | 0.80                        |                              |                             |                              |                             |
|     |                        | 13 TB2.E   | 2.16     | 0.25     | 0.45     | 6                 |                         |                        |                         |                  | 6             | 0.24                         | 1.46                        |                              |                             |                              |                             |
|     |                        | 14 TB2.F   | 2.16     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.24                         | 0.49                        |                              |                             |                              |                             |
|     |                        | 15 TB3.A   | 0.66     | 0.25     | 0.45     | 6                 |                         |                        |                         |                  | 6             | 0.07                         | 0.45                        |                              |                             |                              |                             |
|     |                        | 16 TB3.B   | 1.06     | 0.25     | 0.45     | 4                 |                         |                        |                         |                  | 4             | 0.12                         | 0.48                        |                              |                             |                              |                             |
|     |                        | 17 TB3.C   | 2.11     | 0.25     | 0.45     | 4                 |                         |                        |                         |                  | 4             | 0.24                         | 0.95                        |                              |                             |                              |                             |
|     |                        | 18 TB3.D   | 3.81     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.43                         | 0.86                        |                              |                             |                              |                             |
|     |                        | 19 TB3.E   | 2.16     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.24                         | 0.49                        |                              |                             |                              |                             |
|     |                        | 20 TB3.F   | 2.16     | 0.25     | 0.45     | 2                 |                         |                        |                         |                  | 2             | 0.24                         | 0.49                        |                              |                             |                              |                             |
|     |                        | 21 TB3.G   | 2.96     | 0.25     | 0.45     | 8                 |                         |                        |                         |                  | 8             | 0.33                         | 2.66                        |                              |                             |                              |                             |
|     |                        |            |          |          |          | 153               | -                       | -                      | -                       | -                | 153           |                              | 53.41                       |                              |                             |                              |                             |
|     | <b>Upper Structure</b> |            |          |          |          |                   |                         |                        |                         |                  |               |                              |                             |                              |                             |                              |                             |
| 4   | Kolom                  | 1 K1.D     | 0.40     | 0.30     | 3.38     | 68                |                         |                        |                         |                  | 68            | 0.41                         | 27.58                       |                              |                             |                              |                             |
|     | Konv'                  | 2 K1TD     | 0.40     | 0.30     | 1.70     | 6                 |                         |                        |                         |                  | 6             | 0.20                         | 1.22                        |                              |                             |                              |                             |
|     |                        | 3 K2.D     | 0.40     | 0.30     | 3.38     | 8                 |                         |                        |                         |                  | 8             | 0.41                         | 3.24                        |                              |                             |                              |                             |
|     |                        | 4 K3.D     | 0.30     | 0.30     | 3.38     | 24                |                         |                        |                         |                  | 24            | 0.30                         | 7.30                        |                              |                             |                              |                             |
|     |                        | 5 K1.1/2   | 0.40     | 0.30     | 2.73     |                   | 76                      | 76                     |                         |                  | 152           | 0.33                         | 49.80                       |                              |                             |                              |                             |
|     | Konv'                  | 6 K1T.1/2  | 0.40     | 0.30     | 2.85     |                   | 6                       | 6                      |                         |                  | 12            | 0.34                         | 4.10                        |                              |                             |                              |                             |
|     |                        | 7 K3.1/2   | 0.30     | 0.30     | 2.73     |                   | 20                      | 20                     |                         |                  | 40            | 0.25                         | 9.83                        |                              |                             |                              |                             |
|     |                        | 8 K1.3     | 0.40     | 0.30     | 3.00     |                   |                         |                        | 64                      |                  | 64            | 0.36                         | 23.04                       |                              |                             |                              |                             |
|     |                        | 9 K1A.3    | 0.40     | 0.30     | 2.85     |                   |                         |                        | 12                      |                  | 12            | 0.34                         | 4.10                        |                              |                             |                              |                             |
|     | Konv'                  | 10 K1T.3   | 0.40     | 0.30     | 2.85     |                   |                         |                        | 4                       |                  | 4             | 0.34                         | 1.37                        |                              |                             |                              |                             |
|     | Konv'                  | 11 K1TA.3  | 0.40     | 0.30     | 4.65     |                   |                         |                        | 2                       |                  | 2             | 0.56                         | 1.12                        |                              |                             |                              |                             |
|     |                        | 12 K3.3    | 0.30     | 0.30     | 3.00     |                   |                         |                        | 10                      |                  | 10            | 0.27                         | 2.70                        |                              |                             |                              |                             |
|     |                        | 13 K3A.3   | 0.30     | 0.30     | 2.85     |                   |                         |                        | 10                      |                  | 10            | 0.26                         | 2.57                        |                              |                             |                              |                             |
|     |                        |            |          |          |          | 106               | 102                     | 102                    | 102                     | -                | 412           |                              | 137.97                      |                              | -                           |                              | -                           |



Perencanaan layout produksi, stocking, alur transportasi dan posisi alat pasang harus dilakukan agar pelaksanaan dapat dilakukan dengan lancar dan cepat



**Pembuatan Project Planning dan Controlling : Dengan paralelisasi struktur bawah dan pembuatan komponen struktur atas serta pekerjaan arsitektur yang dapat dilakukan lebih awa l, untuk bangunan bertingkat medium, sistem pracetak dapat efektif 3 – 4 minggu lebih epat dibanding sistem konvensional**



# 5. SISTEM PRODUKSI

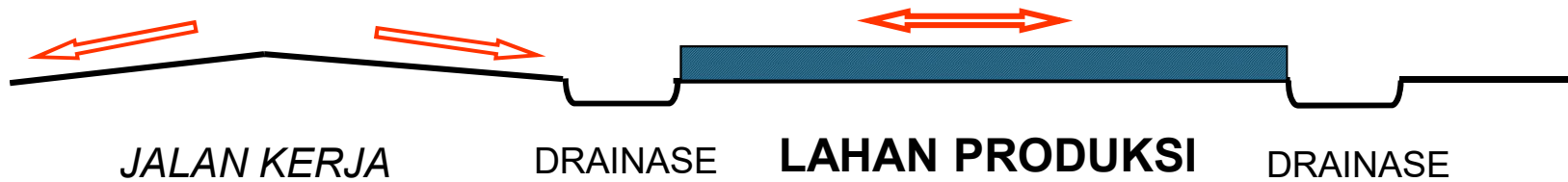
- SISTEM PRODUKSI DI LAPANGAN
  - Komponen : Balok, kolom, pelat, dinding facade
  - Penyiapan landasan kerja
  - Penyiapan cetakan
  - Penyiapan penulangan
  - Penyetelan penulangan di cetakan
  - Pengecoran
  - Pembukaan cetakan di lapangan
  - Pengecekan kualitas dan toleransi dimensi produk
- SISTEM PRODUKSI DI PABRIK
  - Sistem, teknologi dan quality control kualitas dan toleransi dimensi produk
  - Tiang pancang mini
  - Tiang pancang square prategang
  - Tiang pancang spun prategang
  - Preslab prestressed
  - Hollow Core
  - Sandwich panel
  - Beton ringan



# SISTEM PRODUKSI DI LAPANGAN



Pemasangan landasan cetakan



Drainasi perlu dirancang dan dipasang agar proses pekerjaan tidak terganggu genangan air





**KOLOM**



**BALOK + KONSOL**



**BALOK/KOLOM BAJA** PENYIAPAN CETAKAN



**TIE BEAM / SLOOF**





Cetakan pelat waffle  
crete dari bahan polymer



Cetakan pelat column  
slab dari bahan baja





Setting dinding cetakan





# QUALITY CONTROL

## Filosofi Quality Control

### ➤ Sasaran Umum

#### Manual Quality Control :

- Berisi metode-metode yang dimaksudkan untuk mengendalikan kualitas produksi dari komponen-komponen beton pracetak.
- Manual tidak secara otomatis memberikan hasil yang dapat diterima dan keseragaman mutu daripada produk.

Produsen Harus memperhatikan bahwa :

Keseragaman mutu harus ditunjang oleh usaha yang serius, **tekad** yang **terus-menerus** untuk mendapatkan hasil yang baik pada :

- Design
- Material
- Proses produksi beton pracetak
- Instalasi beton pracetak

➤ **Quality Control :**

Bertanggung jawab pada setiap tahapan-tahapan dari operasi untuk mendapatkan performance yang baik.

- Keseluruhan hasil Quality Control merupakan upaya-upaya maksimal yang diberikan oleh setiap orang /bagian dari design, produksi, inspeksi, instalasi dan aturan yang ketat yang harus ditaati.



## PRODUCTION PROCESS CONTROL

| No | Process (Description)                    | Control Particulars             | Quality Specification (Standard / Criteria)  | Reference Standard              | Method of Test | Size of Lot (Frequency)    | Name of Record                         | Person In Charge                  |
|----|--|---------------------------------|--|---------------------------------|----------------|----------------------------|--|-----------------------------------|
| 1  | Receiving & Quality Inspection of Cement | Quantity                        | - Delivery Note  | -                               | Visual         | At delivery                | Order Ledger                           | Procurement (Receiving Inspector) |
|    |  |                                 | - Net Weight & Sealed Condition  | -                               | Visual         |                            |  |                                   |
|    |  |                                 | Freshness  | Check Deterioration or humidity | -              |                            |  |                                   |
|    |  | Specific Surface (Blaine Value) | 280 m <sup>2</sup> /kg or more   | SNI 15-2049-2004                | -              | 1 time/ month (Maker test) | <b>Cement certificate (From maker)</b> | Quality Control (Laboratory)      |
|    |  | Setting time                    | Initial 45 minutes min. Final 375 minutes max.   |                                 |                |                            |  |                                   |
|    |  | Soundness                       | Good   |                                 |                |                            |  |                                   |
|    |  | Compressive Strength            | 3 days 125 kg/cm <sup>2</sup> or more<br>7 days 200 kg/cm <sup>2</sup> or more<br>28 days 280 kg/cm <sup>2</sup> or more |                                 |                |                            |  |                                   |
|    |  | Magnesium Oxide                 | 6.0 % or less  |                                 |                |                            |  |                                   |
|    |  | Sulphur Trioxide                | 3.5 % or less  |                                 |                |                            |  |                                   |
|    |  | Ignition Loss                   | 5.0 % or less  |                                 |                |                            |  |                                   |
|    |  | Insoluble                       | 3.0 % or less  |                                 |                |                            |  |                                   |

## PRODUCTION PROCESS CONTROL

| No          | Process (Description)                              | Control Particulars            | Quality Specification (Standard / Criteria) | Reference Standard | Method of Test         | Size of Lot (Frequency)       | Name of Record               | Person In Charge                   |  |  |
|-------------|--|--------------------------------|---|--------------------|------------------------|-------------------------------|------------------------------|------------------------------------|--|--|
| 2           | Receiving and Quality Inspection of Fine Aggregate | Type                           | Sand for Concrete                           | -                  | Visual                 | At receiving                  | Order Ledger                 | Procurement (Receiving Inspection) |  |  |
|             |  | Quantity                       | Check with delivery note                    | -                  | Visual                 |                               |                              |                                    |  |  |
|             |  | Dirt                           | No Rubbish                                  | -                  | Visual                 |                               |                              |                                    |  |  |
|             |  | Stone Grade                    | Standard sample                             | -                  | Visual                 |                               |                              |                                    |  |  |
|             |  | Shape                          | Standard sample                             | -                  | Visual                 |                               |                              |                                    |  |  |
|             | Fineness (Sieved)                                  | Within Curve                   | ASTM C.33                                   | I-QCL-004          | 1 time/ month (random) | Fine Aggregate Testing Result | Quality Control (Laboratory) |                                    |  |  |
|             | Fineness Modulus                                   | 2.3 - 3.1                      | ASTM C.33                                   | I-QCL-004          |                        |                               |                              |                                    |  |  |
|             | Bulk Specific Gravity                              | 2.40 g/cm <sup>3</sup> or more | ASTM C.33                                   | I-QCL-003          |                        |                               |                              |                                    |  |  |
|             | Water Absorption                                   | 4.0 % or less                  | ASTM C.33                                   | I-QCL-003          |                        |                               |                              |                                    |  |  |
|             | Clay Lumps Content                                 | 5.0 % or less                  | PBI 71                                      | I-QCL-001          |                        |                               |                              |                                    |  |  |
|             | Absolute Volume                                    | 53 % or more                   | ASTM C.33                                   | I-QCL-009          |                        |                               |                              |                                    |  |  |
|             | Bulk Density                                       | 1.4 kg/ Litre or more          | ASTM C.33                                   | I-QCL-009          |                        |                               |                              |                                    |  |  |
|             | Organic Impurities                                 | Lighter than standard          | ASTM C.33                                   | I-QCL-002          |                        |                               |                              | 1 time/ year (random)              |  |  |
| <b>C 02</b> |  |                                |   |                    |                        |                               |                              |                                    |  |  |

## PRODUCTION PROCESS CONTROL

| No | Process (Description)                             | Control Particulars            | Quality Specification (Standard / Criteria) | Reference Standard | Method of Test         | Size of Lot (Frequency)         | Name of Record                     | Person In Charge                   |
|----|---|--------------------------------|---|--------------------|------------------------|---------------------------------|------------------------------------|------------------------------------|
| 3  | Receiving and Quality Inspection Coarse Aggregate | Type                           | Crushed stone for concrete 2010,            | -                  | Visual                 | At Receiving                    | Order Ledger                       | Procurement (Receiving Inspection) |
|    |   | Quantity                       | Check with Delivery Note                    | -                  | Visual                 |                                 |                                    |                                    |
|    |   | Dirt                           | No Rubbish                                  | -                  | Visual                 |                                 |                                    |                                    |
|    |   | Stone Grade                    | Standard Sample                             | -                  | Visual                 |                                 |                                    |                                    |
|    |   | Shape                          | Standard sample                             | -                  | Visual                 |                                 |                                    |                                    |
|    | Fineness (sieved)                                 | Within Curve                   | ASTM C.33                                   | I-QCL-010          | 1 time/ month (random) | Coarse Aggregate Testing Result | Quality Control (Laboratory)       |                                    |
|    | Fineness Modulus                                  | Over than 5                    | ASTM C.33                                   | I-QCL-010          |                        |                                 |                                    |                                    |
|    | Bulk Specific Gravity                             | 2.40 g/cm <sup>3</sup> or more | ASTM C.33                                   | I-QCL-003          |                        |                                 |                                    |                                    |
|    | Water Absorption                                  | 3.0 % or less                  | ASTM C.33                                   | I-QCL-003          |                        |                                 |                                    |                                    |
|    | Clay Lumps Content                                | 1 % or less                    | PBI 71                                      | I-QCL-015          |                        |                                 |                                    |                                    |
|    | Bulk Density                                      | 1.5 kg/ Litre or more          | ASTM C.33                                   | I-QCL-009          |                        |                                 |                                    |                                    |
|    | Absolute Volume                                   | 55 % or more                   | ASTM C.33                                   | I-QCL-009          |                        |                                 |                                    |                                    |
| 4  | Admixture   | Type                           | Conform to spec.                            | -                  | Visual                 | At Receiving                    | Admixture certificate (From maker) | Quality Control (Laboratory)       |
|    |   | Quantity                       | Check with Delivery Note                    | -                  | Visual                 |                                 |                                    |                                    |

## PRODUCTION PROCESS CONTROL

| No                  | Process (Description)                        | Control Particulars                        | Quality Specification (Standard / Criteria) | Reference Standard | Method of Test                   | Size of Lot (Frequency)         | Name of Record             | Person In Charge                   |
|---------------------|--|--|---|--------------------|----------------------------------|---------------------------------|----------------------------|------------------------------------|
| 5                   | Water<br><br><br><b>C 05</b>                 | Chloride content                           | 1000 ppm or less                            | ASTM C.194         | External test for water analysis | 1 time/year                     | Water certificate analysis | Quality Control (Laboratory)       |
|                     |  | Sulphate content                           | 3000 ppm or less                            | ASTM C.194         |                                  |                                 |                            |                                    |
|                     |  | (Na <sub>2</sub> + 0.658 K <sub>2</sub> O) | 6000 ppm or less                            | ASTM C.194         |                                  |                                 |                            |                                    |
|                     |  | Total solids                               | 500000 ppm or less                          | ASTM C.194         |                                  |                                 |                            |                                    |
| 6                   | Steel<br><br><br><br><br><br><br><b>C 06</b> | Brand                                      | Low Carbon Steel Wire                       | -                  | Visual                           | At Receiving                    | Order Ledger               | Procurement (receiving Inspection) |
|                     |  | Quantity                                   | Check with delivery note                    | -                  | Visual                           |                                 |                            |                                    |
|                     |  | Appearance                                 | Rust, Damage                                | -                  | Visual                           | At receiving each size (random) | Test Result                | Quality Control (Laboratory)       |
|                     |  | Diameter of steel                          | < ø 8mm = +0.3/-0.15 mm                     | -                  | Measure                          |                                 |                            |                                    |
|                     |  |  | ø 8 to ø 14mm = +0.4/-0.3 mm                | -                  | Measure                          |                                 |                            |                                    |
|                     |  |  | > ø 14 mm = ± 0.5 mm                        | -                  | Measure                          |                                 |                            |                                    |
|                     |  | Tensile Strength                           | Bj Tp = 2400 kg/cm <sup>2</sup>             | -                  | Tensile                          |                                 |                            |                                    |
|                     |  |  | Bj Td = 4000 kg/cm <sup>2</sup>             | -                  | Tensile                          |                                 |                            |                                    |
| Quality Inspections | Mill Certificate (Maker)                     | -  | -   | 1 time/month       | Mill Certificate of Steel        |                                 |                            |                                    |



## PRODUCTION PROCESS CONTROL

| No | Process (Description)                     | Control Particulars   | Quality Specification (Standard / Criteria) | Reference Standard | Method of Test | Size of Lot (Frequency)  | Name of Record                 | Person In Charge                               |
|----|---|-----------------------|---|--------------------|----------------|--------------------------|--------------------------------|--|
| 7  | Accessories<br><br><b>C 07</b>            | Brand                 | PO  | -                  | -              | At Receiving             | Order Ledger                   | Procurement (receiving Inspection)             |
|    |   | Quantity              | Check with Delivery Note                    | -                  | Count          |                          |                                |  |
|    |   | Appearance            | Corrosion or Flaws                          | -                  | Visual         |                          |                                |  |
|    |   | Dimensions            | ± 0.5 mm                                    | -                  | Measure        | At Receiving (random)    | Operations Section             |  |
| 8  | New Moulds<br><br><b>C 08</b>             | Appearance            | No Corrosion                                | -                  | Visual         | At receiving             | Mould management ledger        | Moulding fabrication Supervisor                |
|    |   |                       | Flat or No Transformation                   | -                  | Visual         |                          |                                |  |
|    |   |                       | Clean                                       | -                  | Visual         |                          |                                |  |
|    |   | Dimension (l,w,t)     | ± 3 mm                                      | -                  | Measure        |                          |                                |  |
|    |   | Diagonal              | ± 5 mm                                      | -                  | Measure        |                          |                                |  |
| 9  | Cutting & Bending Of steel<br><b>C 09</b> | Cutting length        | ± 5 mm                                      | -                  | Measure        | 3 pcs / type or at every | Reinforcement measuring Record | Production (in charge of Steel reinforcement ) |
|    |   | Bending Dimension     | ± 2 mm                                      | -                  | Measure        |                          |                                |  |
| 10 | Steel Cage Inspection<br><br><b>C 10</b>  | ø of steel            | Conform to spec.                            | -                  | Measure        | 3 pcs / type or at every | Steel cage inspection record   | Production (in charge of steel reinforcement   |
|    |   | Pitch of steel        | Conform to spec.                            | -                  | Measure        |                          |                                |  |
|    |   | Pitch of Accessories  | Conform to spec.                            | -                  | Measure        |                          |                                |  |
|    |   | Pitch of Lifting hook | Conform to spec.                            | -                  | Measure        |                          |                                |  |



KODE PENULANGAN

Setting pembesian, serta penempatan yang diatur baik untuk mempercepat proses perakitan besi







