Precast Work Planning Tribun Jakarta International Stadium

Mulsen Sabastony, Koespiadi
Civil Engineering Department, Faculty of Engineering, Narotama University
Surabaya, Indonesia
mulsen.sabastony@gmail.com, koespiadi@narotama.ac.id

Abstract
This study aims to re-calculate the ratio of non-prestressed iron precast stands to prestressed/prestressed precast stands, which are designed for non-prestressed iron which results in increased loads from a large iron ratio and the production process will take longer. Recalculate non-prestressed stands precast into precast concrete prestressed stands. The benefits of this research can change non-prestressed iron to prestressed iron which can change the iron ratio to be more efficient and the implementation process to be faster. And also calculate the strength of the precast concrete stands prestress in accordance with predetermined standards. The location of this research was carried out at the Jakarta International Stadium project in North Jakarta. The results of the research found that the presence of a prestressing system in the stadium stands can save the iron ratio so that the weight of the structure obtained is lighter and optimal.

Keywords:
Precast Concrete, Prestressed Concrete, Prestress, Stadium

1. Introduction
The stadium building is a building that is devoted to sports such as football and rugby. However, over time, the stadium is now a multi-purpose building that can be used for many other activities such as music concerts, political campaigns, and also as a venue for other events. The stadium was chosen because of its capacity that can accommodate many people and also in the middle there is a large space without obstacles so that it can be used for various activities.

The current construction of a building requires innovation and technology in order to obtain an efficient and effective scheme in terms of planning, implementation and maintenance. One example of a building that requires innovation and technology is the construction of a stadium, especially the Jakarta International Stadium Development Project. The innovation made in this stadium construction project is the tribune structure using methods precast and prestressed. The precast and prestress methods are one of the many building technologies that combine the use of prestressed steel and cast concrete.

The use of the method precast in a follow-up building is only seen from the structural aspect but from the time of the construction implementation. From the tribune structure planning, it is reviewed by taking into account the existing planning standards by referring to SNI 1727–2012 concerning Minimum Loading for Buildings and planning using the precast and prestressed methods referring to the SNI 7833–2012 standard regarding Precast and Prestressed Concrete and PCI (Prestressed/Precast Concrete Institute). 8th Edition. The use of this method precast and prestressed, compared to methods precast conventional will reduce the use of reinforcing steel. The use of high-strength steel in the method prestressed-stressed will replace the use of reinforcing steel so that the ratio of reinforcing steel will decrease.

Meanwhile, the time aspect is that the concrete with the method is precast made at the factory so that the production aspect of the stands can go hand in hand with the construction of the stands supporting structures such as columns and building beams. By carrying out production along with the construction of stands precast, it will shorten the implementation of the overall stadium construction.

The purpose of this journal is to show that changing the conventional system to prestress can save costs and also in terms of increased strength or risks that will arise from the construction implementation process. The objectives are:
1. Recalculate the ratio of conventional precast iron to precast/prestressed precast.
2. Benefit from the difference in ratios
3. Evaluate the process of making Tribune precasts using Mathcad.
2. Methodology

Preliminary Design Supporting Planning the dimensions of the main beam and the beam is simple using SNI 2847-2013 guidelines. Initial design of beam dimensions for various spans is shown in the following table.

<table>
<thead>
<tr>
<th>Literature Study</th>
<th>dead load is a load with a constant magnitude and is in the same position at all times. This load consists of the structure's own weight and other loads permanently attached to the structure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SNI 1727-2013, Minimum load for designing buildings and other structures</td>
<td>2. SNI 1726-2012 Earthquake calculations will be calculated using the earthquake response spectral method. The main structure in this building uses concrete material. The parts that will be planned are as follows:</td>
</tr>
<tr>
<td>2. SNI 7833-2012 Procedures for designing precast concrete and prestressed concrete for buildings</td>
<td>3. SNI 2847 -2013 structural concrete requirements for buildings building the planned elements are as follows:</td>
</tr>
</tbody>
</table>
| 3. SNI 2847 -2013 structural concrete requirements for buildings building the planned elements are as follows: | - Planning dimensions of beam and joist concentrated formula is simple using the following approach: 
  \[ h = 16 \]
  - Planning dimensional cantilever beam using the approximate formula as follows: 
  \[ h = 8 \]
  \[ 2.3^3 h \]
  - Planning slab dimensions using the approximate formula as follows: 
  \[ = 20 \]
  - Planning column dimensions using the approximate formula as follows: 
  \[ = 0.75 \] Loading |
| Analysis is carried out so that we can find out what loads will affect the building on the structure of the building. Loads that affect the structure to be reviewed are determined in the reference to SNI 1727-2013, the loads are as follows: | 1. Dead |
| 1. Dead | Load Dead load is a load with a constant magnitude and is in the same position at all times. This load consists of the structure's own weight and other loads permanently attached to the structure. |
| 2. Live Load Live | 2. Live Load Live load is a variable load acting on the building. Examples of live loads are; people, chairs, tables, etc. As for the live load will be reviewed and the magnitude of the stadium building are as follows: |
| a. Live loadtribune: 4.79 kN / m2 | a. Live loadtribune: 4.79 kN / m2 |
| b. Live loadseat fixed: 2.87 kN / m2 | b. Live loadseat fixed: 2.87 kN / m2 |
| 3. Earthquake Load The Requirements for planning for earthquake-resistant buildings and non-building structures are stipulated in SNI 1726-2012. Earthquake calculations will be calculated using the earthquake response spectral method. The main structure in this building uses concrete material. The parts that will be planned are as follows: |
| a. Main Beam | a. Main Beam The main beam planning process uses the same method as the child beams referring to SNI 2847-2013 |
| b. Tribune | b. Tribune Stadium tribune is planned to use prestressed precast material and then the tribune beam which will be the support for the stands designed using ordinary reinforced concrete material. Planning for precast components will refer to SNI 2874-2013 in article 21.8 and the construction procedure will refer to SNI 7833-2012. |
3. Result and Discussion

