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Study and Analysis of Parking & Development Area Design

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ABSTRACT

In this paper, the author has discussed about the construction of parking and development area in NSP metro station. The author has covered all design aspects, keeping in mind design life, imposed loads, seismic force, construction material as well as IS CODES. Everything is constructed on Staad Pro and designed on limit state method keeping in mind all safety points.

1. Introduction

DMRC 3rd phase work from Mukundpur metro station to Yamuna Vihar metro station. This third phase include construction of parking space at Netaji subhash place metro station. This parking space not only include vehicle parking space but also office space upto 2 floor parking space is made remaining floor is used as office building .

We are looking to make a parking and development area as economical, structurally strong and as per IS specification .

Metro is a new rapid transit link in Delhi and is emerging as an important link in the regional transportation network. DMRC has started the development of its 3rd Phase from Mukundpur to Yamuna Vihar/Shiv Vihar corridor (Line-7). The overall view of 3rdPhase starting from Mukundpur to Yamuna Vihar/Shiv.

The construction of 3rdphase is awarded in various contracts. This report deals with the Contract: CC-30. Contract: CC-30 consists of construction of the twin tunnel between Shalimar Bagh Metro Station and Netaji Subhash Place Station by shield TBM, twin box tunnel and Underground ramp on Shakurpur side of Netaji Subhash Place Station. The four major type of structures in Contract CC-30 are bored tunnel, cut and cover section, station buildings and ramp. This document discusses the structural analysis and design of Netaji Subhash Place Metro Station PD area between Grid 8 to 18. The length of Netaji Subhash Metro Station is about 220.2 m (i.e. from grid line 1 to 23). The formation level of the ground has been taken as EL. 216.1 m.

2. Objective

Design of PD area portion between Grid 8 to 18 of NSPS Station.

Design of following structural parts of Netaji Subhash place station between Grid 8 to 18

a) Structural Design of foundation
b) Columns, Beams
c) Roof Slab

Description of Main Civil components

The Netaji Subhash Place Metro Station is a semi-underground structure having a length of about 220.2 m (i.e. from grid line 1 to 23). The formation level of the ground has been taken as EL. 216.1 m. The station is divide din 23 numbers of grids de pending upon the location of columns. As per the requirement the station is divided into various floors viz. undercroft, platform, concourse, roof and ground level.

The levels of various floors are as such:
Undercroft Level EL 206.27
Rail Level EL 207.63 (Varies)
Platform Level EL 208.57
Concourse Level EL 214.63
Roof Level EL 220.33

Netaji Subhash place metro station is analyzed by using the dimensional finite element model in STAAD pro. A typical three dimensional and sectional views of Netaji Subhash place metro station model is shown below.

3. Methods of analysis

Limit state design (LSD), also known as load and resistance factor design (LRFD), refers to a design method used in structural engineering. Alimit state is a condition of a structure beyond which it no longer fulfills the relevant design criteria.[1]The condition may refer to a degree of loading or other actions on the structure, while the criteria refer to structural integrity, fitness for use, durability or other design requirements. A structure designed by LSD is proportioned to sustain all actions likely to occur during its design life, and to remain fit for use, with an appropriate level of reliability for each limit state. Building codes based on LSD implicitly define the appropriate levels of reliability by their prescriptions.

Criteria

Limit state design requires the structure to satisfy two principal criteria: the ultimate limit state (ULS) and the serviceability limit state(SLS).

Any design process involves a number of assumptions. The loads to which a structure will be subjected must be estimated, sizes of members to check must be chosen and design criteria must be selected. All engineering design

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criteria have a common goal: that of ensuring a safe structure and ensuring the functionality of the structure.