**TITIK<sup>2</sup> PEGANGAN**



**MEJA PRODUKSI**

Peralatan bantu untuk memastikan posisi tulangan yang presisi





Teknik pembuatan pracetak akan sangat mereduksi material yang terbuang



## BERSIHKAN



## SETTING



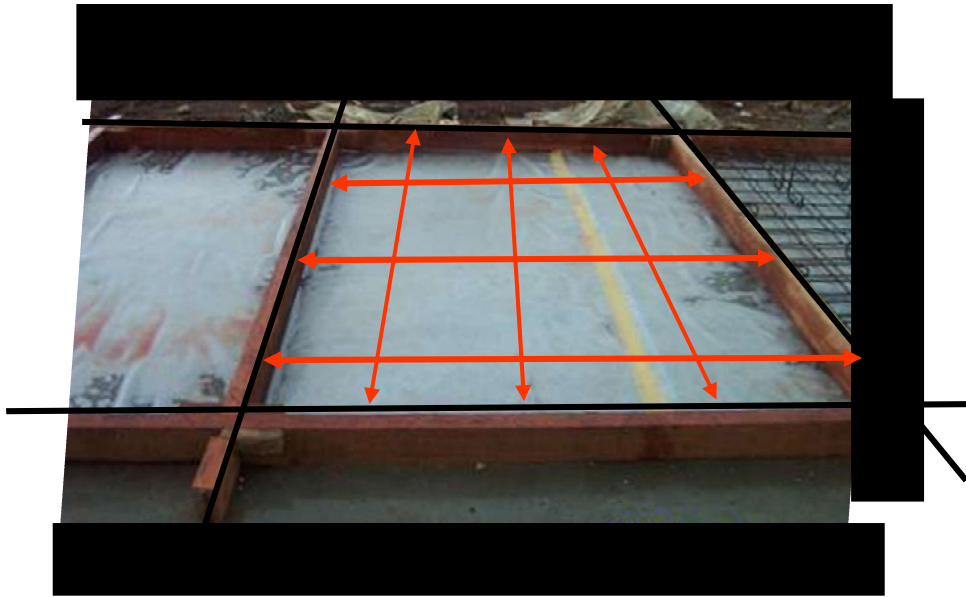
## PELUMASAN



## Setting cetakan



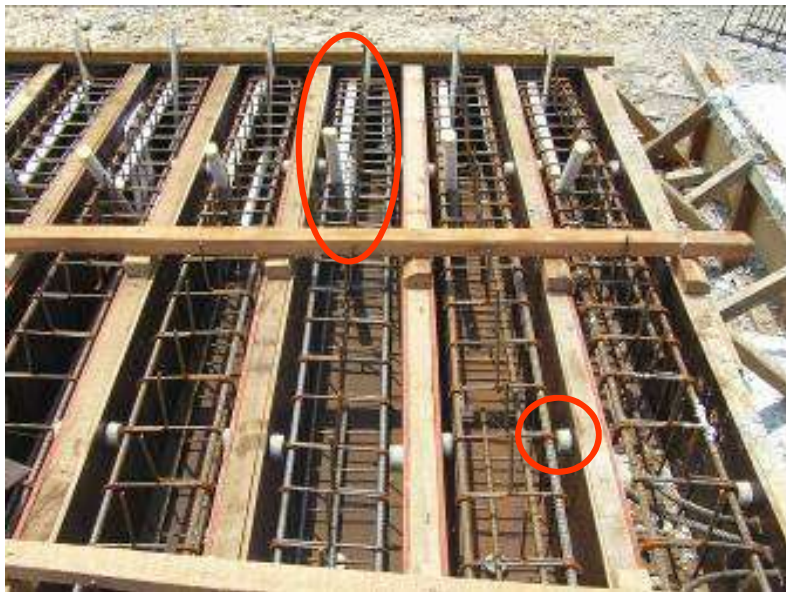




Pengecekan dimensi



Pemasangan tulangan, dan cek ketepatan posisi dengan beton dekinng



Pemasangan alat bantu untuk lubang grouting



Pemasangan angkur sambungan



## Pengecoran komponen

- PEMADAT BETON :**
- TIDAK MENGENAI TULANGAN
  - TEGAK LURUS BIDANG COR
  - TIDAK LEBIH 5 DETIK/TITIK

- K 3**
- SEPATU KERJA
  - HELM

## PERSIAPAN PELINDUNG HUJAN







Proses demolding







**PENGAMATAN :**

- DIMENSI
- KERETAKAN
- KEROPOS

**KODE PRODUKSI**

**PERAWATAN BETON JADI**



## PRODUCTION PROCESS CONTROL

| No | Process (Description)                    | Control Particulars  | Quality Specification (Standard / Criteria)  | Reference Standard | Method of Test                   | Size of Lot (Frequency) | Name of Record            | Person In Charge                                 |
|----|--|----------------------|--|--------------------|----------------------------------|-------------------------|---------------------------|--|
| 17 | Demoulding Inspection<br><br><b>C 20</b> | Timing of demoulding | Time curing 12 hrs min. (or 100 kg/cm <sup>2</sup> the crushing test was obtained) | -                  | Check to compressive test result | All quantity            | Demoulding Record         | Production (in charge of Demoulding)             |
|    |  | Method of demoulding | Do not apply harmful impacts   | -                  | -                                |                         |                           |  |
| 18 | Product Inspection                       | Appearance Shape     | Width of crack < 3mm   | PCI                | Visual                           | All                     | Product inspection result | Quality Control<br><br>(After Casting Inspector) |
|    |  |                      | No Damages to end faces  | PCI                |                                  |                         |                           |  |
|    |  |                      | Pockmarks on surfaces external   | PCI                |                                  |                         |                           |  |
|    |  |                      | No Stains from reinforcement   | PCI                |                                  |                         |                           |  |
|    |  |                      | Concrete surface is smooth   | PCI                |                                  |                         |                           |  |
|    |  |                      | Pinholes < 3mm   | PCI                |                                  |                         |                           |  |
|    |  |                      | Good in Square ness of end faces   | PCI                |                                  |                         |                           |  |
|    |  |                      | Steps at mould seams (joint) < 3mm   | PCI                |                                  |                         |                           |  |
|    |  |                      | No Leakages from mould seams   | PCI                |                                  |                         |                           |  |

# TOLERANSI PRODUK UNTUK ELEMEN PRECAST BERDASAR OAK PCI

| PRODUCT TOLERANCES   | PRODUCTS  |
|--|---|
| Length ___<br>± 1/4 in<br>± 3/8 in<br>± 1/2 in<br>± 3/4 in<br>± 1 in             | 18<br>16, 17<br>6, 7, 8, 9, 13, 15<br>3, 5<br>1, 2, 4, 11, 12, 14 |
| Width ___<br>± 1/4 in<br>± 3/8 in<br>± 1/4 in - ± 3/8 in<br>± 3/8 in<br>± 1/2 in | 1, 2, 3, 5, 6, 7, 8, 9, 12, 15, 16, 18<br>14<br>4<br>11, 13<br>17 |
| Depth ___<br>± 1/8 in - ± 1/4 in<br>± 1/4 in<br>± 1/4 in - ± 1/2 in<br>± 3/8 in  | 10, 18<br>1, 2, 3, 5, 6, 7, 8, 9, 12, 13, 14, 15<br>4<br>11       |

# TOLERANSI PRODUK UNTUK ELEMEN PRECAST REFERENSI PCI

| PRODUCT TOLERANCES  | PRODUCTS   |
|---|--|
| Flange thickness ____<br>± 1/8 in - ± 1/4 in<br>± 1/4 in                      | 1, 2, 8, 10, 12, 15<br>3, 4                      |
| Web thickness ____<br>± 1/8 in<br>± 1/4 in<br>± 1/4 in - ± 3/8 in<br>± 3/8 in | 1, 8, 10, 12, 15<br>2, 3<br>4<br>5               |
| Position of tendon ____<br>± 1/4 in<br>± 1/8 in                               | 1, 2, 3, 4, 5, 6, 8, 9, 11, 12, 14, 15 ,18<br>10 |
| Bearing plates, position ____<br>± 1/2 in<br>± 5/8 in                         | 1, 2, 3, 12, 15<br>4                             |



## TOLERANSI PRODUK UNTUK ELEMEN PRECAST

| KETERANGAN   | KETERANGAN   |
|--|--|
| <p>1 = double tee<br/>2 = single tee<br/>3 = building beam (rect. and ledger)<br/>4 = I-beam<br/>5 = box beam<br/>6 = column<br/>7 = hollow-core slab<br/>8 = ribbed wall panel<br/>9 = insulated wall panel</p> | <p>10 = architectural wall panel<br/>11 = pile<br/>12 = joist<br/>13 = step unit<br/>14 = sheet piling<br/>15 = single riser bleacher slabs<br/>16 = prison cell module - single<br/>17 = prison cell module - single<br/>18 = prestressed concrete panels for storage tanks</p> |

# SISTEM PRODUKSI DI PABRIK

- Komponen Tiang Pancang : Tiang Mini Beton Bertulang  
Tiang Persegi Beton Prategang  
Tiang Bulat Berongga Beton Prategang
- Komponen Struktur : Balok  
Kolom  
: Pelat : Hollow Core  
Pre slab  
Full Slab
- Komponen arsitektur : Beton Ringan  
Sandwich Panel  
Panel beton  
Calciboard  
Gypsum board

# SISTEM PRODUKSI DI PABRIK



Tiang pancang mini beton bertulang



Tiang pancang persegi beton prategang



Tiang pancang bulat berongga beton prategang



Tiang pancang persegi berongga beton prategang

# SISTEM PRODUKSI DI PABRIK



Kolom



Balok



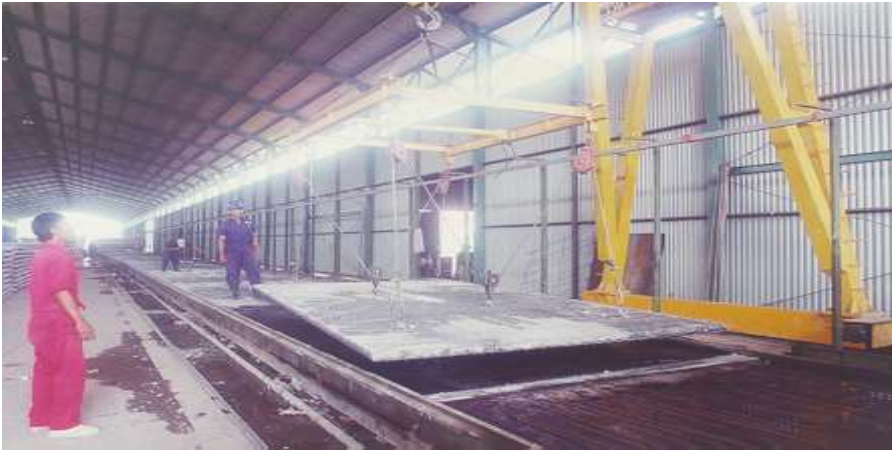
Pelat grid beton prategang



Half slab beton bertulang



# SISTEM PRODUKSI DI PABRIK



Preslab beton prategang



Hollow core beton prategang



Full slab beton prategang

# SISTEM PRODUKSI DI PABRIK

## Autoclaved Aerated Concrete

Autoclaved Aerated Concrete (AAC) adalah beton ringan terbuat dari bahan baku berkualitas tinggi, diproduksi dengan teknologi Jerman dan standar Deutch Industrie Norm. (DIN).



▶ Blok hebel



▶ Blok Jumbo hebel





# SISTEM PRODUKSI DI PABRIK

## How to Build with M-System



### EASY HANDLING

The lightweight of M-System Panels brings advantages to their use at the construction site. M-system Panels can be easily moved by one or two workers, even when assembled and measuring over time. They may be handled and placed by hand by only one worker without the need of using a lifting device. This makes their installation easier and faster in any situation without the need of skilled labor. Using skilled labour will markedly increase productivity. The extraordinary lightweight of M-system Panels allows for easy and rapid handling and carrying.



### EASY ERECTION

M-System Panels can be placed by hand and are connected one to another using either a pneumatic gun or ordinary construction wire.



### PLASTERING

Once the panels are assembled, after their vertical placing, the concrete is cast in case of double panels and the systems are laid. Then, the plaster can be directly sprayed on both sides. Here again, the advantages of the M-system Panel compared to other building methods are obvious as plaster of any type can be used with the supporting mesh. In addition, the plaster applied onto the strictly connected walls, reinforced by the metal mesh will turn out to become monolithic, which excludes any possible cracking due to mechanic and / or thermal stress. Moreover, chases do not need punching - which on the contrary is always so viable in traditional systems. So the plastering process would be more effective and efficient.



### EASE IN CONCRETING

Concrete is poured directly without any need for form work in case of double floor, stair and landing panel and sprayed directly in case of single as well as other panels.



### SIMPLICITY

Same panel for both floor and wall.



### CHASES

Chases are made by melting square foam behind the meshwork by means of a hot-air gun or any other source of heat.



### EASY INSTALLATION OF UTILITIES

As for the installation of the various systems (plumbing, heating, electric, telephone, etc.), the ease with which chases are made confirms once again the many advantages offered by this method. In fact, the operation is quickly carried out with no additional masonry assistance while the construction site is always clean. First, the paths of the various systems are marked on the wall, then the chases are made in the super foam by means of a hot-air generator or any other source of heat. At the end, pipes are placed behind the steel wire mesh.



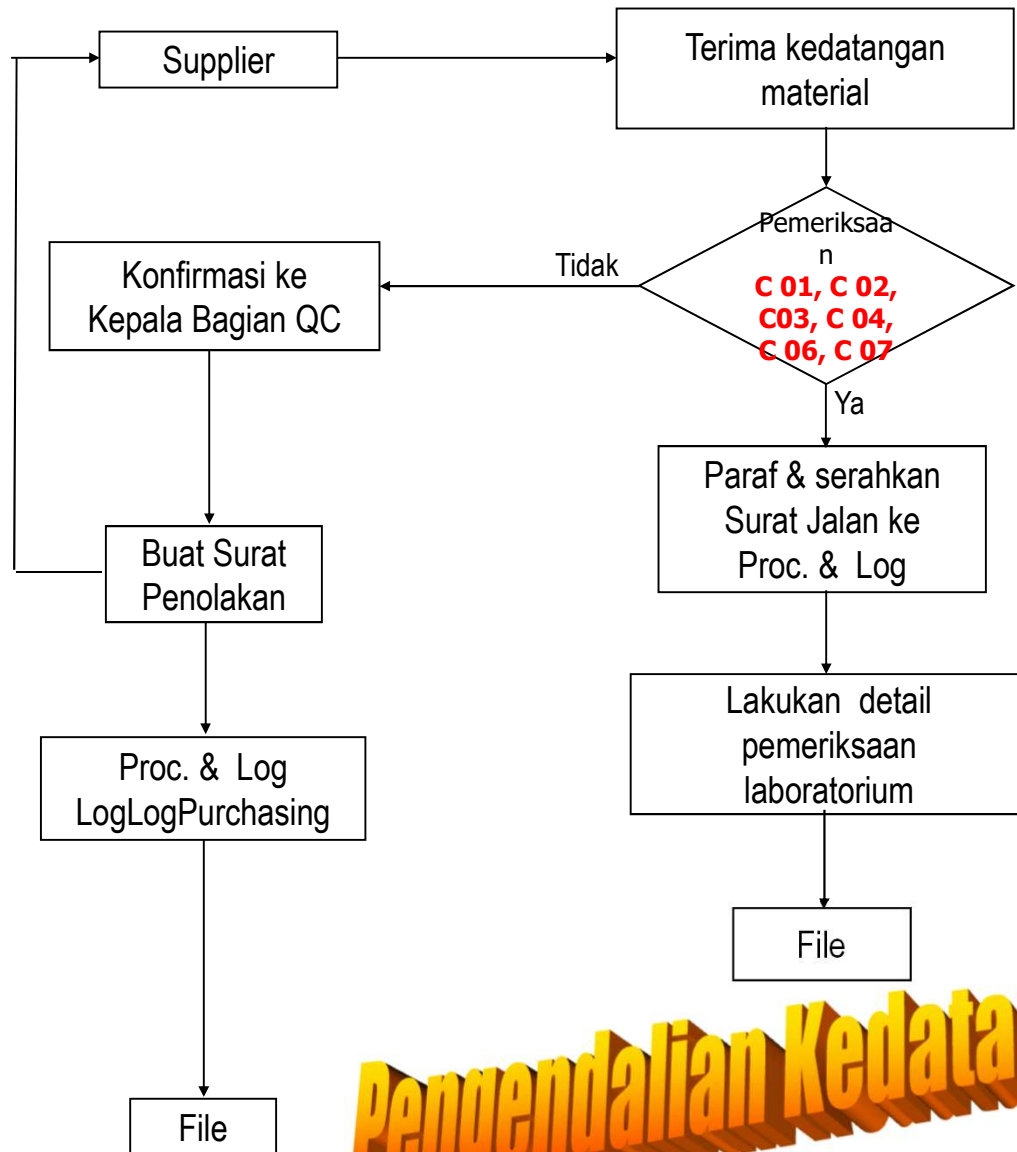
Rigid or semi-rigid pipes for public services (electricity, water, gas, etc.) are easily placed behind the wire mesh.