Figure 1. Research Method Flowchart

Figure 2. Area Moment
1. Moment

<table>
<thead>
<tr>
<th>Moment service</th>
<th>Ms = Mill</th>
<th>Ms = 10 kNm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment Ultimate</td>
<td>Mu = 1.2 Ms + 1.3 Ms + 1.6 Mill</td>
<td>= 27, 506 kNm</td>
</tr>
</tbody>
</table>

2. Effective prestressed reinforcement stress

\[
fpe = \frac{Peff}{Aps}
\]

so :

\[
value \ for \ \wp = \frac{fpy}{fpu} = 0.9 \wp = 0.28
\]

\[
\beta = \begin{cases} 0.85 \text{ if } fc \leq 30 \text{ Mpa} \\ 0.65 \text{ if } fc \geq 55 \text{ Mpa} \\ 0.85 - 0.008 \left(\frac{fc}{Mpa} - 30\right) \text{ if } 30 \text{ Mpa} < fc \leq 55 \text{ Mpa} \end{cases}
\]

\[
\rho_p = \frac{Aps}{bw.dp} = 0.001
\]

\[
\rho_t = \frac{As}{bw.d} = 0.006
\]

\[
\omega_c = 0
\]

\[
\omega_t = \rho \frac{fyd}{fc} = 0.068
\]

\[
fps = \frac{fpu}{\beta} \left[1 - \frac{\wp}{\beta} \left(\rho_p \frac{fpu}{fc} + \frac{a}{d_p} (\omega_t \omega_c)\right)\right]
\]

\[
= 1533,578.\text{Mpa}
\]

\[
\omega_p = \frac{PP}{fc} = 0.032
\]

\[
Tps = fps.Aps = 331,229\text{kN}
\]

\[
a = \frac{0.85.fcdw}{A_{st1}.fyd + A_{st2}.fyd2} = 11,134 \text{ mm}
\]

\[
a_1 = \frac{0.85.fcdw}{A_{st1}.fyd + A_{st2}.fyd2} = 5.19 \text{ mm}
\]

\[
Mn = Tps\left(dp - \frac{a}{2}\right) + (A_{st1}.fyd + A_{st2}.fyd2)\left(dp - \frac{a_1}{2}\right)
\]

\[
= 113,91 \text{kNm}
\]

Moment of cross section capacity = "Qualify" if \(\varphi.Mn > Mu\)

Moment of cross section capacity = "Not Eligible" otherwise

3. PC Wire

So the number of tendons \(n = 11\)

Total area prestress

\[
Aps = n.Ap = 215,985.\text{mm}^2
\]

\[
fp = 0.75.fpu \ fpu = 1217,25 \text{ Mpa}
\]

\[
fpeff = 0.8 fpi = 973.8 \text{ MPA}
\]

\[
Pi = \frac{fpi \cdot Aps}{St} = 262.908 \text{kN}
\]

Concrete cover \(cv = 30\text{mm}\)

Stirrup \(Ds = 8\text{mm}\)

Eccentricity \(e_c = Cb - cv - Ds - \frac{1}{2} \cdot \text{dia} = 68.753 \text{ mm}\)

4. Check Voltage

At the time of transfer

Top fiber

\[
\sigma_{1t} = \frac{P_i}{Ac} - \frac{P_i e}{St} + \frac{Mslb}{St} \leq Fti = 1.192 \text{ Mpa}
\]

\[
\sigma_{1t} = 0.14 \text{ Mpa}
\]

Check = "Ok" if \(\sigma_{1t} \leq Fti\)

Check = "Not Ok" otherwise
5. Bottom fiber
\[ \sigma_{blt} = \frac{-P_i}{A_c} - \frac{P_e}{S_b} + \frac{M_{slb}}{S_t} \leq F_{ci} = -13.65 \text{MPa} \]
\[ \sigma_{blt} = -1.423 \text{MPa} \]
Check = "ok" if |\( \sigma_{blt} \)| ≤ |\( F_{ci} \)|
"Not Ok" otherwise
Check = "Ok"