Ultimate limit state

A clear distinction is made between the ultimate state (US) and the ultimate limit state (ULS). The US is a physical situation that involves either excessive deformations leading and approaching collapse of the component under consideration or the structure as a whole, as relevant, or deformations exceeding pre-agreed values. It involves of course considerable inelastic (plastic) behavior of the structural scheme and residual deformations. While the ULS is not a physical situation but rather an agreed computational condition that must be fulfilled, among other additional criteria, in order to comply with the engineering demands for strength and stability under design loads.

The ULS condition is computationally checked at a certain point along the behavior function of the structural scheme, located at the upper part of its elastic zone at approximately 15% lower than the elastic limit. That means that the ULS is a purely elastic condition, located on the behavior function far below the real Ultimate point, which is located deeply within the plastic zone. The rationale for choosing the ULS at the upper part of the elastic zone is that as long as the ULS design criteria are fulfilled, the structure will behave in the same way under repetitive loadings, and as long as it keeps this way, it proves that the level of safety and reliability assumed as the basis for this design is properly maintained and justified, (following the probabilistic safety approach).

A structure is deemed to satisfy the ultimate limit state criterion if all factored bending, shear and tensile or compressive stresses are below the factored resistances calculated for the section under consideration. The factored stresses referred to are found by applying Magnification Factors to the loads on the section. Reduction Factors are applied to determine the various factored resistances of the section.

The limit state criteria can also be set in terms of load rather than stress: using this approach the structural element being analyzed (i.e. a beam or a column or other load bearing elements, such as walls) is shown to be safe when the "Magnified" loads are less than the relevant "Reduced" resistances.

Complying with the design criteria of the ULS is considered as the minimum requirement (among other additional demands) to provide the proper structural safety.

Serviceability limit state

1. limit state of deflection. 2) limit state of cracking. 3) limit state of vibration. In addition to the ULS check mentioned above, a Service Limit State (SLS) computational check must be performed. As for the ULS, here also the SLS is not a physical situation but rather a computational check. The aim is to prove that under the action of Characteristic design loads (un-factored), and/or whilst applying certain (un-factored) magnitudes of imposed deformations, settlements, or vibrations, or temperature gradients etc. the structural behavior complies with, and does not exceed, the SLS design criteria values, specified in the relevant standard in force. These criteria involve various stress limits, deformation limits (deflections, rotations and curvature), flexibility (or rigidity) limits, dynamic behavior limits, as well as crack control requirements (crack width) and other arrangements concerned with the durability of the structure and its level of everyday service level and human comfort achieved, and its abilities to fulfill its everyday functions. In view of non-structural issues it might also involve limits applied to acoustics and heat transmission that might also affect the structural design. To satisfy the serviceability limit state criterion, a structure must remain functional for its intended use subject to routine (read: everyday) loading, and as such the structure must not cause occupant discomfort under routine conditions. This calculation check is performed at a point located at the lower half of the elastic zone, where characteristic (un-factored) actions are applied and the structural behavior is purely elastic.