# SISTEM PRODUKSI DI PABRIK



Dinding façade beton bertulang



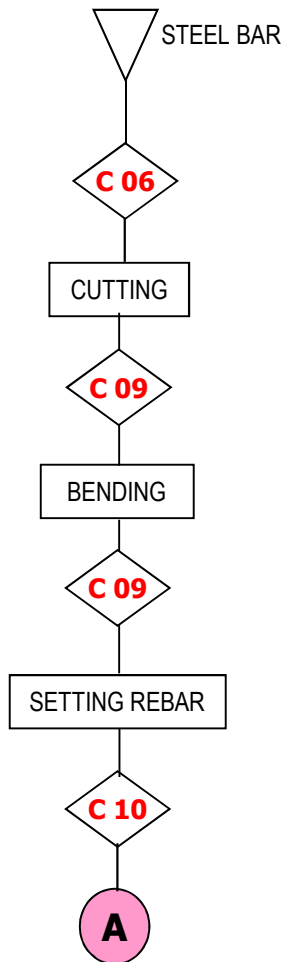
# Pengendalian Kedatangan Material



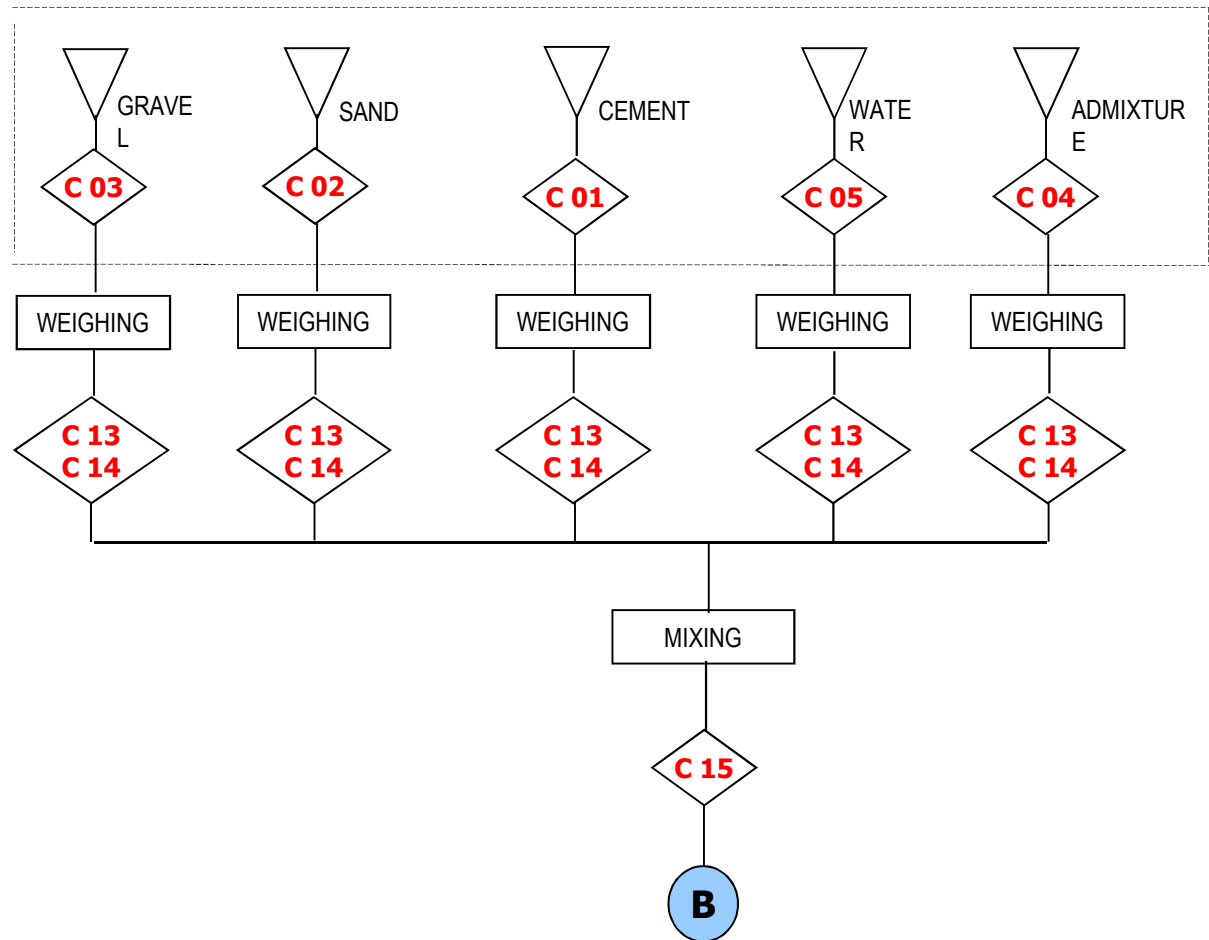


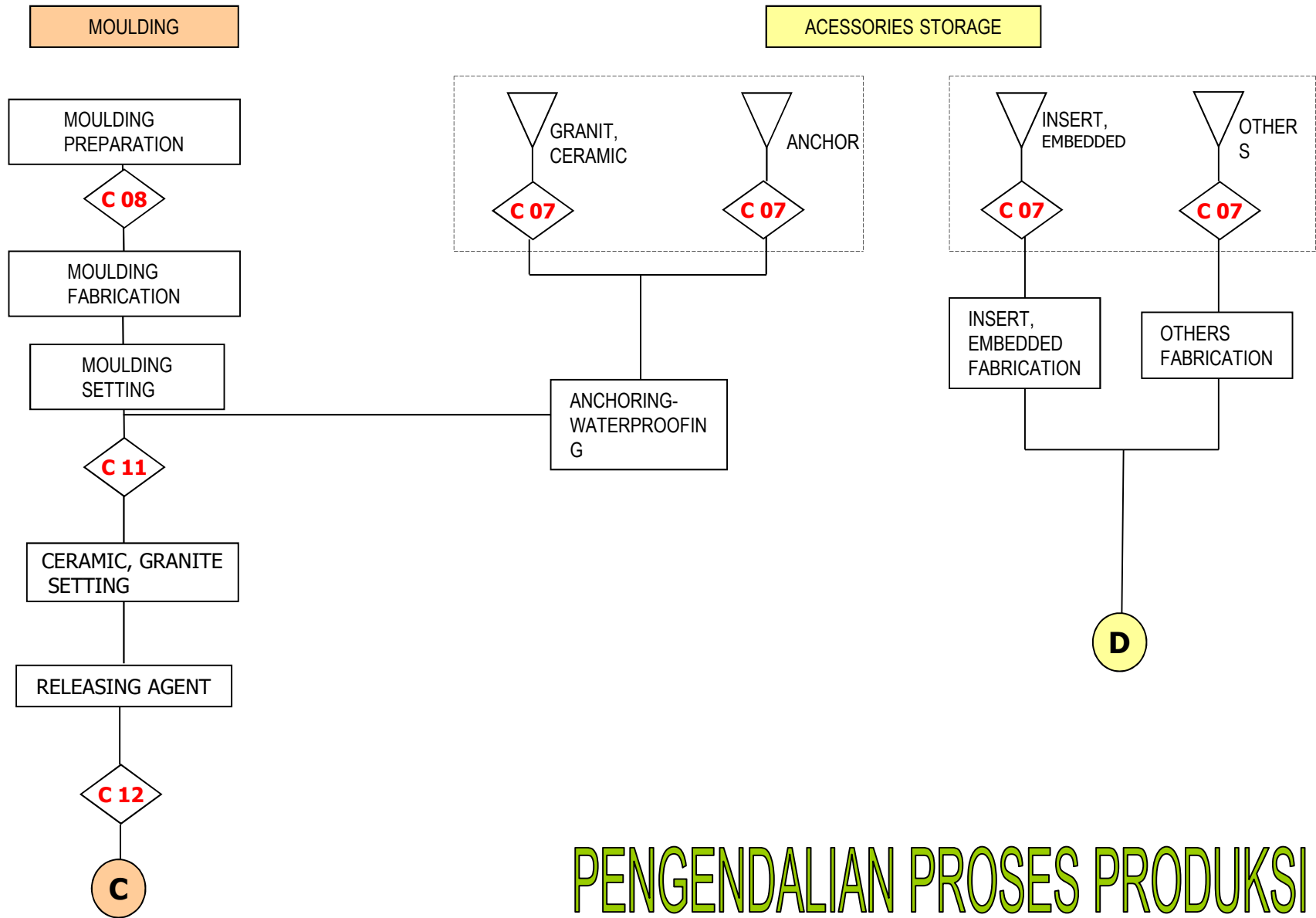
# Pengendalian Proses Produksi

## REINFORCEMENT



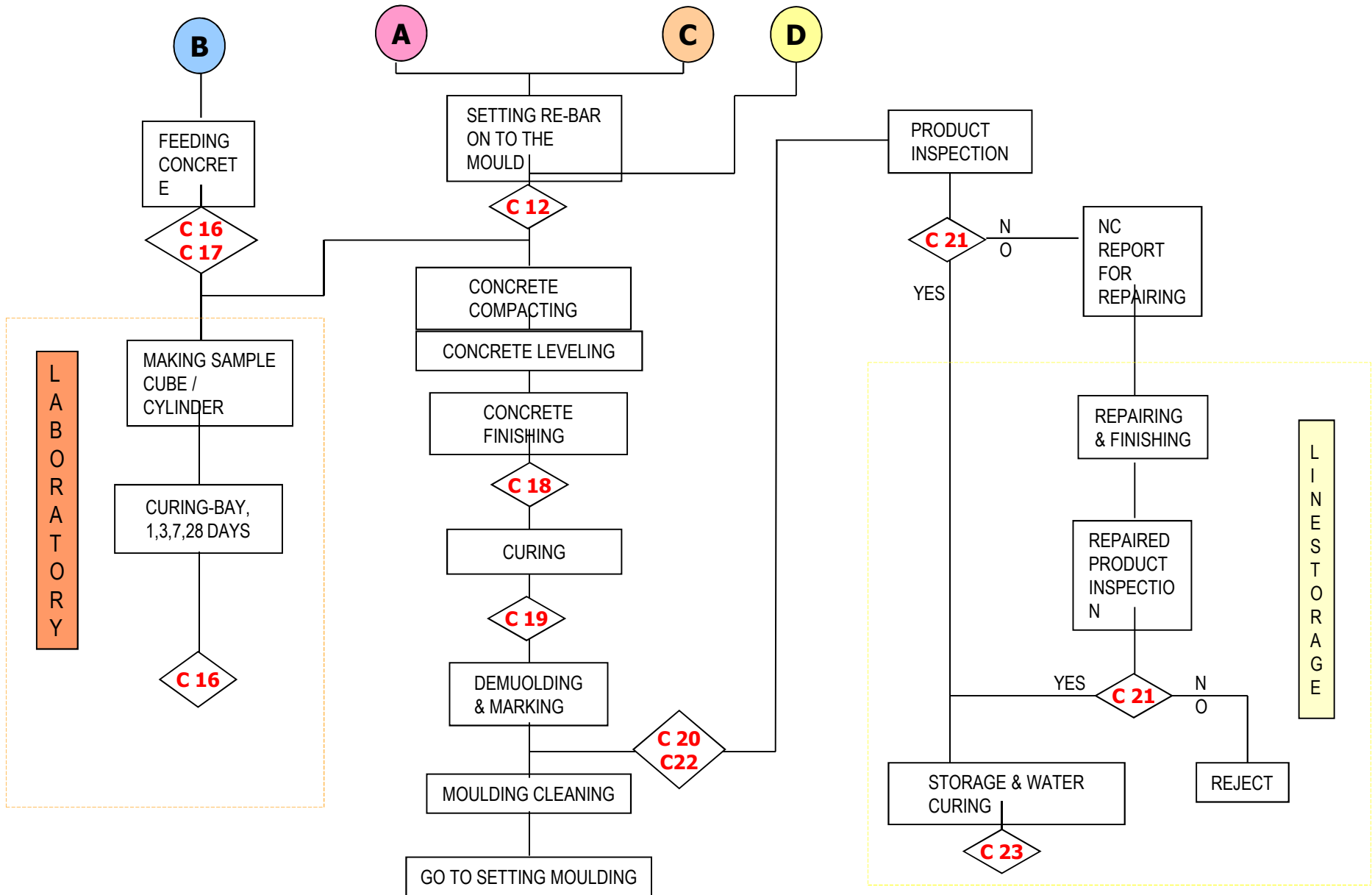
## BATCHING PLANT





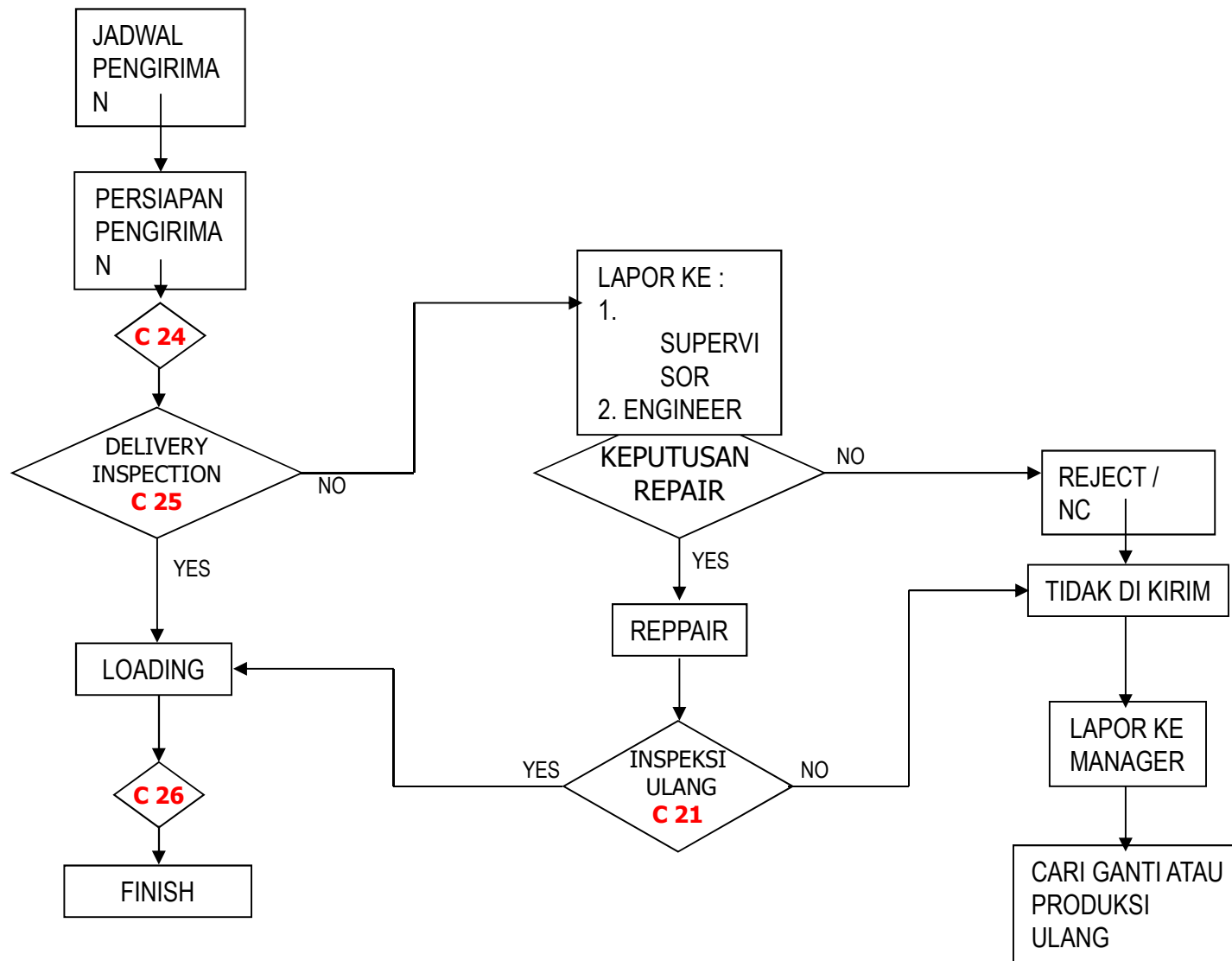
# PENGENDALIAN PROSES PRODUKSI

# PENGENDALIAN PROSES PRODUKSI





# PENGENDALIAN PROSES PENGIRIMAN



**MIX COMPOSITION**

Date of Trial : 20 Nov 2006

TARGET SPECIFICATION

|                   |   |  |
|-------------------|---|--|
| Class of concrete | : | K-350 at 28 days in cube test specimen |
| Slump             | : | 15 ± 2 cm                              |

SSDC SPECIFIC GRAVITY of MATERIAL

|           |   |                            |              |
|-----------|---|----------------------------|--------------|
| Gravel    | : | Quarindo (Max. size 20 mm) | <b>2.600</b> |
| Sand 1    | : | Belitung                   | <b>2.400</b> |
| Cement    | : | OPC 1                      | <b>3.150</b> |
| Admixture | : | SP 430                     | <b>1.180</b> |
| Additive  | : | ---                        | <b>3.150</b> |

RATIO CHARACTERISTIC

|                            |             |
|----------------------------|-------------|
| Water Cement Ratio (W / C) | <b>56</b> % |
| Sand proportion (S / A)    | <b>38</b> % |
| Air void content (± 1 %)   | <b>2</b> %  |

DESIGN CALCULATION

|           |     |                 |
|-----------|-----|-----------------|
| Cement    |     | <b>360</b> kg   |
| Additive  | %   | - kg            |
| Admixture | 1 % | <b>3.600</b> kg |
| Water     |     | <b>201.6</b> kg |

VOLUME

|                     |         |       |
|---------------------|---------|-------|
| Volume of Cement    | 114.286 | litre |
| Volume of Additive  | -       | litre |
| Volume of Water     | 201.600 | litre |
| Volume of Admixture | 3.051   | litre |
| Volume of Void      | 20.000  | litre |
| Volume of Aggregate | 661.063 | litre |

|                          |
|--------------------------|
| Average SG.<br>Aggregate |
| <b>2.52</b>              |

- Weight of material for 1m3 volume (kg on SSDC)

|                |               |               |               |       |                |
|----------------|---------------|---------------|---------------|-------|----------------|
| Gravel         | Sand          | Cement        | Water         | Adm.  | Add.           |
| <b>1032.92</b> | <b>633.08</b> | <b>360.00</b> | <b>201.60</b> | 3.600 | -              |
|                |               |               |               |       | TOTAL          |
|                |               |               |               |       | <b>2231.21</b> |

- Correction weight by actual moisture content

|                        |        |       |
|------------------------|--------|-------|
| Item                   | Gravel | Sand  |
| Absorption (%)         | 0.72   | 1.15  |
| Moisture Content (%)   | 2      | 3.4   |
| Difference (%)         | -1.28  | -2.25 |
| Correction Weight (kg) | -13.2  | -14.2 |

- Summary weight of material (kg on Actual condition)

|                |               |               |               |       |                |
|----------------|---------------|---------------|---------------|-------|----------------|
| Gravel         | Sand          | Cement        | Water         | Adm.  | Add.           |
| <b>1046.15</b> | <b>647.33</b> | <b>360.00</b> | <b>174.13</b> | 3.600 | -              |
|                |               |               |               |       | TOTAL          |
|                |               |               |               |       | <b>2231.21</b> |

- Necessary of material for trial

Volume = 0.0250 m<sup>3</sup>

|               |               |              |              |              |              |
|---------------|---------------|--------------|--------------|--------------|--------------|
| Gravel        | Sand          | Cement       | Water        | Adm.         | Add.         |
| <b>26.154</b> | <b>16.183</b> | <b>9.000</b> | <b>4.353</b> | <b>0.090</b> | -            |
|               |               |              |              |              | TOTAL        |
|               |               |              |              |              | <b>55.78</b> |

Testing Result

|                         |                          |                      |        |        |         |
|-------------------------|--------------------------|----------------------|--------|--------|---------|
| Slump<br>..... cm       | Air Content<br>..... %   | Compressive Strength |        |        |         |
|                         |                          | 1 day                | 3 days | 7 days | 28 days |
| Temperature<br>..... °C | Water adjust<br>..... ml |                      |        |        |         |
|                         |                          |                      |        |        |         |

Prepared by :

(Lab.  
Inspector)

**Remark :**

Approved by

(QC Engineer)



Project : MALL KELAPA GADING  
 Locatio : JAKARTA UTARA

CONCRETE QUALITY CONTROL CHART

Product Name : HALF SLAB  
 Customer : PT. DECORIENT INDONESIA

MONTH : DECEMBER 2006 - JANUARI 2007

| DESIGN SPECIFICATION              |             |           |  |
|-----------------------------------|-------------|-----------|--|
| Compressive Strength Design (K)   | : K- 350    | (28 Days) | Cement Type : OPC 1                          |
| Design Of Standard Deviation (SR) | : 40        | kg/cm2    | Max. Aggregate Size : 2.5 cm (crushed stone) |
| Coef. Failure Factor (k)          | : 1.64      | (for 5%)  | Test Piece Size : Cube 15x15x15 cm           |
| Slump Range (S)                   | : 15 + /- 3 | cm        | Curing Method : Natural Curing               |