6. At the time after losses
Top fiber
\[ \sigma_{atl} = \frac{-(P_{eff} + P_h)}{A_c} + \frac{(P_{eff} + P_h) e}{S_t} - \frac{M_{slb}}{S_b} \leq F_t = 2.958 \text{MPa} \]
\[ \sigma_{atl} = -0.194 \text{MPa} \]
Check = "ok" if \( \sigma_{atl} \leq F_t \)
"Not Ok" otherwise
Check = "Ok"

7. Bottom fiber
\[ \sigma_{blt} = \frac{-P_i}{A_c} - \frac{P_e}{S_b} + \frac{M_{slb}}{S_b} \leq F_{ci} = -21 \text{MPa} \]
\[ \sigma_{blt} = -1.669 \text{MPa} \]
Check = "ok" if |\( \sigma_{blt} \)| ≤ |\( F_{ci} \)|
"Not Ok" otherwise
Check = "Ok"

When the service load is working
Top fiber
\[ \sigma_{a} = \frac{-(P_{eff} + P_h)}{A_c} + \frac{(P_{eff} + P_h) e}{S_t} - \frac{M_{ll} + M_{sl}}{S_b} \leq F_{ct} = -21 \text{MPa} \]
\[ \sigma_{a} = -2.054 \text{MPa} \]
Check = "ok" if \( \sigma_{a} \) ≤ |\( F_{ct} \)|
"Not Ok" otherwise
Check = "Ok"

Bottom fiber
\[ \sigma_{b} = \frac{-(P_{eff} + P_h)}{A_c} + \frac{(P_{eff} + P_h) e}{S_b} + \frac{M_{slb}}{S_b} \leq F_{ct} = 2.958 \text{MPa} \]
\[ \sigma_{b} = -0.885 \text{MPa} \]
Check = "ok" if \( \sigma_{b} \) ≤ \( F_t \)
"Not Ok" otherwise
Check = "Ok"

Diameter of Prestressed Reinforcement
\[ D_w = Dia \]
\[ D_w = 5 \text{mm} \]
Diameter of reinforcement
\[ D_{s1} = 8 \text{mm} \]
\[ f_{yd1} = 240 \text{MPa} \]
\[ D_{s2} = 13 \text{mm} \]
\[ f_{yd2} = 400 \text{MPa} \]

Area per reinforcement
\[ A_{s1} = \frac{1}{4} \pi D_{s1}^2 \]
\[ A_{s1} = 50,265 \text{mm}^2 \]
\[ A_{s2} = \frac{1}{4} \pi D_{s2}^2 \]
\[ A_{s2} = 132,732 \text{mm}^2 \]

Amount reinforcement pull
\[ n_{p1} = 4 \]
Area reinforcement pull
\[ A_{st1} = n_{p1} A_{s1} \]
\[ A_{st1} = 201.062 \text{mm}^2 \]
\[ n_{p2} = 2 \]
\[ A_{st2} = n_{p2} A_{s2} \]
\[ A_{st2} = 265.465 \text{mm}^2 \]

Total Area reinforcement pull
\[ A_{st} = A_{st1} + A_{st2} \]
\[ A_{st} = 333.794 \text{mm}^2 \]
Concrete cover
\[ d_c = 30 \text{mm} \]
Presteressed reinforcing arm
\[ d_p = c + e \]
\[ d_p = 30.5 \text{mm} \]
Non prestressed reinforcing arm
\[ d_m = h - d_c - 0.5 \]
\[ D_{s1} - D_{s1} \]
\[ d = 78 \text{mm} \]

4. Conclusion
At the end of this research and based on the results of research on the case study of the Jakarta International Stadium project that the author has carried out. The author can conclude, among others:

1. In planning this precast tribune using the prestressing precast method produces the Ultimate Moment \( M_u = 26.9 \text{kNm} \) and the Nominal Moment of \( M_n = 101.085 \text{kNm} \) so that \( M_n \geq M_u \) thus the tribune precast planning is able to withstand the forces that happened.
2. The advantages obtained from changing the prestressing tribune method are:
   a. Has a more minimal/efficient cross-sectional area with dimensions A(cross-sectional width) = 1000 mm, 
      B(plate thickness) = 130 mm, C(backrest thickness) = 200 mm and Lsl(cross-sectional length) = 4000 mm.
   b. From the minimal dimensions it makes the lifting or installation process in the field easier with the 
      dimensions above having an area of 0.696 m^3 thus 0.696 m^3 x 2400 kg = 1670.4 kg (1.67 tons) so that 
      the material can still be lifted using Tower Crane in the field.
   c. With the precast tribune method, good results are obtained compared to conventional casting

3. By planning this precast tribune with minimal dimensions and minimal iron, the precast tribune cross section 
   is more efficient but still strong.

References
   —. 2012. Design Procedures for Precast Concrete and Prestressed Concrete for Buildings. SNI 7833 - 2012.
   —. 2013. Requirements for Structural Concrete for Buildings. SNI 2847 - 2013