Design and Analysis of Shield Tunnel

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ABSTRACT

Excavations of tunnels using an Tunnel Boring Machine (TBM) are requiring a high volume of segments. These segments are produced in specialized pre-cast plants. Advantages of pre-cast plants are the speed of production in a controlled working environment ensuring constant quality of the concrete segment. Most pre-cast plants use computer controlled systems for the batch and mixing equipment with automatic moisture control of the aggregates. This leads to a better quality, homogeneous mix with fewer variations in workability and strength. In order to comply with the required design life, sometimes more than 100 years, higher structural performances and increased durability of pre-cast structures are necessary..

Keyword: - *Tunnel Boring Machine (TBM), Pre-cast Plants, Segments, Admixtures.*

1. INTRODUCTION

The applications of pre-cast tunnel lining segment in the tunneling technology are increasing due to its proficient and cost-effective installation process compared with the conventional in-situ lining technique. PTL can be act as a preliminary as well as final support for carrying the complex surrounding loads. It is suitable for both soft and hard ground. PTL segments are usually installed through tunnel boring machine in the form of a circular ring.

Tunnel lining design requires an interactive approach as the design is not merely about the strength, but how much the tunnel allows to flexure to overcome the ground movement. When tunnel interacts with soil, stress from the ground is distributed into the structure. In the case of pre-cast segmental bolted tunnel lining, it is critical to investigate the lining joints reaction, as this affects the overall flexural behavior of tunnel lining.

2. OBJECTIVE

1) To Study the sewer tunnel and its design concept using Japan Society of Civil Engineering code for shield tunneling.
2) To study the shield tunnel and its design procedure.
3) To identify the major challenges that is faced by precast technology at a project site and industry level.
4) Designing using Japanese code and analysis of tunnel using ANSYS 15 software.
5) Evaluation of the design procedure to understand the forces acting on the tunnel.

3. LITERATURE REVIEW

3.1 Thomas Telford, Tunnel lining design guide, London, 2004.

This Guide is intended to cover the design of structural linings for all manner of driven tunnels and shafts to be constructed in most types of ground conditions. A bibliography is provided of source data and references for more detailed understanding and analysis, and for use where hybrid designs do not fit one particular category described in this guide**.**

3.2 Agus Dwi Hariyanto, Hon Pui Kwan, Yee Weng Cheong Quality control in pre- cast production, A case study on Tunnel Segment Manufacture,Singapore,2013.

In this study, the quality control system implemented in a precast factory is discussed. The precast factory is set up for the manufacture of large quantity of tunnel segments under a contract. Processes in the precast manufacture are discussed with respect to the control procedures in the quality inspection plan. The standard tests involved roles of inspectors and corrective actions on-site are highlighted**.**

3.3 Jan L. Vítek , Matouš Hilar , Petr Vítek Fibre reinforced concrete for pre-cast tunnel segments,2011.

Fiber reinforced concrete is a promising material for application in precast concrete tunnel segments. The paper focuses on the material properties of steel fiber reinforced Concrete and comparison with those of the classical reinforced concrete. The experimental results on specimens made of steel fiber reinforced concrete are presented. Comments on numerical modeling of steel fiber reinforced concrete indicate that there is a field for future research. If the geotechnical conditions are reasonable the steel fiber reinforced concrete may represent a cost-effective alternative to the classical reinforced concrete segments.

3.4 Fritz Gruebl1 ,Segmental Ring Design – New Challenges with High Tunnel Diameters, World Tunnel Congress 2012, Bangkok, Thailand, 20 – 23 May 2012.

Tunnel lining with segmental rings behind TBMs are reinforced concrete elements and must be calculated and designed according to the standards of reinforced concrete constructions. In tunneling, however, specific circumstances must be taken in account, which make design much more complicated: The determination of loads during ring erection, advance of the TBM, earth pressure and bedding of the articulated ring, is difficult. The ring model and the design input values must be studied carefully according to the parameters of the surrounding soil .

4. DESIGN PHILOSOPHY

1) LIMIT STATE METHOD FOR DESIGN. (Japan society of civil engineers, Shield Tunneling 1996 and IS 456 2000).
2) Calculation of , Bending moment, Axial force and Shear force.

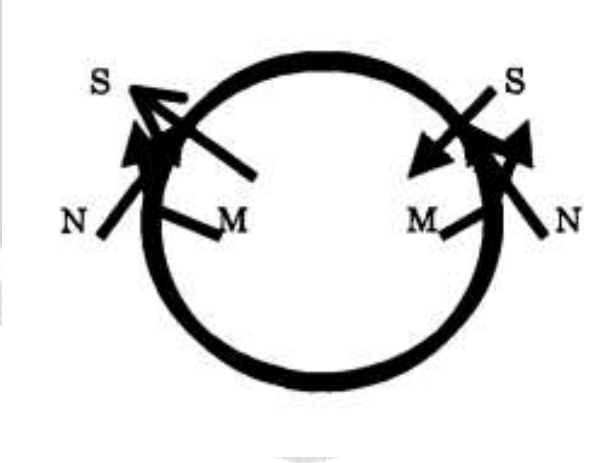

Fig 1-Forces Acting.