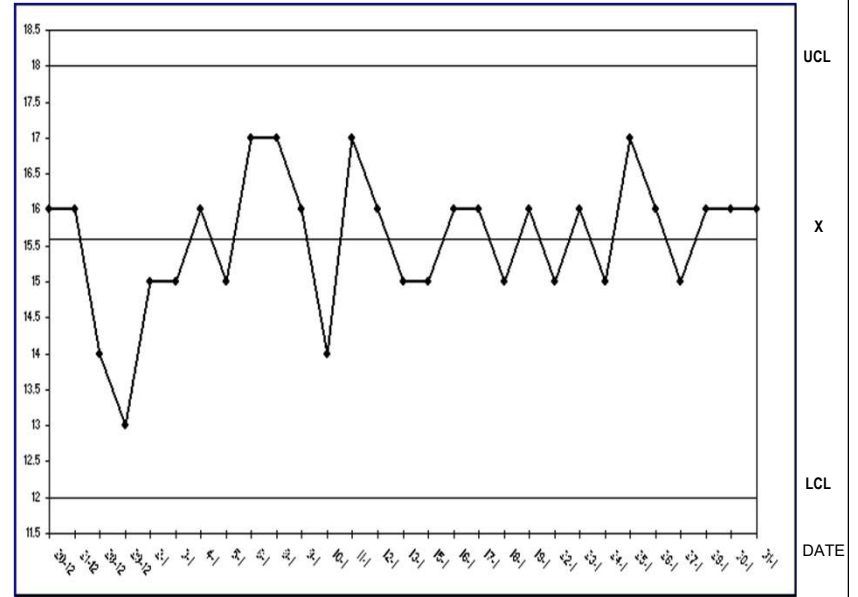
| TEST RESULT |              |            |   |      |        |       |        |       |         |       |
|-------------|--------------|------------|---|------|--------|-------|--------|-------|---------|-------|
| No.         | Casting Date | Slump (cm) | Average Compressive Strength ( Kg/cm2 ) |      |        |       |        |       |         |       |
|             |              |            | 1 day                                   |      | 3 days |       | 7 days |       | 28 days |       |
|             |              |            | X                                       | %    | X      | %     | X      | %     | X       | %     |
| 1           | 20-Dec       | 16.0       | 147                                     | 42.0 | 356    | 101.7 | 400    | 114.3 | 458     | 130.9 |
| 2           | 21-Dec       | 16.0       | 158                                     | 45.1 | 334    | 95.3  | 374    | 106.7 | 447     | 127.6 |
| 3           | 28-Dec       | 14.0       | 151                                     | 43.1 | 338    | 96.6  | 373    | 106.6 | 469     | 134.0 |
| 4           | 29-Dec       | 15.0       | 123                                     | 35.0 | 289    | 82.6  | 322    | 92.0  | 428     | 122.2 |
| 5           | 2-Jan        | 15.0       | 122                                     | 34.9 | 247    | 70.4  | 351    | 100.3 | 419     | 119.6 |
| 6           | 3-Jan        | 15.0       | 129                                     | 36.9 | 282    | 80.6  | 367    | 104.9 | 414     | 118.3 |
| 7           | 4-Jan        | 16.0       | 131                                     | 37.4 | 333    | 95.1  | 380    | 108.6 | 450     | 128.6 |
| 8           | 5-Jan        | 15.0       | 129                                     | 36.9 | 282    | 80.6  | 353    | 100.9 | 400     | 114.3 |
| 9           | 6-Jan        | 17.0       | 233                                     | 66.6 | 273    | 78.0  | 369    | 105.4 | 411     | 117.4 |
| 10          | 8-Jan        | 17.0       | 142                                     | 40.6 | 305    | 87.0  | 380    | 108.4 | 429     | 122.6 |
| 11          | 9-Jan        | 16.0       | 162                                     | 46.3 | 276    | 78.7  | 289    | 82.6  | 447     | 127.6 |
| 12          | 10-Jan       | 14.0       | 140                                     | 40.0 | 318    | 90.9  | 380    | 108.4 | 459     | 131.0 |
| 13          | 11-Jan       | 16.0       | 140                                     | 40.0 | 294    | 84    | 360    | 102.9 | 457     | 130.4 |
| 14          | 12-Jan       | 16.0       | 149                                     | 42.6 | 291    | 83    | 345    | 98.4  | 417     | 119.1 |
| 15          | 13-Jan       | 15.0       | 267                                     | 76.1 | 291    | 83    | 369    | 105.3 | 422     | 120.6 |
| 16          | 15-Jan       | 15.0       | 138                                     | 39.3 | 305    | 87    | 342    | 97.7  | 433     | 123.8 |
| 17          | 16-Jan       | 16.0       | 144                                     | 41.1 | 278    | 79    | 378    | 108.0 | 419     | 119.6 |
| 18          | 17-Jan       | 16.0       | 149                                     | 42.6 | 336    | 96    | 349    | 99.7  | 428     | 122.3 |
| 19          | 18-Jan       | 15.0       | 156                                     | 44.4 | 347    | 99    | 376    | 107.3 | 451     | 128.9 |
| 20          | 19-Jan       | 16.0       | 258                                     | 73.6 | 240    | 68    | 320    | 91.3  | 389     | 111.1 |
| 21          | 22-Jan       | 15.0       | 124                                     | 35.4 | 278    | 79    | 349    | 99.7  | 428     | 122.1 |
| 22          | 23-Jan       | 16.0       | 118                                     | 33.6 | 278    | 79    | 338    | 96.6  | 447     | 127.6 |
| 23          | 24-Jan       | 15.0       | 140                                     | 40.0 | 289    | 82    | 366    | 104.6 | 468     | 133.6 |
| 24          | 25-Jan       | 17.0       | 171                                     | 48.9 | 365    | 104   | 398    | 113.7 | 476     | 135.9 |
| 25          | 26-Jan       | 16.0       | 160                                     | 45.7 | 298    | 85    | 380    | 108.6 | 459     | 131.1 |
| 26          | 27-Jan       | 15.0       | 236                                     | 67.3 | 276    | 79    | 300    | 85.7  | 411     | 117.4 |
| 27          | 29-Jan       | 16.0       | 113                                     | 32.3 | 280    | 80    | 355    | 101.4 | 399     | 113.9 |
| 28          | 30-Jan       | 16.0       | 138                                     | 39.3 | 295    | 84    | 389    | 111.1 | 449     | 128.2 |
| 29          | 31-Jan       | 16.0       | 149                                     | 42.4 | 258    | 73.6  | 376    | 107.3 | 460     | 131.4 |
| AVERAGE     |              |            | 156                                     | 44.5 | 297    | 85.0  | 359    | 102.7 | 436     | 124.5 |

| CHECKING CALCULATION :                             |         |        |   |
|--|---------|--------|---|
| Actual Standard Deviation ( Kg/cm2 )               | 28 days |        |   |
| SD = $\sqrt{\frac{1}{(N-1)} \sum (X - \bar{X})^2}$ | 23.27   | kg/cm2 | % SD to design SR = (SD/SR) * 100 = 58.19 %   |
|  |         |        | Variation Coefficient = (SD/X) * 100 = 5.34 % |

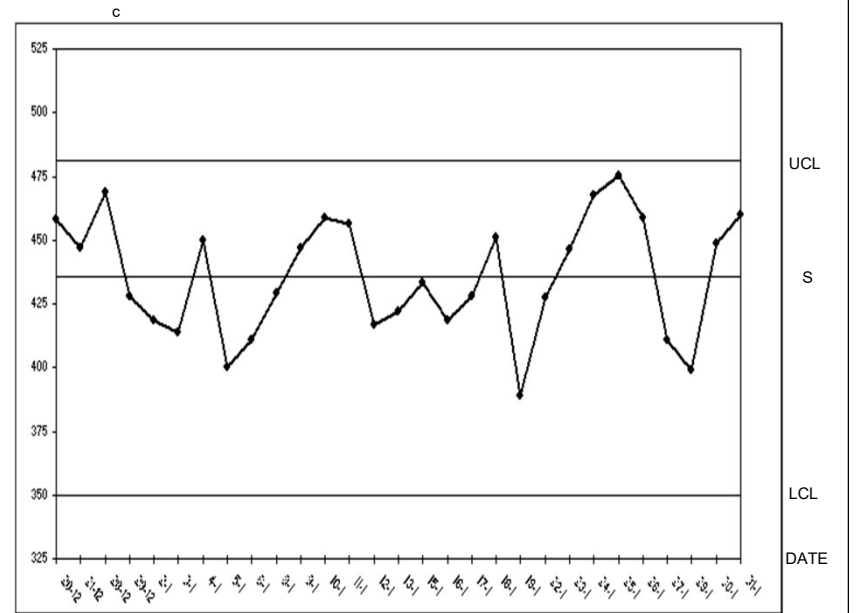
| X CHART at 28 days                                     | Remarks : | Quality Control Div. |
|--|-----------|----------------------|
| X (Average) = 436 kg/cm2                               |           |                      |
| Uper Control Limit (UCL) & Lower Control Limit (LCL) : |           |                      |
| UCL = K + 1.64 x SR x 2 = 481 kg/cm2                   |           |                      |
| LCL = K = 350 kg/cm2                                   |           |                      |

Compressive Strength Control Chart

X Chart at 28 days



Slump Control Chart





|           |                           |            |                    |
|-----------|---------------------------|------------|--------------------|
|           | FORMULIR                  | Kode Dok.  | :F-QCL-010         |
|           | <b>PRODUCT INSPECTION</b> | Revisi No. | : 0                |
|           |                           | Halaman    | : 1                |
|           | PRODUCT TYPE:             | Tgl Terbit | : January 12, 2006 |
| TYPE NO.: | PROJECT                   | :          |                    |

**DAFTAR PERIKSA KUALITAS PRODUK / CHECK-LIST OF PRODUCT QUALITY**

LEMBAR NO. : SHEET NO.

| NO.                   | PARAMETER  | HASIL / RESULT                       |     | TINDAKAN PERBAIKAN <i>REPAIR</i> |                           | KOLOM KONTROL<br><i>CONTROL COLUMN</i> |
|-----------------------|--|--------------------------------------|-----|----------------------------------|---------------------------|--|
|                       |  | OK                                   | NOK | PERBAIKAN KE-1 / TANGGAL:        | PERBAIKAN KE-2 / TANGGAL: |  |
| 1.                    | DIMENSI/ <i>DIMENSION, TOLERANCE</i> ± 5 mm            |                                      |     |                                  |                           | <i>SIGN OF QC INSPECTOR:</i>           |
|                       | 1.1 PANJANG/ <i>LENGTH</i>                             |                                      |     |                                  |                           |  |
|                       | 1.2 LEBAR/ <i>WIDTH</i>                                |                                      |     |                                  |                           |  |
|                       | 1.3 TINGGI/ <i>HEIGHT</i>                              |                                      |     |                                  |                           |  |
|                       | 1.4 DIAGONAL   |                                      |     |                                  |                           |  |
|                       | 1.5 BUKAAN/ <i>OPENING</i>                             |                                      |     |                                  |                           |  |
|                       | 1.6 SUDUT/ <i>CORNER</i>                               |                                      |     |                                  |                           |  |
| 2.                    | PEMERIKSAAN TAMPAK/ <i>VISUAL CHECK.</i>               |                                      |     |                                  |                           | <i>SIGN OF REPAIR FOREMAN:</i>         |
|                       | 2.1 TIDAK KROPOS / <i>HONEY COMB FREE</i>              |                                      |     |                                  |                           |  |
|                       | 2.2 TIDAK ADA RETAKAN / <i>CRACK FREE</i>              |                                      |     |                                  |                           |  |
|                       | 2.3 TIDAK ADA PORI / <i>NO PIN-HOLES &gt;3 mm</i>      |                                      |     |                                  |                           |  |
|                       | 2.4 TIDAK ADA GOMPAL / <i>NO DEFECT</i>                |                                      |     |                                  |                           |  |
|                       | 2.5 TIDAK ADA BOCOR SEMEN / <i>LOOSE CONCRETE FREE</i> |                                      |     |                                  |                           |  |
| 3.                    | LAIN-LAIN/ <i>OTHERS</i>                               |                                      |     |                                  |                           | <i>SIGN OF FINAL INSPECTOR:</i>        |
|                       | 3.1 ANCHOR   |                                      |     |                                  |                           |  |
|                       | 3.2 INSERT   |                                      |     |                                  |                           |  |
|                       | 3.3 BRACKET  |                                      |     |                                  |                           |  |
|                       | 3.4 .....  |                                      |     |                                  |                           |  |
| Tanggal/ <i>DATE:</i> |  | Diperiksa oleh:<br><i>CHECKED BY</i> |     | <i>STATUS</i>                    | PASSED                    | <i>Date:</i>                           |
|                       |  |                                      |     |                                  | REJECTED                  |  |
| <i>QA Approval:</i>   |  |                                      |     |                                  |                           |  |

**LAMPIRAN-LAMPIRAN / ATTACHMENTS:**

1. DRAWING NO. : .....

2. CUBE TEST NO.: .....

|               |  |                   |           |            |
|---------------|--|-------------------|-----------|------------|
|               |  |                   |           |            |
| Project       |  | <b>Q.C PASSED</b> |           |            |
| Type of Panel |  | P.T G.I           | Main Con. | Consultant |
| Casting Date  |  |                   |           |            |

Dokumen No. : F-QCL-007  
 Revisi : 1  
 Tanggal Terbit : September 25, 2006

Proses quality control sistem pracetak bersifat “built in” dalam metoda. Jika ada sesuatu kesalahan dalam proses produksi, produk akan cacat saat lahir, sehingga dapat langsung direject atau direpair (jika dimungkinkan) sebelum dikirim ke lapangan

Produk yang dikirim ke lapangan harus tidak boleh cacat !



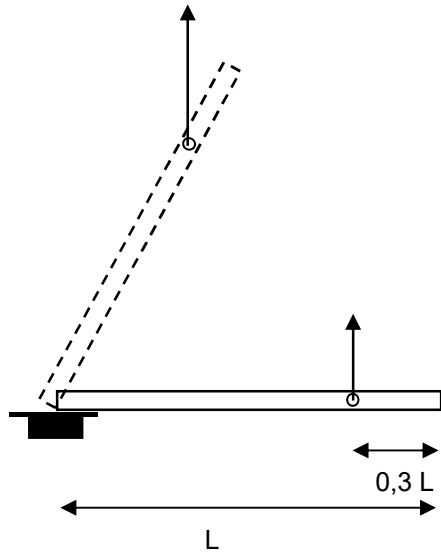
# 6. SISTEM HANDLING, STOCKING DAN TRANSPORTASI





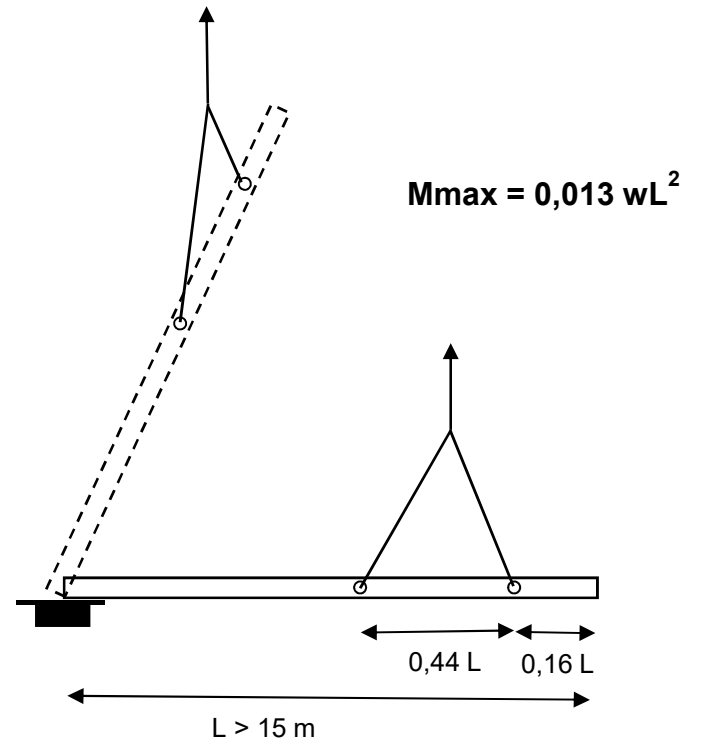
Sistem handling merupakan kombinasi dari bentuk dan berat komponen serta peralatan yang digunakan. Sistem harus direncanakan dengan baik agar dapat mampu memindah-mindahkan komponen tanpa mengakibatkan kerusakan



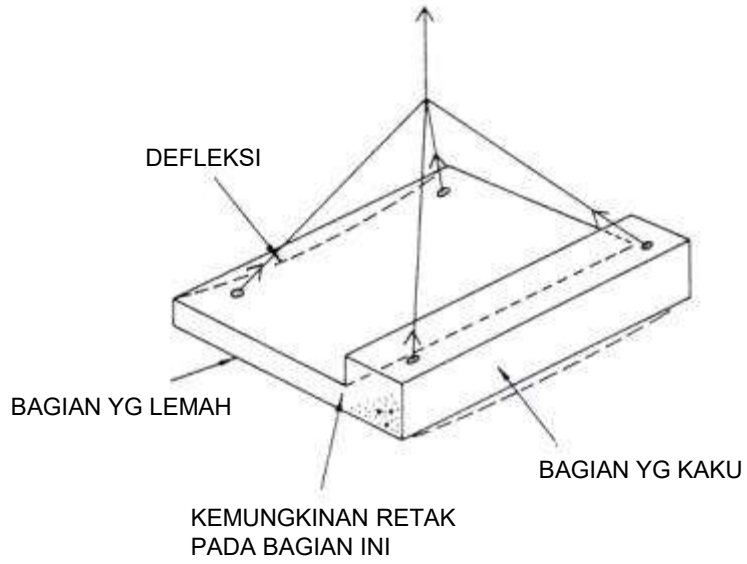


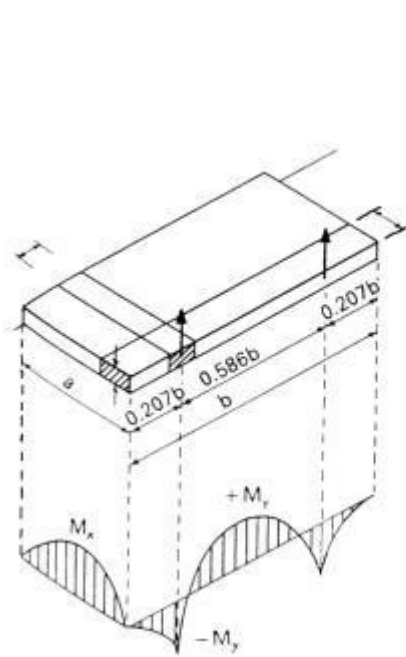
$$M_{max} = 0,045 wL^2$$

w = berat sendiri + 25% beban kejut

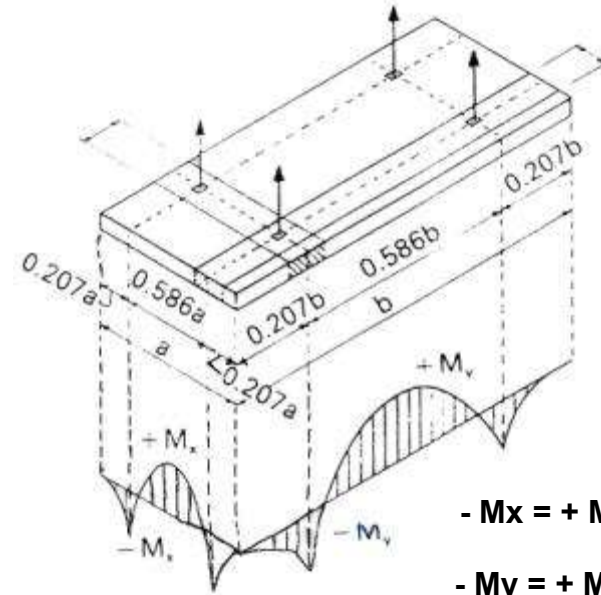


$$M_{max} = 0,013 wL^2$$

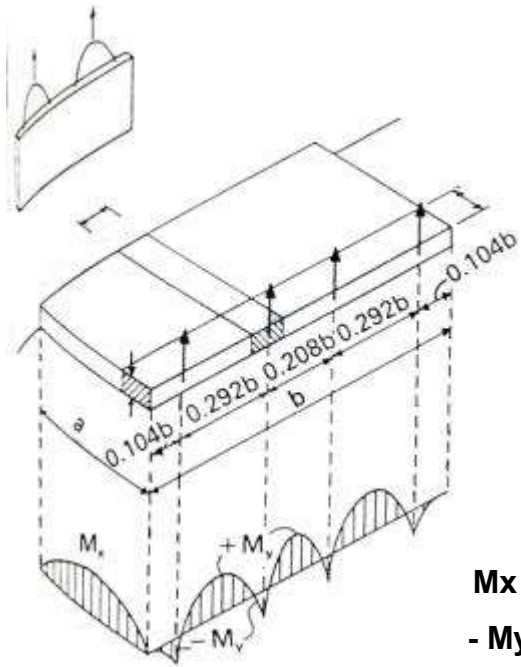




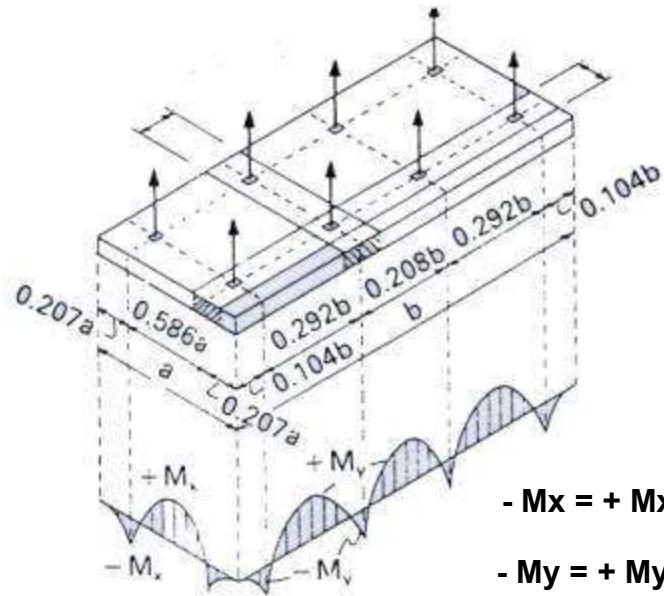
$M_x = 1/8 wba^2$   
 $- M_y = + M_y = 0,0107 wab^2$



$- M_x = + M_x = 0,0107 wba^2$   
 $- M_y = + M_y = 0,0107 wab^2$



$M_x = 1/8 wba^2$   
 $- M_y = + M_y = 0,0027 wab^2$



$- M_x = + M_x = 0,0054 wba^2$   
 $- M_y = + M_y = 0,0107 wab^2$

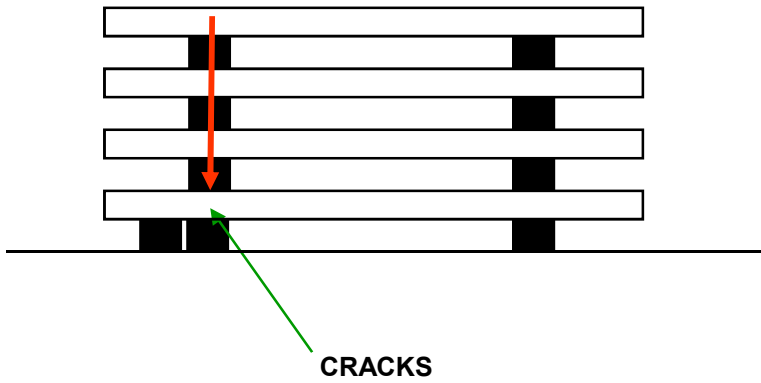
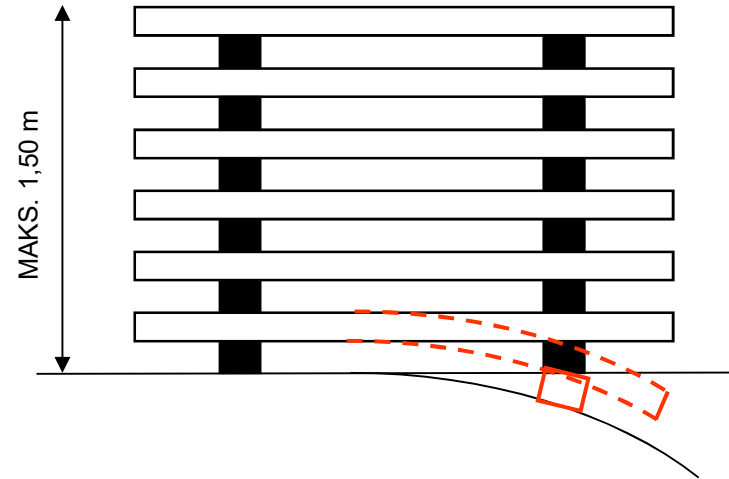
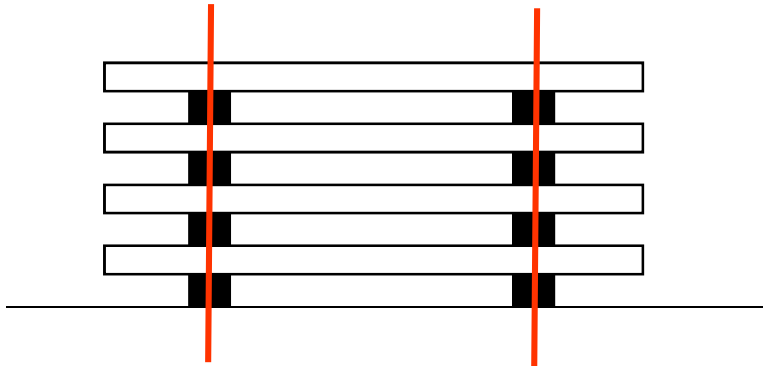




Perencanaan sistem stocking menyangkut layout penempatan dan urutan penumpukan agar komponen dapat mudah diambil sesuai dengan kebutuhan pelaksanaan serta perencanaan landasan, penumpu, dan jumlah tumpukan maksimum agar komponen tidak mengalami kerusakan.