4. COLUMN AND BEAM STAAD ANALYSIS DESIGN OUTPUT

```
==============================================================================
B E A M N O.          1 D E S I G N R E S U L T S
M35              Fe500(Main)          Fe500(Sec.)
LENGTH:14500.0mm        SIZE: 300.0 mm X 600.0 mm COVER: 25.0mm

SUMMARY OF REINF. AREA (Sq.mm)
-----------------------------------------------------------------------
SECTION  0.0mm     3625.0mm     7250.0mm     10875.0mm     14500.0mm
-----------------------------------------------------------------------
TOP      3695.37      302.24        0.00        289.61       3653.35
REINF.  (Sq. mm)     (Sq.mm)      (Sq.mm)      (Sq. mm)      (Sq.mm)
BOTTOM   1579.79      768.39      1230.28       788.33       1536.56
REINF.  (Sq. mm)     (Sq.mm)      (Sq.mm)      (Sq. mm)      (Sq.mm)
-----------------------------------------------------------------------

SUMMARY OF PROVIDED REINF. AREA
```

```
-------------------------------------------------------------------------
SECTION  0.0mm     3625.0mm     7250.0mm     10875.0mm     14500.0mm
-------------------------------------------------------------------------
TOP    12-20φ       3-20φ       2-20φ       3-20φ       12-20φ
REINF.   2 layer(s)  1layer(s)    1layer(s)    1 layer(s)    2layer(s)
BOTTOM  14-12φ       7-12φ       11-12φ       7-12φ       14-12φ
REINF.   2 layer(s)  1layer(s)    2layer(s)    1 layer(s)    2layer(s)
SHEAR 2 legged 8φ 2 legged 8φ 2 legged 8φ 2 legged 8φ 2 legged 8φ
REINF. @ 200 mm c/c @ 200 mm c/c @ 200 mm c/c @ 200 mm c/c @ 200 mm c/c
-------------------------------------------------------------------------

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT
-------------------------------------------------------------------------
SHEAR DESIGN RESULTS AT 945.0 mm AWAY FROM START SUPPORT
VY =   220.58MX=      0.83 LD=12
Provide 2 Legged 8φ @ 200 mm c/c
SHEAR DESIGN RESULTS AT 945.0 mm AWAY FROM END SUPPORT
VY =   198.40MX=      0.83 LD=11
Provide 2 Legged 8φ @ 125 mm c/c
=============================================================================


=============================================================================
B E A M N O.            2 D E S I G N R E S U L TS
M35                    Fe500(Main)              Fe500(Sec.)
LENGTH:13500.0mm          SIZE: 300.0 mm X 600.0 mm COVER: 25.0mm
¾STAAD SPACE                               -- PAGE NO.17

SUMMARY OF REINF. AREA (Sq.mm)
-------------------------------------------------------------------------
SECTION    0.0mm     3375.0mm     6750.0mm     10125.0mm     13500.0mm
-------------------------------------------------------------------------
TOP      3436.36      361.67       0.00       352.21      3400.91
REINF.    (Sq. mm)     (Sq.mm)      (Sq.mm)      (Sq. mm)      (Sq.mm)
BOTTOM     1302.27      747.98      1028.03      767.95      1265.75
REINF.    (Sq. mm)     (Sq.mm)      (Sq.mm)      (Sq. mm)      (Sq.mm)
-------------------------------------------------------------------------

SUMMARY OF PROVIDED REINF. AREA
-------------------------------------------------------------------------
SECTION    0.0mm     3375.0mm     6750.0mm     10125.0mm     13500.0mm
-------------------------------------------------------------------------
TOP     11-20φ       3-20φ       2-20φ       3-20φ       11-20φ
REINF.   2 layer(s)   1layer(s)    1layer(s)    1 layer(s)    2layer(s)
BOTTOM    12-12φ       7-12φ       10-12φ       7-12φ       12-12φ
REINF.   2 layer(s)   1layer(s)    2layer(s)    1 layer(s)    2layer(s)
SHEAR 2 legged 8φ 2 legged 8φ 2 legged 8φ 2 legged 8φ 2 legged 8φ
REINF. @ 200 mm c/c @ 200 mm c/c @ 200 mm c/c @ 200 mm c/c @ 200 mm c/c
-------------------------------------------------------------------------

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT
-------------------------------------------------------------------------
```