## PRODUCTION PROCESS CONTROL

| No | Process (Description)                   | Control Particulars               | Quality Specification (Standard / Criteria)                      | Reference Standard | Method of Test | Size of Lot (Frequency) | Name of Record             | Person In Charge                                   |
|----|---|-----------------------------------|--|--------------------|----------------|-------------------------|----------------------------|--|
| 19 | Marking<br><br><b>C 22</b>              | Marking details                   | According to standard  | -                  | Visual         | All (passes products)   | -                          | Production (in charge of inspection)               |
|    |   |                                   | Clean  | -                  | Visual         |                         |                            |  |
| 20 | Storage<br><br><b>C 23</b>              | Stacking Height                   | Support from wood  | -                  | Visual         | All Quantity            | -                          | Delivery   |
|    |   |                                   | Support position at handling point and linier in vertical toward |                    |                |                         |                            |  |
| 21 | Delivery Preparation<br><br><b>C 24</b> | Accessories                       | Conform to instruction (attached or put in product)              | -                  | Visual         | All Quantity            | Final Inspection checklist | Delivery (in charged of delivery)                  |
|    |   | Condition of delivery preparation | Appearance, Mark, Age, Accessories                               | -                  | Visual         |                         |                            |  |
|    |   | Product inspection                | Confirmation of entries  | -                  | Visual         |                         |                            |  |
| 22 | Delivery Inspection<br><br><b>C 25</b>  | Appearance shape                  | Same as moulding & good in appearance                            | -                  | Visual         | All Quantity            | Delivery Inspection sheet  | Quality Control (in charge of delivery inspection) |
|    |   | Type                              | Check with delivery instructions                                 | -                  | Visual         |                         |                            |  |
|    |   | Marking                           | Details, clarity   | -                  | Visual         |                         |                            |  |
|    |   | Age                               | 3 days or more   | -                  | Visual         |                         |                            |  |
|    |   | Quantity                          | Check with delivery instructions                                 | -                  | Visual         |                         |                            |  |
| 23 | Delivery<br><br><b>C 26</b>             | Condition of loading secure       | Good at support, guard, height, weight, slink.                   | -                  | Visual         | At every delivery       | Delivery note              | Delivery (Delivery inspector)                      |
|    |   | Delivery note                     | Conform to type and  | -                  | Visual         |                         |                            |  |



Fig 5.2.18 Equations for equal tensile stresses top and bottom-unsymmetrical members

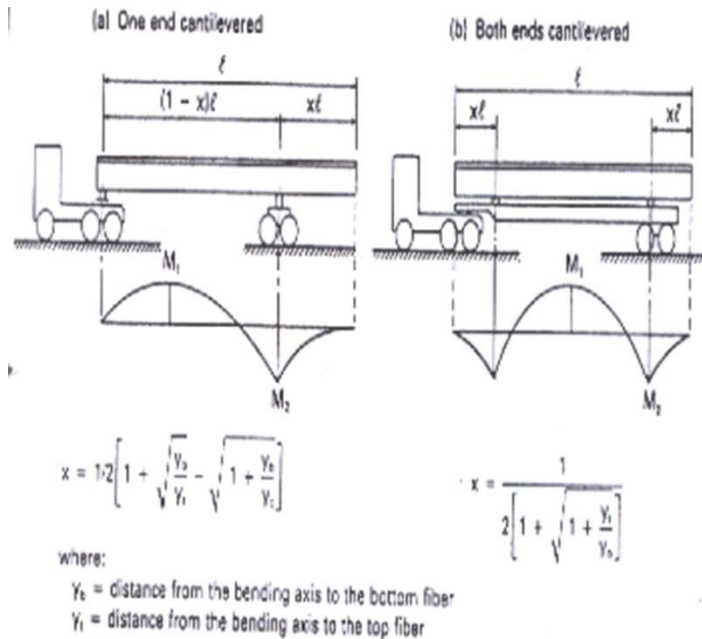
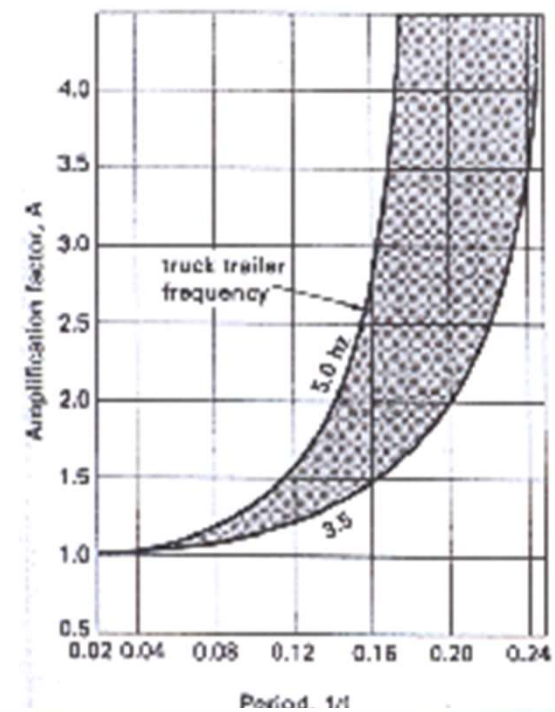


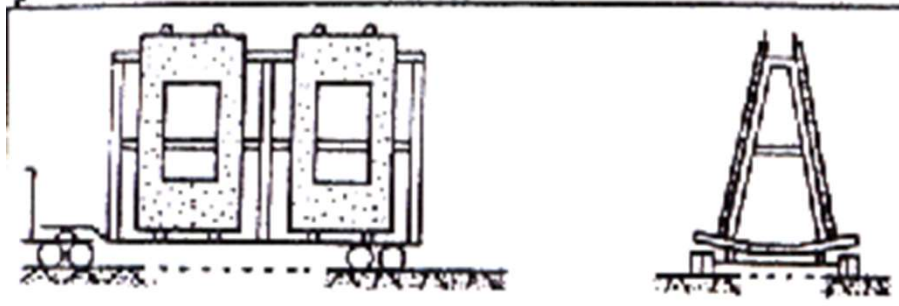
Fig 5.2.19 Load amplification factors



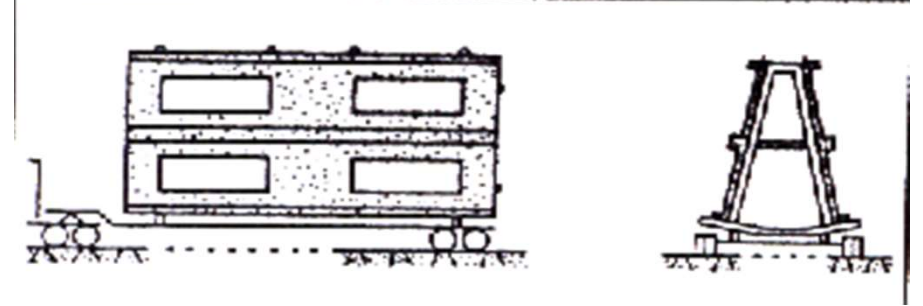
Sistem transportasi menyangkut pemilihan alat transportasi, pemilihan penumpang atau alat bantu yang harus menjamin komponen tidak rusak selama proses transportasi, termasuk akibat beban-beban dinamik



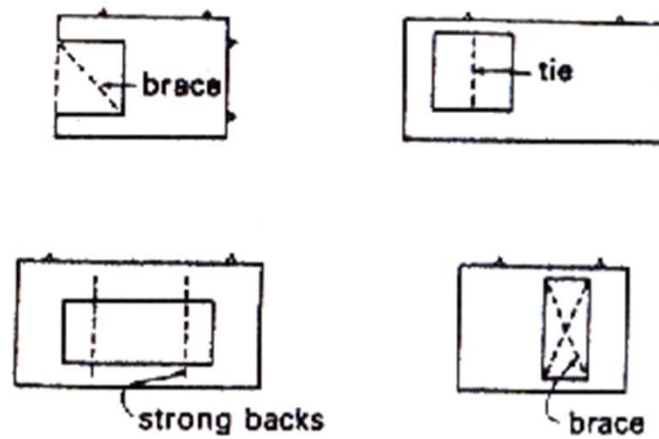
**Fig. 5.2.15 Transportation of single-story panels**



**Fig. 5.2.16 Transportation of multi-story panels**



**Fig. 5.2.17 Methods of temporary strengthening of panels with significant openings**



# 7. SISTEM PEMASANGAN DAN PENYAMBUNGAN

- Sistem pemasangan menyangkut pemilihan alat angkut yang disesuaikan dengan karakter lokasi, dimensi dan berat komponen; peralatan pembantu; peralatan pengukuran untuk menset komponen agar memenuhi persyaratan toleransi pemasangan, serta pekerja pemasang.
- Sistem penyambungan menyangkut penyiapan material dan peralatan pembantu sambungan. Material umumnya berupa ankur penyambung dan grouting tidak susut untuk menyatukan komponen dan/atau ankur-ankurnya.





Peralatan Hydraulic Hammer

Pekerjaan pemancangan



Peralatan Diesel Hammer



# PEMILIHAN JENIS HAMMER

## ◆ Diesel Hammer

## ◆ Hydraulic Hammer

$$\frac{Wh}{Wp} = \frac{4.5}{8.83} = 0.51$$

$$\frac{Wh}{Wp} = \frac{9.5}{8.83} = 1.07$$

**Panduan ideal:**  
 **$Wh/Wp = 0.3$  sd  $1$**

Polusi Asap

Tidak Ada Asap

Tinggi Jatuh  
Tergantung Perlawanan  
Tanah

**REFEREN**  
**SI:**  
**J.**  
**BOWLES**  
**atau**

Tinggi Jatuh  
Bisa Diatur Operator

**lainnya**

Tingkat kebisingan  
Dan getaran besar

Relatif lebih bisa  
diatur

Biaya Driving  
relatif lebih murah

Biaya Driving  
relatif lebih mahal

## HAL2 YANG PERLU DIKONTROL “DURING DRIVING”

1. **Positioning titik pancang** (berdasarkan staking out berupa patok kayu, paku+ rafia, dan titik bantu).
2. **Kontrol “verticality”** (ideal dg 2 theodolit, namun dg Plumber/unting2 dalam 2 arah tegak lurus umumnya memadai). (**rule 1:75 atau 1:80**)
3. Tergantung panjang tiang dan kondisi tanah, namun umumnya: **jumlah pukulan dibatasi 1000 sd 1500 blows.**
4. Hasil akhir **final set** (sesuai Formula Dinamis), maupun **posisi pergeseran** aktual arah X dan Y, diupayakan dalam batas toleransi (sesuai ketentuan konsultan: umumnya **7,5cm sd 10cm**).
5. Jika terjadi hal2 yang diluar toleransi, perlu dibicarakan dengan konsultan perencana, terkait dg daya dukung efektif yang bisa dipertimbangkan.

# FORMULA DINAMIS **MODIFIED ENR**

$$Pa = \frac{eh.Wr.h}{S + 0.254} \times \frac{Wr + (n^2.Wp)}{Wr + Wp} \times \frac{1}{Sf}$$

**Pa = Bearing Capacity of Pile**

**Wr = Weight of Ram**

**Wp = Weight of Pile**

**h = Height of free fall of Ram**

**n = Restitution Coefficient = 0.85**

**eh = efficiency factor = 0.85**

**Sf = Safety factor = 6**

# CONTOH FORM PDR & GRAFIK FINAL SET

**PT. JHS PILING SYSTEM**  
PILE DRIVING RECORD

Piling No.: 45

PROJECT : GRPKC  
CONTRACTOR : JHS

Hammer Type : K35  
Unit No. : 02  
Hammer Weight : 3500kg  
Ram Stroke : C

Axis No. : 104  
Date : 28.6.06  
Time Started :  
Time Completed :

| Penetration (M CM) | BLOW | Penetration (Metric) (M CM) | BLOW | Penetration (Metric) (M CM) | BLOW |
|--------------------|------|-----------------------------|------|-----------------------------|------|
| 0                  |      | 10                          | 15   | 20                          | 30   |
|                    |      | 50                          | 221  | 50                          | 30   |
| 50                 | 1    | 11                          | 260  | 31                          | 30   |
|                    |      | 50                          | 301  | 50                          | 30   |
| 50                 | 2    | 12                          | 352  | 22                          | 30   |
|                    |      | 50                          | 404  | 50                          | 30   |
| 50                 | 3    | 13                          | 473  | 23                          | 30   |
|                    |      | 50                          | 021  | 50                          | 30   |
| 50                 | 4    | 14                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 8    | 15                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 13   | 16                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 20   | 17                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 26   | 18                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 33   | 19                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 41   | 20                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 54   | 21                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 69   | 22                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 85   | 23                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 99   | 24                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |
| 50                 | 118  | 25                          |      | 50                          | 30   |
|                    |      | 50                          |      | 50                          | 30   |

FINAL SET : 0,3 cm    PILE LENGTH : 13,2 m

100% BLOW : 621 cm    DEPTH PENETRATION : 13,20 m

PROBLEM RECORD :  
Dolly Rt + mas

PT JHS REPRESENTATIVE :  
S. H. H.

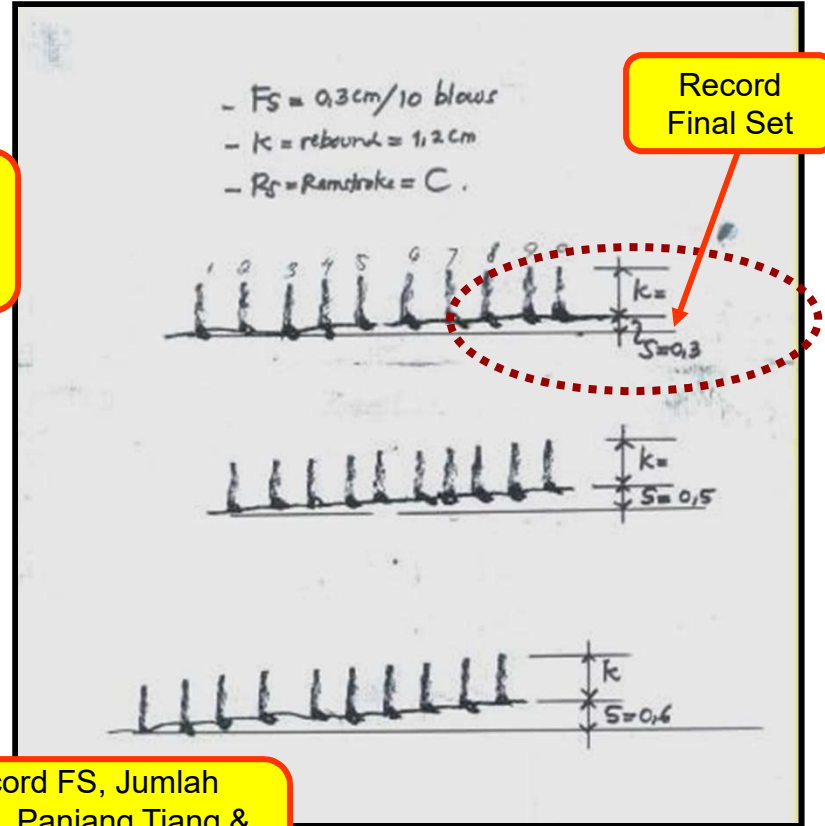
CLIENTS REPRESENTATIVE :  
M. H.

FINAL POSITION

OPERATION HEAD

Data Aksis dan Tanggal Pelaksanaan

Data Teknis hammer dan Jumping Head aktual



ID TIANG

Record FS, Jumlah Blows, Panjang Tiang & Kedalaman tiang terpancang



# PRESSURE/JACKING PILE



Memancang  
tanpa suara  
dan getaran



TABEL PERHITUNGAN KONVERSI:  
HYDRAULIC PRESSURED vs GAYA KOMPRESI TIANG PANCANG  
ZYC 240 B - S HYDRAULIC STATIC PILE DRIVER

| Pressure (Max) (Mpa) | Piling Pressure (1) (Sylinder 1) (T) | Piling Pressure (2) (Sylinder 2) (T) | Piling Pressure (3) (Sylinder 3) (T) |
|----------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| 3.50                 | 39.69                                | 39.69                                | 119.07                               |
| 3.58                 | 39.73                                | 39.73                                | 119.19                               |
| 3.66                 | 39.77                                | 39.77                                | 119.31                               |
| 3.74                 | 39.81                                | 39.81                                | 119.43                               |
| 3.82                 | 39.85                                | 39.85                                | 119.55                               |
| 3.90                 | 39.89                                | 39.89                                | 119.67                               |
| 3.98                 | 39.93                                | 39.93                                | 119.79                               |
| 4.06                 | 39.97                                | 39.97                                | 119.91                               |
| 4.14                 | 40.01                                | 40.01                                | 120.03                               |
| 4.22                 | 40.05                                | 40.05                                | 120.15                               |
| 4.30                 | 40.09                                | 40.09                                | 120.27                               |
| 4.38                 | 40.13                                | 40.13                                | 120.39                               |
| 4.46                 | 40.17                                | 40.17                                | 120.51                               |
| 4.54                 | 40.21                                | 40.21                                | 120.63                               |
| 4.62                 | 40.25                                | 40.25                                | 120.75                               |
| 4.70                 | 40.29                                | 40.29                                | 120.87                               |
| 4.78                 | 40.33                                | 40.33                                | 120.99                               |
| 4.86                 | 40.37                                | 40.37                                | 121.11                               |
| 4.94                 | 40.41                                | 40.41                                | 121.23                               |
| 5.02                 | 40.45                                | 40.45                                | 121.35                               |
| 5.10                 | 40.49                                | 40.49                                | 121.47                               |
| 5.18                 | 40.53                                | 40.53                                | 121.59                               |
| 5.26                 | 40.57                                | 40.57                                | 121.71                               |
| 5.34                 | 40.61                                | 40.61                                | 121.83                               |
| 5.42                 | 40.65                                | 40.65                                | 121.95                               |
| 5.50                 | 40.69                                | 40.69                                | 122.07                               |
| 5.58                 | 40.73                                | 40.73                                | 122.19                               |
| 5.66                 | 40.77                                | 40.77                                | 122.31                               |
| 5.74                 | 40.81                                | 40.81                                | 122.43                               |
| 5.82                 | 40.85                                | 40.85                                | 122.55                               |
| 5.90                 | 40.89                                | 40.89                                | 122.67                               |
| 5.98                 | 40.93                                | 40.93                                | 122.79                               |
| 6.06                 | 40.97                                | 40.97                                | 122.91                               |
| 6.14                 | 41.01                                | 41.01                                | 123.03                               |
| 6.22                 | 41.05                                | 41.05                                | 123.15                               |
| 6.30                 | 41.09                                | 41.09                                | 123.27                               |
| 6.38                 | 41.13                                | 41.13                                | 123.39                               |
| 6.46                 | 41.17                                | 41.17                                | 123.51                               |
| 6.54                 | 41.21                                | 41.21                                | 123.63                               |
| 6.62                 | 41.25                                | 41.25                                | 123.75                               |
| 6.70                 | 41.29                                | 41.29                                | 123.87                               |
| 6.78                 | 41.33                                | 41.33                                | 123.99                               |
| 6.86                 | 41.37                                | 41.37                                | 124.11                               |
| 6.94                 | 41.41                                | 41.41                                | 124.23                               |
| 7.02                 | 41.45                                | 41.45                                | 124.35                               |
| 7.10                 | 41.49                                | 41.49                                | 124.47                               |
| 7.18                 | 41.53                                | 41.53                                | 124.59                               |
| 7.26                 | 41.57                                | 41.57                                | 124.71                               |
| 7.34                 | 41.61                                | 41.61                                | 124.83                               |
| 7.42                 | 41.65                                | 41.65                                | 124.95                               |
| 7.50                 | 41.69                                | 41.69                                | 125.07                               |
| 7.58                 | 41.73                                | 41.73                                | 125.19                               |
| 7.66                 | 41.77                                | 41.77                                | 125.31                               |
| 7.74                 | 41.81                                | 41.81                                | 125.43                               |
| 7.82                 | 41.85                                | 41.85                                | 125.55                               |
| 7.90                 | 41.89                                | 41.89                                | 125.67                               |
| 7.98                 | 41.93                                | 41.93                                | 125.79                               |
| 8.06                 | 41.97                                | 41.97                                | 125.91                               |
| 8.14                 | 42.01                                | 42.01                                | 126.03                               |
| 8.22                 | 42.05                                | 42.05                                | 126.15                               |
| 8.30                 | 42.09                                | 42.09                                | 126.27                               |
| 8.38                 | 42.13                                | 42.13                                | 126.39                               |
| 8.46                 | 42.17                                | 42.17                                | 126.51                               |
| 8.54                 | 42.21                                | 42.21                                | 126.63                               |
| 8.62                 | 42.25                                | 42.25                                | 126.75                               |
| 8.70                 | 42.29                                | 42.29                                | 126.87                               |
| 8.78                 | 42.33                                | 42.33                                | 126.99                               |
| 8.86                 | 42.37                                | 42.37                                | 127.11                               |
| 8.94                 | 42.41                                | 42.41                                | 127.23                               |
| 9.02                 | 42.45                                | 42.45                                | 127.35                               |
| 9.10                 | 42.49                                | 42.49                                | 127.47                               |
| 9.18                 | 42.53                                | 42.53                                | 127.59                               |
| 9.26                 | 42.57                                | 42.57                                | 127.71                               |
| 9.34                 | 42.61                                | 42.61                                | 127.83                               |
| 9.42                 | 42.65                                | 42.65                                | 127.95                               |
| 9.50                 | 42.69                                | 42.69                                | 128.07                               |
| 9.58                 | 42.73                                | 42.73                                | 128.19                               |
| 9.66                 | 42.77                                | 42.77                                | 128.31                               |
| 9.74                 | 42.81                                | 42.81                                | 128.43                               |
| 9.82                 | 42.85                                | 42.85                                | 128.55                               |
| 9.90                 | 42.89                                | 42.89                                | 128.67                               |
| 9.98                 | 42.93                                | 42.93                                | 128.79                               |
| 10.06                | 42.97                                | 42.97                                | 128.91                               |
| 10.14                | 43.01                                | 43.01                                | 129.03                               |
| 10.22                | 43.05                                | 43.05                                | 129.15                               |
| 10.30                | 43.09                                | 43.09                                | 129.27                               |
| 10.38                | 43.13                                | 43.13                                | 129.39                               |
| 10.46                | 43.17                                | 43.17                                | 129.51                               |
| 10.54                | 43.21                                | 43.21                                | 129.63                               |
| 10.62                | 43.25                                | 43.25                                | 129.75                               |
| 10.70                | 43.29                                | 43.29                                | 129.87                               |
| 10.78                | 43.33                                | 43.33                                | 129.99                               |
| 10.86                | 43.37                                | 43.37                                | 130.11                               |
| 10.94                | 43.41                                | 43.41                                | 130.23                               |
| 11.02                | 43.45                                | 43.45                                | 130.35                               |
| 11.10                | 43.49                                | 43.49                                | 130.47                               |
| 11.18                | 43.53                                | 43.53                                | 130.59                               |
| 11.26                | 43.57                                | 43.57                                | 130.71                               |
| 11.34                | 43.61                                | 43.61                                | 130.83                               |
| 11.42                | 43.65                                | 43.65                                | 130.95                               |
| 11.50                | 43.69                                | 43.69                                | 131.07                               |
| 11.58                | 43.73                                | 43.73                                | 131.19                               |
| 11.66                | 43.77                                | 43.77                                | 131.31                               |
| 11.74                | 43.81                                | 43.81                                | 131.43                               |
| 11.82                | 43.85                                | 43.85                                | 131.55                               |
| 11.90                | 43.89                                | 43.89                                | 131.67                               |
| 11.98                | 43.93                                | 43.93                                | 131.79                               |
| 12.06                | 43.97                                | 43.97                                | 131.91                               |
| 12.14                | 44.01                                | 44.01                                | 132.03                               |
| 12.22                | 44.05                                | 44.05                                | 132.15                               |
| 12.30                | 44.09                                | 44.09                                | 132.27                               |
| 12.38                | 44.13                                | 44.13                                | 132.39                               |
| 12.46                | 44.17                                | 44.17                                | 132.51                               |
| 12.54                | 44.21                                | 44.21                                | 132.63                               |
| 12.62                | 44.25                                | 44.25                                | 132.75                               |
| 12.70                | 44.29                                | 44.29                                | 132.87                               |
| 12.78                | 44.33                                | 44.33                                | 132.99                               |
| 12.86                | 44.37                                | 44.37                                | 133.11                               |
| 12.94                | 44.41                                | 44.41                                | 133.23                               |
| 13.02                | 44.45                                | 44.45                                | 133.35                               |
| 13.10                | 44.49                                | 44.49                                | 133.47                               |
| 13.18                | 44.53                                | 44.53                                | 133.59                               |
| 13.26                | 44.57                                | 44.57                                | 133.71                               |
| 13.34                | 44.61                                | 44.61                                | 133.83                               |
| 13.42                | 44.65                                | 44.65                                | 133.95                               |
| 13.50                | 44.69                                | 44.69                                | 134.07                               |
| 13.58                | 44.73                                | 44.73                                | 134.19                               |
| 13.66                | 44.77                                | 44.77                                | 134.31                               |
| 13.74                | 44.81                                | 44.81                                | 134.43                               |
| 13.82                | 44.85                                | 44.85                                | 134.55                               |
| 13.90                | 44.89                                | 44.89                                | 134.67                               |
| 13.98                | 44.93                                | 44.93                                | 134.79                               |
| 14.06                | 44.97                                | 44.97                                | 134.91                               |
| 14.14                | 45.01                                | 45.01                                | 135.03                               |
| 14.22                | 45.05                                | 45.05                                | 135.15                               |
| 14.30                | 45.09                                | 45.09                                | 135.27                               |
| 14.38                | 45.13                                | 45.13                                | 135.39                               |
| 14.46                | 45.17                                | 45.17                                | 135.51                               |
| 14.54                | 45.21                                | 45.21                                | 135.63                               |
| 14.62                | 45.25                                | 45.25                                | 135.75                               |
| 14.70                | 45.29                                | 45.29                                | 135.87                               |
| 14.78                | 45.33                                | 45.33                                | 135.99                               |
| 14.86                | 45.37                                | 45.37                                | 136.11                               |
| 14.94                | 45.41                                | 45.41                                | 136.23                               |
| 15.02                | 45.45                                | 45.45                                | 136.35                               |
| 15.10                | 45.49                                | 45.49                                | 136.47                               |
| 15.18                | 45.53                                | 45.53                                | 136.59                               |
| 15.26                | 45.57                                | 45.57                                | 136.71                               |
| 15.34                | 45.61                                | 45.61                                | 136.83                               |
| 15.42                | 45.65                                | 45.65                                | 136.95                               |
| 15.50                | 45.69                                | 45.69                                | 137.07                               |
| 15.58                | 45.73                                | 45.73                                | 137.19                               |
| 15.66                | 45.77                                | 45.77                                | 137.31                               |
| 15.74                | 45.81                                | 45.81                                | 137.43                               |
| 15.82                | 45.85                                | 45.85                                | 137.55                               |
| 15.90                | 45.89                                | 45.89                                | 137.67                               |
| 15.98                | 45.93                                | 45.93                                | 137.79                               |
| 16.06                | 45.97                                | 45.97                                | 137.91                               |
| 16.14                | 46.01                                | 46.01                                | 138.03                               |
| 16.22                | 46.05                                | 46.05                                | 138.15                               |
| 16.30                | 46.09                                | 46.09                                | 138.27                               |
| 16.38                | 46.13                                | 46.13                                | 138.39                               |
| 16.46                | 46.17                                | 46.17                                | 138.51                               |
| 16.54                | 46.21                                | 46.21                                | 138.63                               |
| 16.62                | 46.25                                | 46.25                                | 138.75                               |
| 16.70                | 46.29                                | 46.29                                | 138.87                               |
| 16.78                | 46.33                                | 46.33                                | 138.99                               |
| 16.86                | 46.37                                | 46.37                                | 139.11                               |
| 16.94                | 46.41                                | 46.41                                | 139.23                               |
| 17.02                | 46.45                                | 46.45                                | 139.35                               |
| 17.10                | 46.49                                | 46.49                                | 139.47                               |
| 17.18                | 46.53                                | 46.53                                | 139.59                               |
| 17.26                | 46.57                                | 46.57                                | 139.71                               |
| 17.34                | 46.61                                | 46.61                                | 139.83                               |
| 17.42                | 46.65                                | 46.65                                | 139.95                               |
| 17.50                | 46.69                                | 46.69                                | 140.07                               |
| 17.58                | 46.73                                | 46.73                                | 140.19                               |
| 17.66                | 46.77                                | 46.77                                | 140.31                               |
| 17.74                | 46.81                                | 46.81                                | 140.43                               |
| 17.82                | 46.85                                | 46.85                                | 140.55                               |
| 17.90                | 46.89                                | 46.89                                | 140.67                               |
| 17.98                | 46.93                                | 46.93                                | 140.79                               |
| 18.06                | 46.97                                | 46.97                                | 140.91                               |
| 18.14                | 47.01                                | 47.01                                | 141.03                               |
| 18.22                | 47.05                                | 47.05                                | 141.15                               |
| 18.30                | 47.09                                | 47.09                                | 141.27                               |
| 18.38                | 47.13                                | 47.13                                | 141.39                               |
| 18.46                | 47.17                                | 47.17                                | 141.51                               |
| 18.54                | 47.21                                | 47.21                                | 141.63                               |
| 18.62                | 47.25                                | 47.25                                | 141.75                               |
| 18.70                | 47.29                                | 47.29                                | 141.87                               |
| 18.78                | 47.33                                | 47.33                                | 141.99                               |
| 18.86                | 47.37                                | 47.37                                | 142.11                               |
| 18.94                | 47.41                                | 47.41                                | 142.23                               |
| 19.02                | 47.45                                | 47.45                                | 142.35                               |
| 19.10                | 47.49                                | 47.49                                | 142.47                               |
| 19.18                | 47.53                                | 47.53                                | 142.59                               |
| 19.26                | 47.57                                | 47.57                                | 142.71                               |
| 19.34                | 47.61                                | 47.61                                | 142.83                               |
| 19.42                | 47.65                                | 47.65                                | 142.95                               |
| 19.50                | 47.69                                | 47.69                                | 143.07                               |
| 19.58                | 47.73                                | 47.73                                | 143.19                               |
| 19.66                | 47.77                                | 47.77                                | 143.31                               |
| 19.74                | 47.81                                | 47.81                                | 143.43                               |
| 19.82                | 47.85                                | 47.85                                | 143.55                               |
| 19.90                | 47.89                                | 47.89                                | 143.67                               |
| 19.98                | 47.93                                | 47.93                                | 143.79                               |
| 20.06                | 47.97                                | 47.97                                | 143.91                               |
| 20.14                | 48.01                                | 48.01                                | 144.03                               |
| 20.22                | 48.05                                | 48.05                                | 144.15                               |
| 20.30                | 48.09                                | 48.09                                | 144.27                               |
| 20.38                | 48.13                                | 48.13                                | 144.39                               |
| 20.46                | 48.17                                | 48.17                                | 144.51                               |
| 20.54                | 48.21                                | 48.21                                | 144.63                               |
| 20.62                | 48.25                                | 48.25                                | 144.75                               |
| 20.70                | 48.29                                | 48.29                                | 144.87                               |
| 20.78                | 48.33                                | 48.33                                | 144.99                               |
| 20.86                | 48.37                                | 48.37                                | 145.11                               |
| 20.94                | 48.41                                | 48.41                                | 145.23                               |
| 21.02                | 48.45                                | 48.45                                | 145.35                               |
| 21.10                | 48.49                                | 48.49                                | 145.47                               |
| 21.18                | 48.53                                | 48.53                                | 145.59                               |
| 21.26                | 48.57                                | 48.57                                | 145.71                               |
| 21.34                | 48.61                                | 48.61                                | 145.83                               |
| 21.42                | 48.65                                | 48.65                                | 145.95                               |
| 21.50                | 48.69                                | 48.69                                | 146.07                               |
| 21.58                | 48.73                                | 48.73                                | 146.19                               |
| 21.66                | 48.77                                | 48.77                                | 146.31                               |
| 21.74                | 48.81                                | 48.81                                | 146.43                               |
| 21.82                | 48.85                                | 48.85                                | 146.55                               |
| 21.90                | 48.89                                | 48.89                                | 146.67                               |
| 21.98                | 48.93                                |                                      |                                      |





Pekerjaan struktur bawah penting yang terkait dengan sistem pracetak adalah membuat angkur untuk kolom lantai dasar





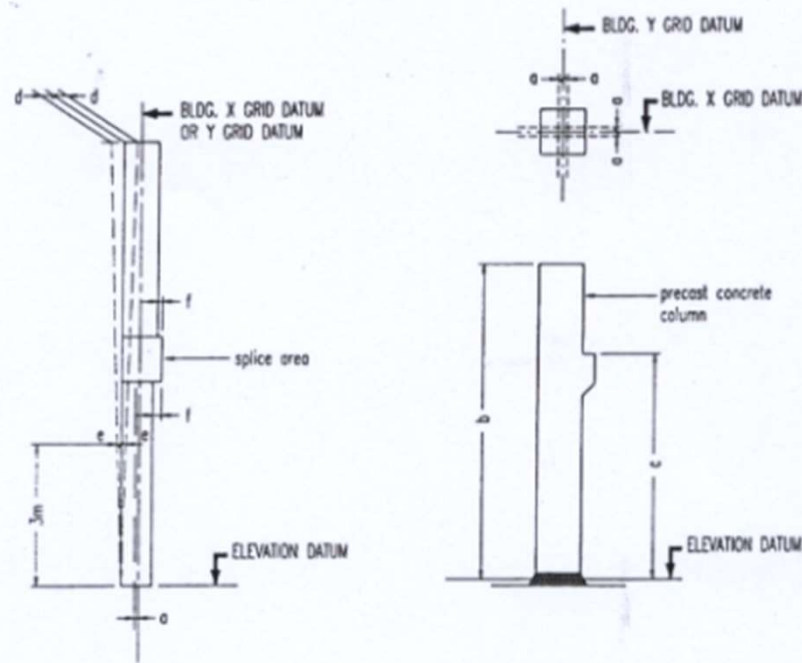


Alat bantu  
mal  
diperlukan  
untuk  
menjamin  
angkur  
dapat  
masuk ke  
lubang  
kolom dasar



# TOLERANSI PEMASANGAN KOLOM PRECAST : Posisi terhadap as bangunan dan kemiringan

|   |  |                   |
|---|--|-------------------|
| a | = Plan location from building grid datum   |                   |
|   | Structural applications  | $\pm 13\text{mm}$ |
|   | Architectural applications   | $\pm 10\text{mm}$ |
| b | = Top elevation from nominal top elevation   |                   |
|   | Maximum low  | $\pm 13\text{mm}$ |
|   | Maximum high   | $\pm 6\text{mm}$  |
| c | = Bearing haunch elevation from nominal elevation  |                   |
|   | Maximum low  | $\pm 13\text{mm}$ |
|   | Maximum high   | $\pm 6\text{mm}$  |
| d | = Maximum plumb variation over height of element<br>(element in structure of maximum height 30m) | $\pm 25\text{mm}$ |
| e | = Plumb in any (3m) of element height  | $\pm 6\text{mm}$  |
| f | = Maximum jog in alignment of matching edges   |                   |
|   | Architectural exposed edges  | $\pm 6\text{mm}$  |
|   | Visually non-critical edges  | $\pm 13\text{mm}$ |



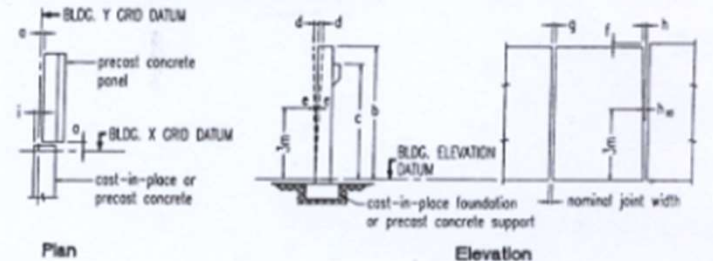


# TOLERANSI PEMASANGAN DINDING PRECAST

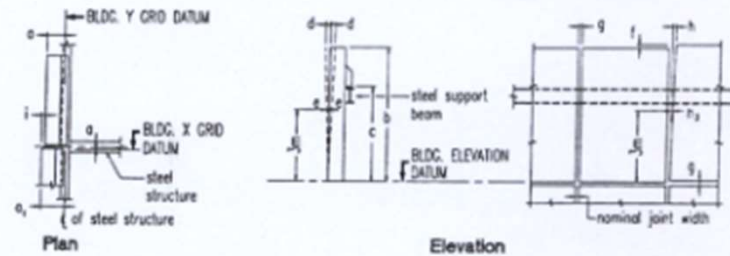
|                |  |       |
|----------------|--|-------|
| a              | = Plan location from building grid datum*                                      | ±13mm |
| a <sub>1</sub> | = Plan location from centreline of steel**                                     | ±13mm |
| b              | = Top elevation from nominal top elevation                                     |       |
|                | Exposed individual panel   | ±13mm |
|                | Nonexposed individual panel  | ±19mm |
|                | Exposed relative to adjacent panel   | ±13mm |
|                | Nonexposed relative to adjacent panel  | ±19mm |
| c              | = Bearing elevation from nominal elevation                                     |       |
|                | Maximum low  | 13mm  |
|                | Minimum high   | 6mm   |
| d              | = Maximum plumb variation over height of structure or 30 m whichever is less** | 25mm  |
| e              | = Plumb in any 3m of element height  | 6m    |
| f              | = Maximum jog in alignment of matching edges                                   | 13mm  |
| g              | = Joint width (governs over joint taper)                                       | ±10mm |
| h              | = Joint taper over length of panel   | 13mm  |
| h <sub>3</sub> | = Joint taper over 3m length   | 10mm  |
| i              | = Maximum jog in alignment of matching faces                                   |       |
|                | Exposed  | 10mm  |
|                | Nonexposed   | 19mm  |
| j              | = Differential bowing, as erected, between adjacent members of the same design | 13mm  |

\* For precast buildings in excess of 30m height, tolerances "a" and "d" can increase at a rate of 3mm per story to a maximum of 50mm.