SHEAR DESIGN RESULTS AT 946.8 mm AWAY FROM START SUPPORT

VY = 210.18MX= -0.04 LD=12

Provide 2 Legged 8φ @ 200 mm c/c

SHEAR DESIGN RESULTS AT 946.8 mm AWAY FROM END SUPPORT

VY = 204.22MX= -0.04 LD=11

Provide 2 Legged 8φ @ 125 mm c/c

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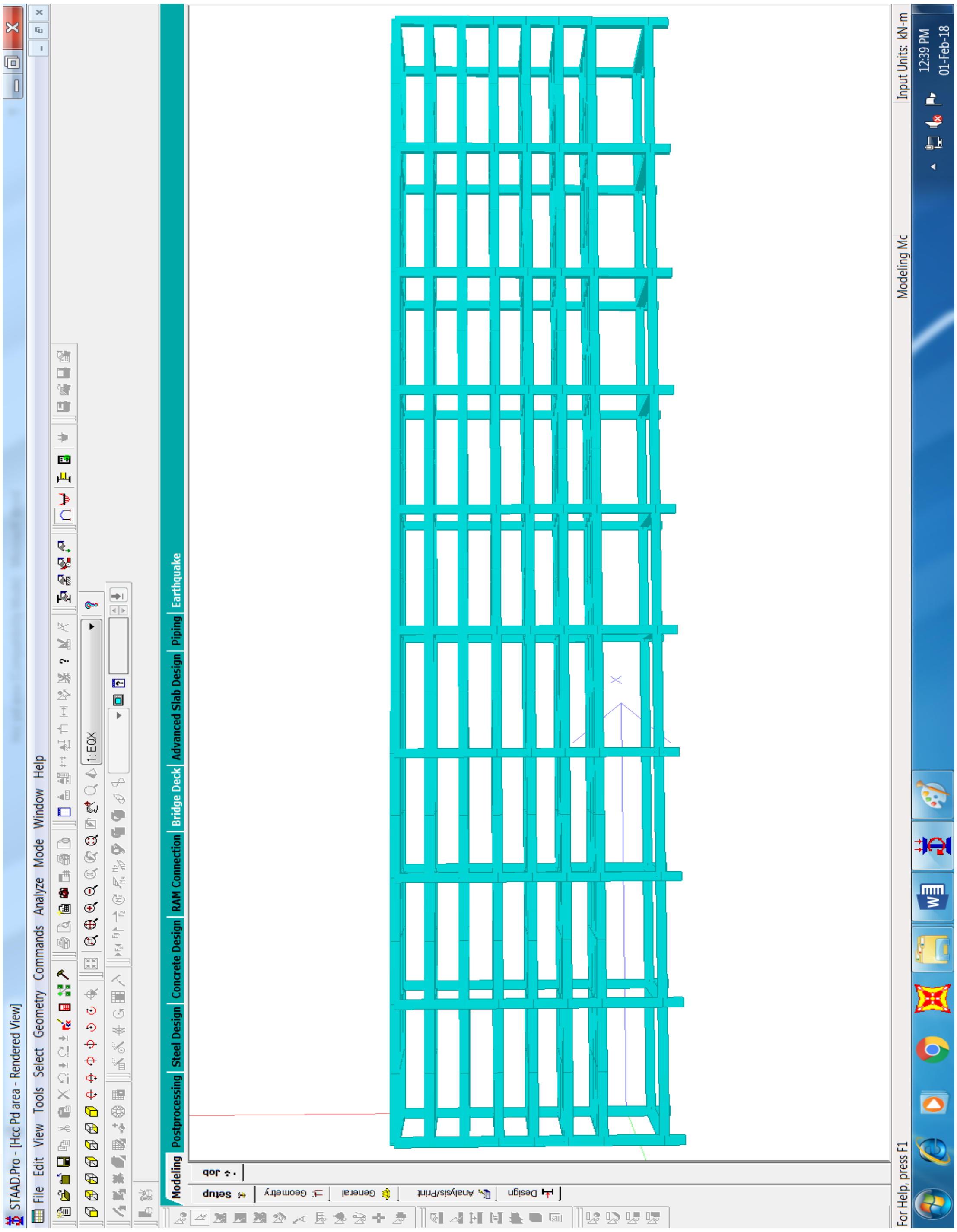

Fig. 1: 3D VIEW OF STRUCTURE IN STAAD

5. Conclusion

We have tried to reduce the cost of construction to optimum value. we didn't compromise with safety of structure. Limit state method used with all factor kept in mind. Detailing and other construction is as per IS codes. Staad pro is used which helps in reducing time and do work in more precise way.

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