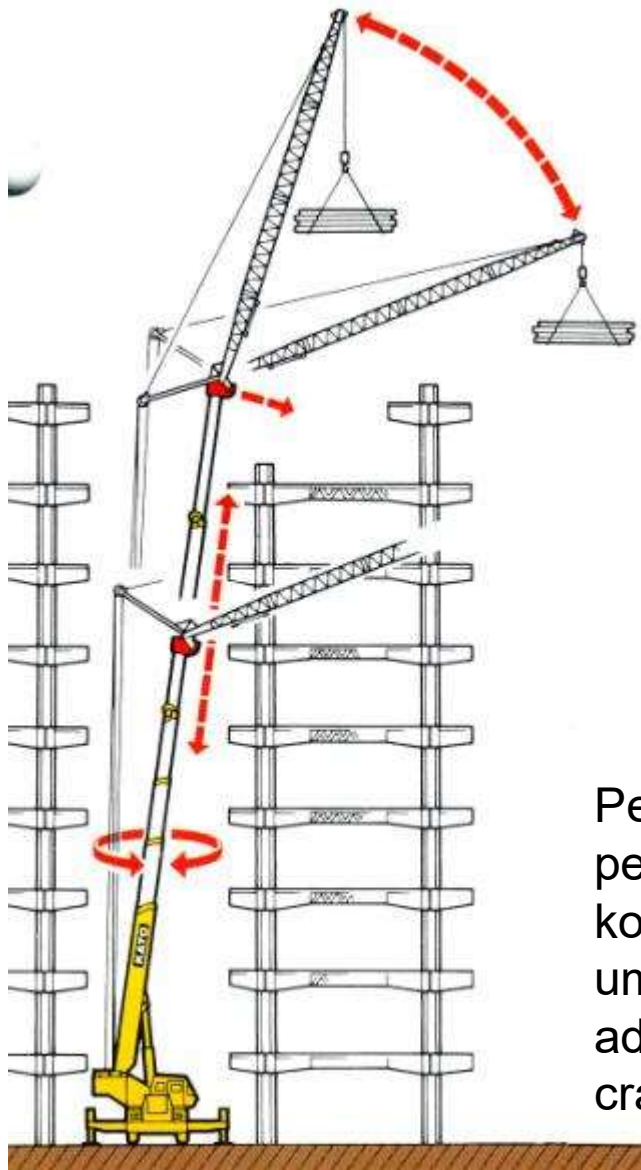
\*\* For precast concrete erected on a steel frame building, this tolerance takes precedence over tolerance on dimension "a".



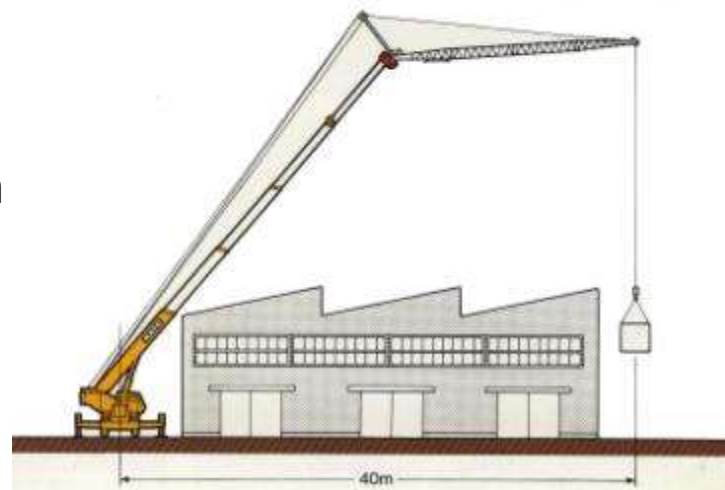
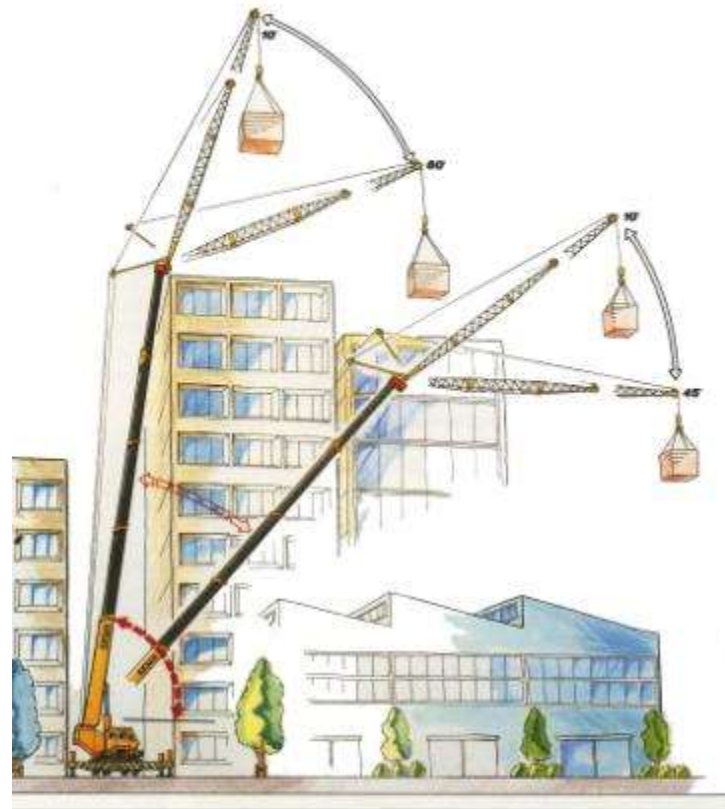
Precast Element to Precast or Cast-in-place Concrete or Masonry



Precast Element to Structural Steel



Peralatan pemasangan komponen yang umum digunakan adalah mobil crane



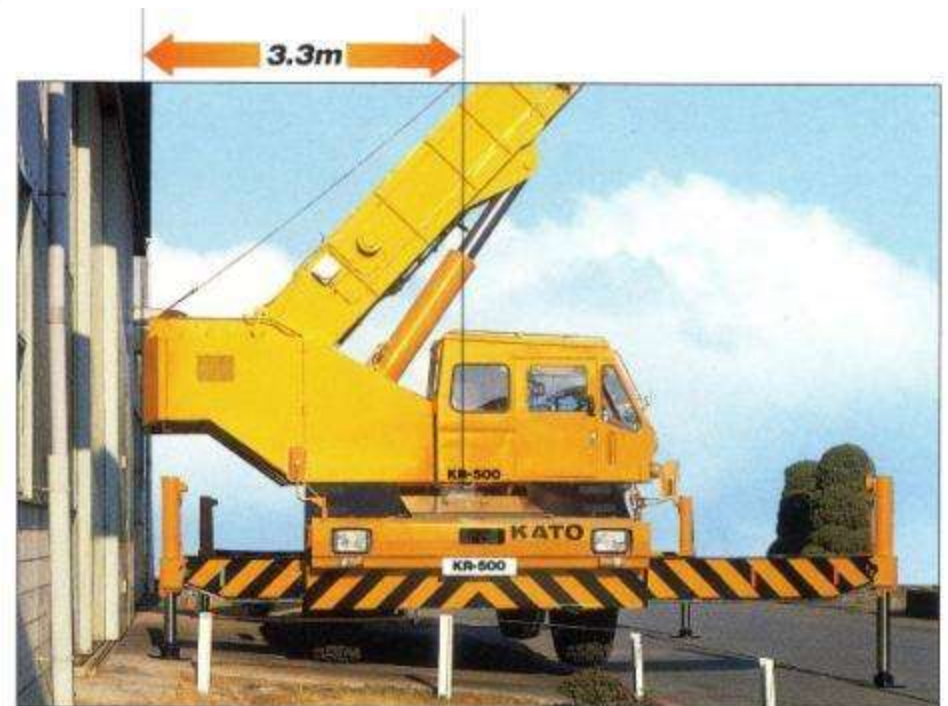
**Intermediate  
Extension of  
Outriggers for  
Outstanding  
Performance**



Intermediate stroke **4.85m**

Maximum stroke **7.20m**

Dimensi peralatan untuk mencapai kestabilan selama proses pemasangan menjadi pertimbangan utama dalam mengatur layout stocking dan urutan pemasangan





# NK-800

## FULLY HYDRAULIC TRUCK CRANE

### LIFTING CAPACITIES

\* Over side and Over rear or 360° (With optional front Jack)

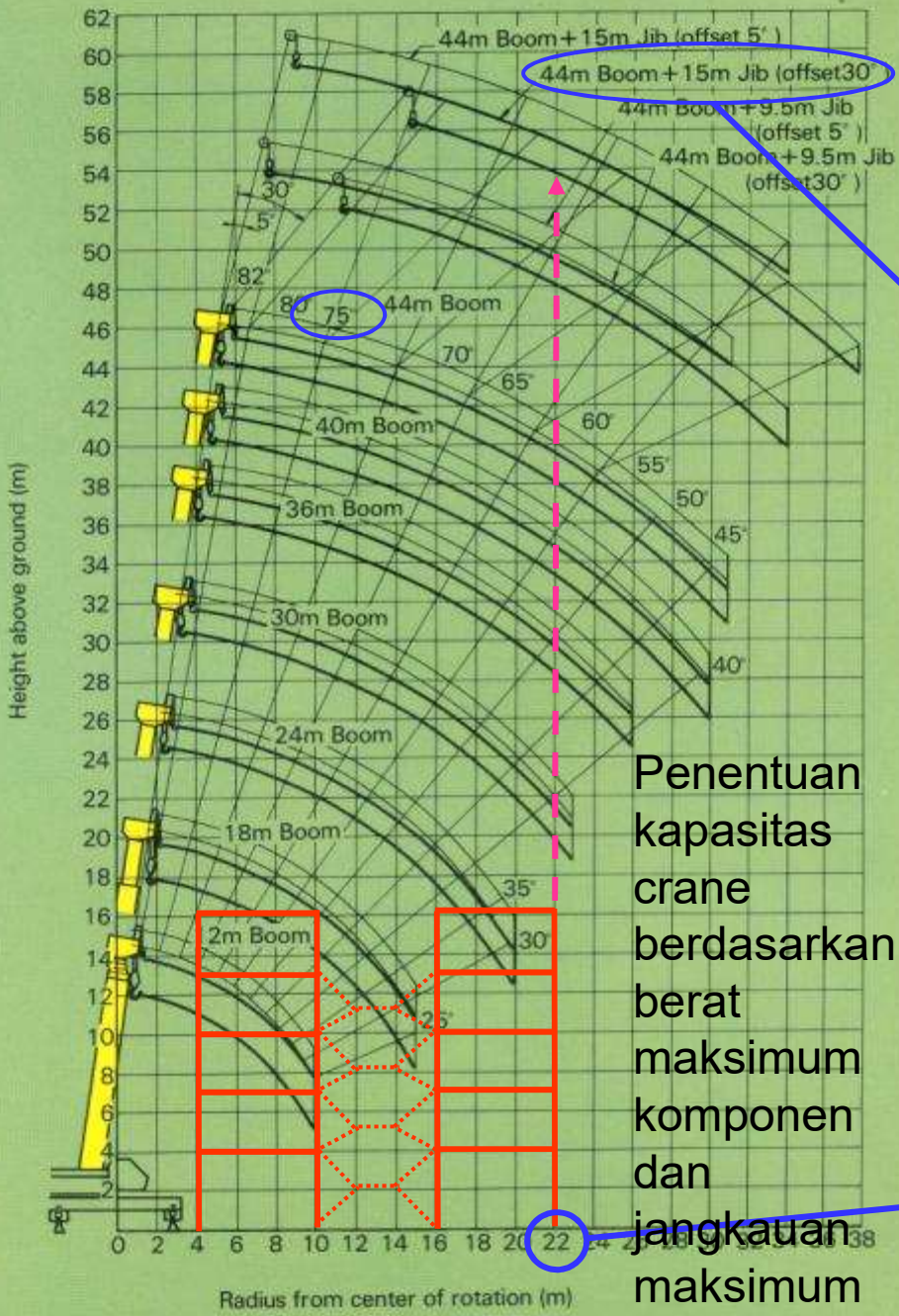
(in metric ton)

| Working radius (m) | 360°            |          |          |          |             |           |          | Without outriggers<br>12m Boom |
|--------------------|-----------------|----------|----------|----------|-------------|-----------|----------|--------------------------------|
|                    | With outriggers |          |          |          |             |           |          |                                |
|                    | 12m Boom        | 18m Boom | 24m Boom | 30m Boom | 36m Boom    | 40m Booms | 44m Boom |                                |
| 2.5                | 80.0            | 45.0     |          |          |             |           |          | 15.0                           |
| 3.0                | 80.0            | 45.0     | 35.0     |          |             |           |          | 15.0                           |
| 3.5                | 80.0            | 45.0     | 35.0     |          |             |           |          | 15.0                           |
| 4.0                | 70.0            | 45.0     | 35.0     | 27.0     |             |           |          | 11.7                           |
| 4.5                | 62.0            | 45.0     | 35.0     | 27.0     |             |           |          | 9.5                            |
| 5.0                | 56.0            | 45.0     | 35.0     | 27.0     |             |           |          | 8.0                            |
| 5.5                | 52.0            | 45.0     | 35.0     | 27.0     |             |           |          | 7.2                            |
| 6.0                | 49.0            | 44.5     | 35.0     | 27.0     |             |           |          | 7.0                            |
| 6.5                | 47.0            | 41.8     | 33.5     | 27.0     | 22.0        |           |          | 6.2                            |
| 7.0                | 45.0            | 40.0     | 32.5     | 26.3     | 22.0        |           |          | 5.8                            |
| 7.5                | 43.0            | 38.9     | 30.5     | 24.9     | 22.0        | 18.0      |          | 5.0                            |
| 8.0                | 38.0            | 34.6     | 29.0     | 23.8     | 22.0        | 18.0      |          | 4.4                            |
| 8.5                | 37.1            | 34.2     | 28.6     | 23.5     | 21.8        | 18.0      |          | 4.3                            |
| 9.0                | 31.5            | 30.5     | 25.5     | 21.3     | 20.1        | 18.0      | 12.0     | 3.3                            |
| 9.5                | 28.8            | 27.5     | 24.0     | 20.1     | 19.0        | 17.1      | 12.0     | 2.7                            |
| 10.0               | 27.0            | 23.5     | 21.5     | 18.2     | 17.2        | 15.7      | 12.0     | 2.0                            |
| 11.0               | 22.0            | 21.7     | 20.4     | 17.4     | 16.4        | 15.1      | 12.0     | 1.7                            |
| 11.3               |                 | 18.8     | 18.0     | 15.9     | 15.0        | 14.0      | 12.0     |                                |
| 12.0               |                 | 18.0     | 17.4     | 15.4     | 14.6        | 13.8      | 12.0     |                                |
| 13.0               |                 | 16.1     | 15.9     | 14.5     | 13.8        | 12.8      | 11.3     |                                |
| 14.0               |                 | 15.0     | 14.0     | 12.8     | 12.7        | 11.7      | 10.5     |                                |
| 15.0               |                 | 12.0     | 12.2     | 11.3     | 11.2        | 10.8      | 9.7      |                                |
| 16.0               |                 | 10.5     | 10.7     | 10.1     | 10.0        | 9.8       | 9.0      |                                |
| 18.0               |                 |          | 9.4      | 9.1      | 9.0         | 8.9       | 8.4      |                                |
| 19.0               |                 |          | 7.2      | 7.1      | 7.1         | 7.3       | 7.4      |                                |
| 20.0               |                 |          | 5        | 5.5      | 5.6         | 6.0       | 6.2      |                                |
| 22.0               |                 |          |          | 4.3      | 4.4         | 4.8       | 5.1      |                                |
| 23.0               |                 |          |          | 3.7      | 3.8         | 4.3       | 4.6      |                                |
| 24.0               |                 |          |          |          | 3.3         | 3.8       | 4.2      |                                |
| 26.0               |                 |          |          |          | 2.4         | 3.0       | 3.3      |                                |
| 28.0               |                 |          |          |          |             | 2.2       | 2.6      |                                |
| 30.0               |                 |          |          |          |             | 1.6       | 2.0      |                                |
| 31.0               |                 |          |          |          |             |           | 1.7      |                                |
| Standard hook      | for 80 tons     |          |          |          | for 35 tons |           |          |                                |
| Hook weight        | 1000 kg         |          |          |          | 500 kg      |           |          |                                |
| Parts of line      | 12              | 8        | 6        |          |             | 4         |          |                                |
| Min. boom angle    |                 |          |          | 25°      |             | 35°       | 40°      |                                |

\* Over side and Over rear or 360° (With optional front Jack)

(in metric ton)

| Boom angle (°)  | 360°                        |          |                    |          |                    |          |                    |          |
|-----------------|-----------------------------|----------|--------------------|----------|--------------------|----------|--------------------|----------|
|                 | With outriggers             |          |                    |          |                    |          |                    |          |
|                 | Jib offset 5°               |          | 15m Jib            |          | 9.5m Jib           |          | Jib offset 30°     |          |
|                 | Working radius (m)          | Load (t) | Working radius (m) | Load (t) | Working radius (m) | Load (t) | Working radius (m) | Load (t) |
| 80.4            | 11.00                       | 6.00     | 11.50              | 4.00     | 14.50              | 2.50     | 18.00              | 1.30     |
| 80.0            | 11.45                       | 5.80     | 13.00              | 4.00     | 15.00              | 2.50     | 18.60              | 1.30     |
| 78.0            | 13.70                       | 4.95     | 15.25              | 3.60     | 17.10              | 2.25     | 20.60              | 1.20     |
| 76.0            | 15.70                       | 4.45     | 17.25              | 3.20     | 18.80              | 2.00     | 22.50              | 1.15     |
| 74.0            | 17.30                       | 4.10     | 19.35              | 2.90     | 20.40              | 2.10     | 24.40              | 1.10     |
| 72.0            | 19.10                       | 3.75     | 21.55              | 2.65     | 22.30              | 2.05     | 26.20              | 1.05     |
| 70.0            | 20.70                       | 3.50     | 23.35              | 2.50     | 23.60              | 2.00     | 28.00              | 1.00     |
| 68.0            | 22.30                       | 3.25     | 25.10              | 2.35     | 25.50              | 1.90     | 29.80              | 0.95     |
| 66.0            | 24.10                       | 3.00     | 27.20              | 2.20     | 26.80              | 1.85     | 31.60              | 0.90     |
| 64.0            | 25.70                       | 2.80     | 29.00              | 2.10     | 28.30              | 1.80     | 33.20              | 0.85     |
| 62.0            | 27.40                       | 2.70     | 30.80              | 1.75     | 29.85              | 1.75     | 34.80              | 0.80     |
| 60.0            | 28.90                       | 1.80     | 32.45              | 1.45     | 31.20              | 1.70     | 36.30              | 0.75     |
| 58.0            | 30.30                       | 1.50     | 34.05              | 1.20     | 32.60              | 1.45     | 37.60              | 0.70     |
| 56.0            | 31.70                       | 1.25     |                    |          | 34.00              | 1.30     |                    |          |
| Use hook        | for 6 tons (weight) 250 kg! |          |                    |          |                    |          |                    |          |
| Min. boom angle | 53°                         |          | 55°                |          | 53°                |          | 55°                |          |



Penentuan kapasitas crane berdasarkan berat maksimum komponen dan jangkauan maksimum

Note: This does not include deflection of Boom and Jib.





Berat komponen maksimum yang bisa diangkat oleh alat-alat di Indonesia umumnya tidak lebih dari 2.5 ton



Pemasangan kolom lantai dasar dan alat-alat bantu untuk menyetel ketegakan kolom



Bahan pengikat angkur dengan komponen adalah material grouting yang laju pengerasannya cepat, mudah mengalir dan tidak susut.







Pengecoran grouting angkur







Pemasangan balok







Pemasangan angkur join





Pengecoran join dengan material grouting yang laju pengerasannya cepat, dan tidak susut.





**Pemasangan Pelat : Half Slab : yang membutuhkan perancah sementara dan topping**











**Pemasangan komponen pelat :  
hollow core yang tidak  
memerlukan perancah**







**Pemasangan komponen pelat  
full slab yang tidak memerlukan  
perancah**



Struktur yang telah menyatu :  
balok, kolom dan pelat di join



# 8.KOMPONEN PRACETAK UNTUK ARSITEKTUR



# 8.KOMPONEN PRACETAK UNTUK ARSITEKTUR



Pekerjaan arsitektur konvensional yang sering memakan waktu lama dan kualitas yang tidak merata adalah pekerjaan dinding plaster aci. Pekerjaan plaster harus dilakukan minimal selama seminggu, dipelihara secara telaten pagi siang malam, sebelum dilakukan pengacian dan pengecatan. Banyak pelaksana yang tidak memenuhi kaidah pelaksanaan ini sehingga kualitas finishing rumah susun sederhana banyak yang mengecewakan. Pekerjaan arsitektur konvensional juga membuat kondisi kerja tidak rapi karena pencampuran bahan plaster (pasir dan semen) dilakukan di tingkat atas.



# 8.KOMPONEN PRACETAK UNTUK ARSITEKTUR



VS



Penggunaan komponen pracetak akan membuat pekerjaan lebih cepat dengan kualitas yang merata,serta kondisi kerja yang rapi.

# 8.KOMPONEN PRACETAK UNTUK ARSITEKTUR



Komponen façade yang harus beban permukaan dan tahan cuaca

Sandwich panel



Panel beton





# 8.KOMPONEN PRACETAK UNTUK ARSITEKTUR

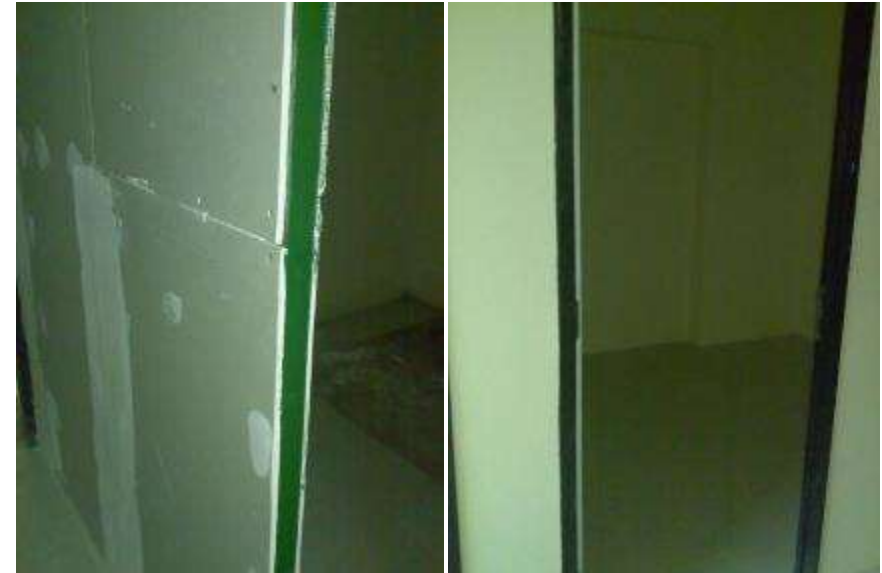


Dinding antar unit yang menggunakan bata ringan dan mortar instant (langsung dicampur dengan air), dalam waktu 3 hari dapat langsung dicat

# 8.KOMPONEN PRACETAK UNTUK ARSITEKTUR



Bahan calciboard dengan rangka untuk partisi yang tahan air



Bahan gipsuboard untuk partisi daerah kering

# 8.KOMPONEN PRACETAK UNTUK ARSITEKTUR



Kombinasi bahan arsitektur pracetak : panel beton untuk façade, bata ringan untuk dinding antar unit dan rangka calciboard untuk dinding partisi



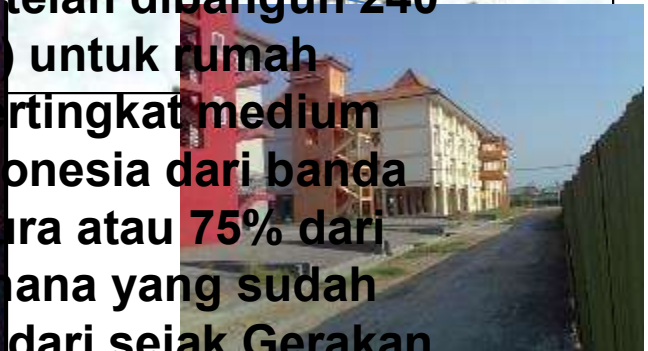
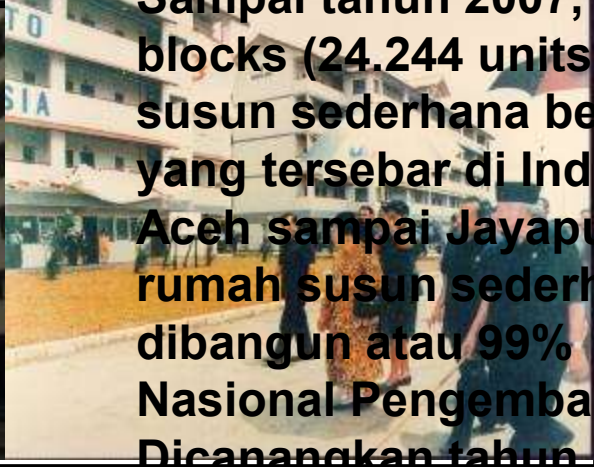
Kombinasi bahan-bahan ringan ini dapat menghemat berat struktur sampai 200 kg/m<sup>2</sup> (+/- 25%) yang dapat mereduksi biaya bangunan total sekitar 10%



# 9. PENERAPAN DI LAPANGAN

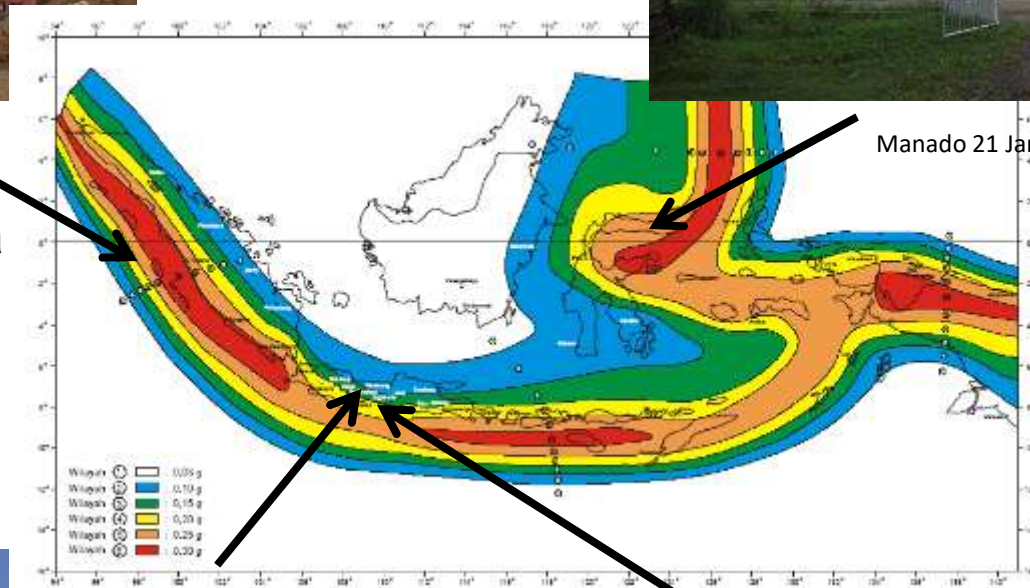


Medium rise of Low Cost Apartment in



Sampai tahun 2007, telah dibangun 240 blocks (24.244 units) untuk rumah susun sederhana bertingkat medium yang tersebar di Indonesia dari banda Aceh sampai Jayapura atau 75% dari rumah susun sederhana yang sudah dibangun atau 99% dari sejak Gerakan Nasional Pengembangan Sejuta Rumah Dicanangkan tahun 2003.





Padang, 11 September 2007

Manado 21 January 2007

•Beberapa diantaranya sudah mengalami pengujian beban gempa kuat secara aktual, yaitu di Yogyakarta, Padang dan Manado.



Surakarta 27 May 2006



Yogyakarta 27 May 2006

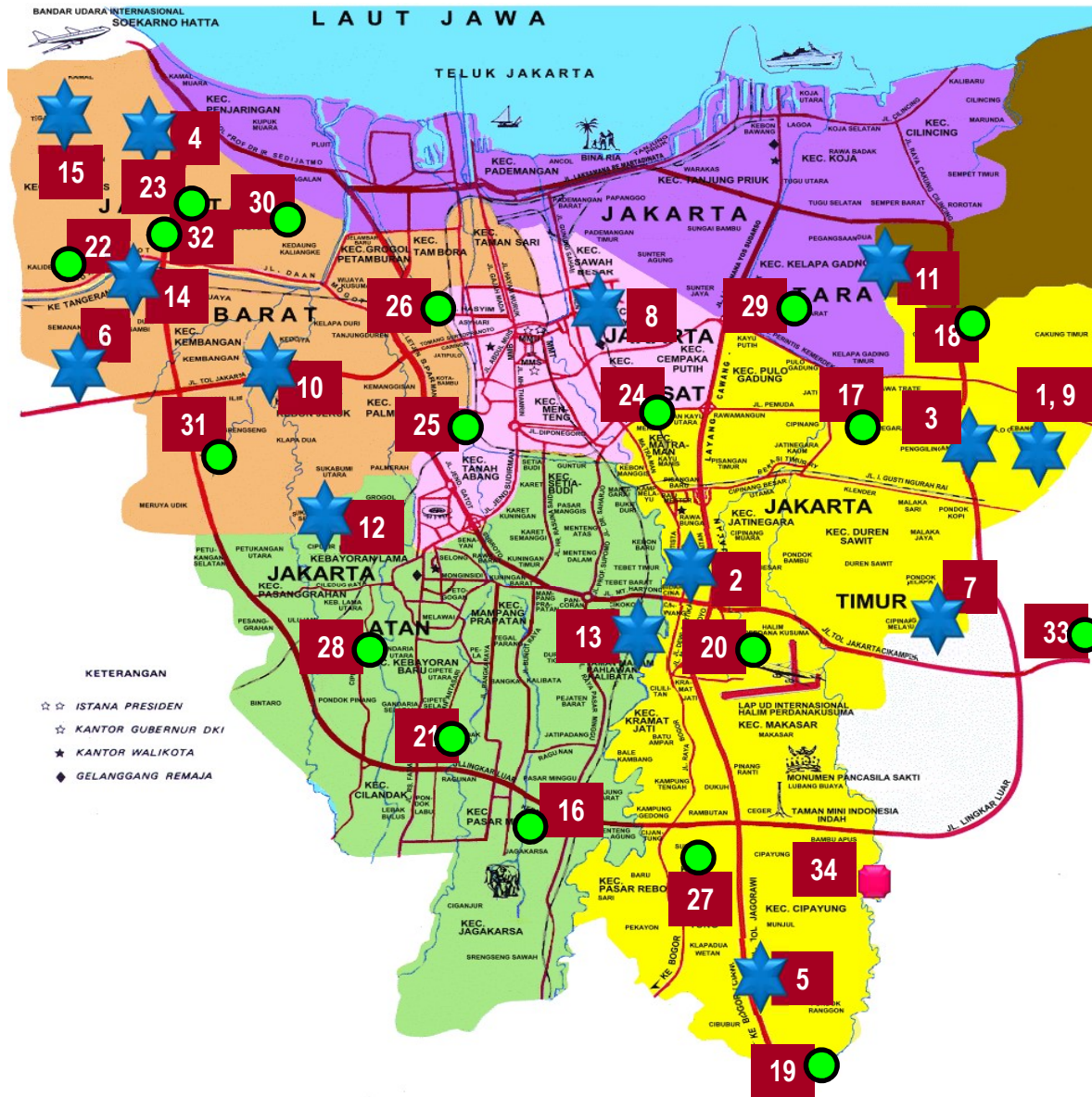
# 1000 TOWER PROGRAMME 2007 - 2011

| KAWASAN PERKOTAAN          | 2007      |               | 2008      |               | 2009       |               | 2010       |                | 2011       |                | 2007 - 2011  |                |
|----------------------------|-----------|---------------|-----------|---------------|------------|---------------|------------|----------------|------------|----------------|--------------|----------------|
|                            | Σ Tower   | Σ Unit        | Σ Tower   | Σ Unit        | Σ Tower    | Σ Unit        | Σ Tower    | Σ Unit         | Σ Tower    | Σ Unit         | Σ Tower      | Σ Unit         |
| 1                          | 2         | 3             | 4         | 5             | 6          | 7             | 8          | 9              | 10         | 11             | 10           | 11             |
| Jabodetabek                | 68        | 27,460        | 60        | 27,336        | 124        | 62,688        | 148        | 76,160         | 204        | 107,296        | 604          | 300,940        |
| P. Jawa (Luar Jabodetabek) | 4         | 1,584         | 20        | 7,552         | 52         | 21,468        | 64         | 28,880         | 84         | 43,244         | 224          | 102,728        |
| Luar Pulau Jawa            | 6         | 1,632         | 8         | 2,450         | 43         | 14,938        | 45         | 18,040         | 70         | 31,036         | 172          | 68,096         |
| <b>TOTAL</b>               | <b>78</b> | <b>30,676</b> | <b>88</b> | <b>37,338</b> | <b>219</b> | <b>99,094</b> | <b>257</b> | <b>123,080</b> | <b>358</b> | <b>181,576</b> | <b>1,000</b> | <b>471,764</b> |





# 1000 TOWER PROGRAMME in DKI JAKARTA 2007 - 2008



## ★ Progres Pelaksanaan Konstruksi (Total 75 twr)

1. PULO GEBANG, KSU Perum Perumnas dengan PT. Primaland, TOWER Ke-1 (1 twr)
2. CAWANG, PT. Cawang Housing Development, TOWER Ke-2 (1 twr)
3. PENGGILINGAN CAKUNG, PT. Nusuno Karya, TOWER Ke 3-5 (3 twr)
4. CENGKARENG, KSU antara Perum Perumnas dengan PT. Reka Rumanda Agung Abadi, TOWER Ke 6-15 (10 twr)
5. CIBUBUR, PT. Rajawali Core Indonesia, TOWER Ke 16-19 (4 twr)
6. KOTA MODERN - TANGERANG, PT. Modernland Realty, TOWER Ke 20-22 (3 twr)
7. KALIMALANG, PT. Mitra Safir Sejahtera, TOWER Ke 23-29 (7 twr)
8. KEMAYORAN, DP3KK dengan Perum Perumnas, TOWER Ke 30-34 (5 twr)
9. PULO GEBANG, KSU Perum Perumnas dengan PT. Bakrieland, TOWER Ke 35-40 (6 twr)
10. KEBON JERUK, PT. Anggana Development, TOWER Ke 41 (1 twr)
11. KELAPA GADING, PT. Tiara Metropolitan Jaya, TOWER Ke 42-55 (14 twr)
12. CILEDUG, PT. Bina Karya Jaya Abadi, TOWER Ke 56 (1 twr)
13. KALIBATA, PT. Pradani Sukses Abadi, TOWER Ke 57-62 (6 twr)
14. DAAN MOGOT, Km 14, PT. Inten Cipta Sejati, TOWER Ke 63-71 (9 twr)
15. PERUM TAMAN SURYA - KALIDERES, PT. Satwika Permai Indah, TOWER Ke 72-75 (4 twr)

## ● Progres DED dan Perijinan (Total 100 twr)

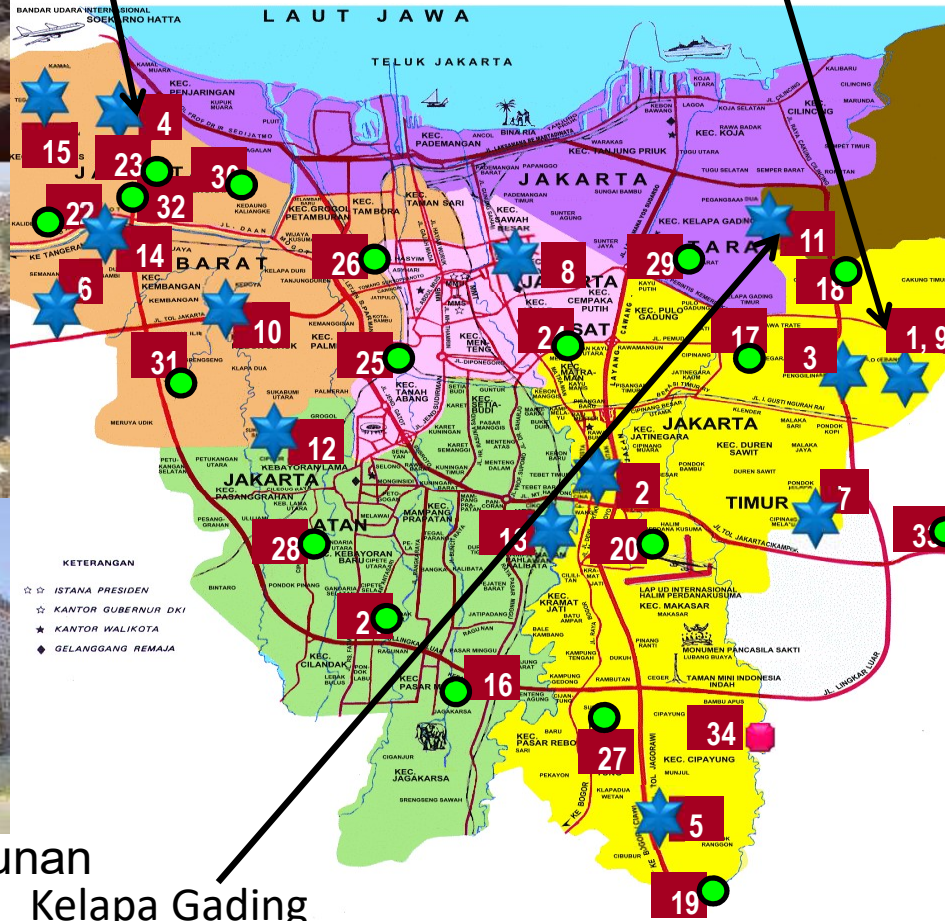
16. KEBAGUSAN, PT. Perdana Gapuraprima (5TWR dari 15 TWR)
17. PULO GADUNG, BPLIP (2 TWR)
18. PULO JAHE JATINEGARA, PT. Cakra Sarana Persada (3 TWR dari 6 TWR)
19. CIBUBUR, Cibubur Village Apartment, PT. Bina Karya Jaya Abadi (5 TWR)
20. KALIBATA, PT. Graha Rayhan Triputra (3 TWR dari 6 TWR)
21. BINTARO, PT. Graha Rayhan Triputra (3 TWR dari 15 TWR)
22. DAAN MOGOT, Km 14, PT. Crown Porcelain (3 TWR dari 8 TWR)
23. CILEDUG - TANGERANG, PT. Sari Indah Lestari (3 TWR)
24. MATRAMAN, PT. Bahama Development (4 TWR)
25. LATUMENTEN, PT. Bahama Development (2 TWR)
26. DURI KEPA, PT. Bahama Development (4 TWR)
27. JL. RAYA BOGOR - PEKAYON, PT. Kasama Ganda (9 TWR)
28. BINTARO - PESANGGRAHAN, PT. Esta Sarana Lestari (4 TWR)
29. KELAPA GADING, PT. Esta Sarana Lestari (6 TWR)
30. DAAN MOGOT, PT. Mahkota Kemayoran Realty (36 TWR)
31. JL. JOMBANG - TANGERANG, PT. Arsidinamika Cipta (2 TWR)
32. JL. RAYA CILEDUG - TANGERANG, PT. Berkas Bina Jaya Lestari (3 TWR)
33. JL. JEND. AHMAD YANI - BEKASI, Pt. Gayaland Prokencana (3 TWR)
34. CIPAYUNG, PT. Bina Kualita Teknik (3 TWR dari 6 TWR)





Cengkareng

Pulogebang



Progress pembangunan di beberapa lokasi Kelapa Gading



# 10. PENUTUP

- Teknologi pembangunan gedung yang menggunakan sistem pracetak tahan gempa sampai saat ini merupakan teknologi yang terbukti tepat untuk mendukung pembangunan rumah susun sederhana karena mempunyai banyak keunggulan dibanding sistem konvensional. Hal ini menyebabkan Pemerintah Indonesia menggunakan teknologi tersebut untuk mempercepat pembangunan berbagai bangunan fasilitas publik, dan secara khusus rumah susun sederhana
- Untuk mendukung program pembangunan massal perumahan pemerintah 1000 tower sampai tahun 2011, sampai saat ini telah tersedia sekitar 30 sistem pracetak tahan gempa sebagai teknologi pembangunan rumah susun sederhana.



# 10. PENUT