4. VALIDATION USING ANSYS

In this finite element model was prepared using ANSYS software which is based on finite element analysis. A calibrated model was prepared to generate the analytical load carrying capacity and deformation at the 0 degree Concrete tunnel is discussed and compared with design results. Uniform homogenous pre-cast RCC concrete section is considered , modeled and analysis.

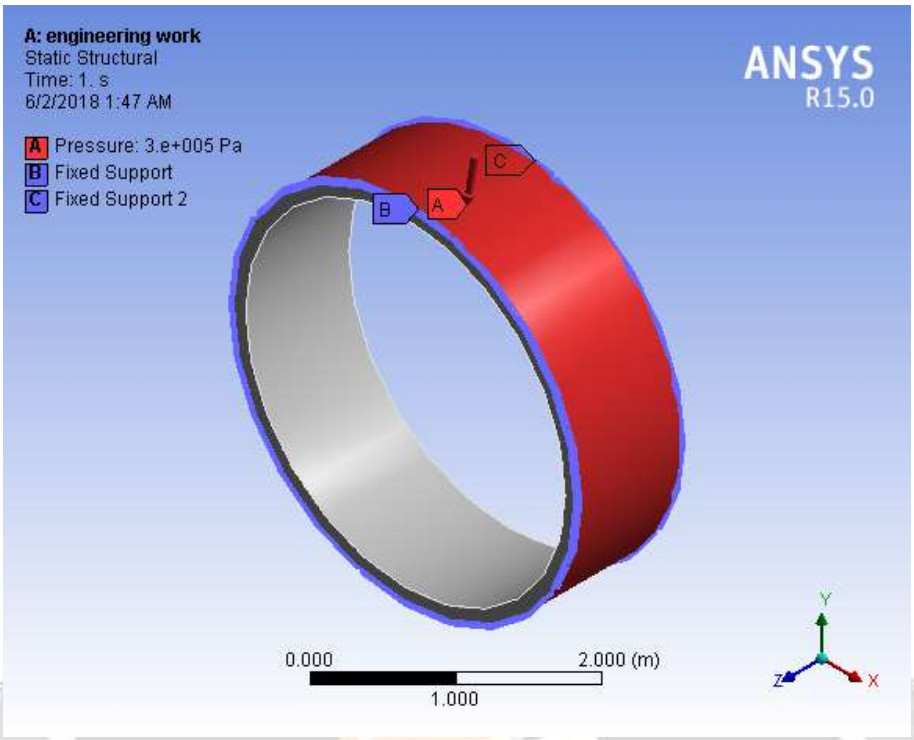

Fig- 2 Forces acting on Structure

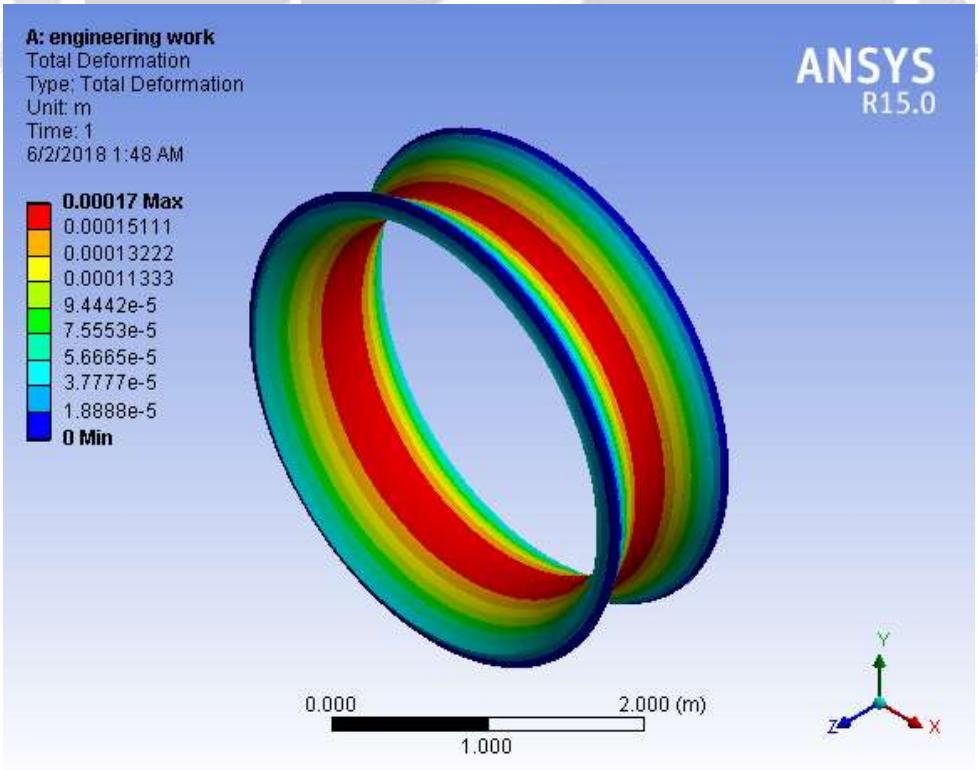

Fig-3 Total Deformation develops.

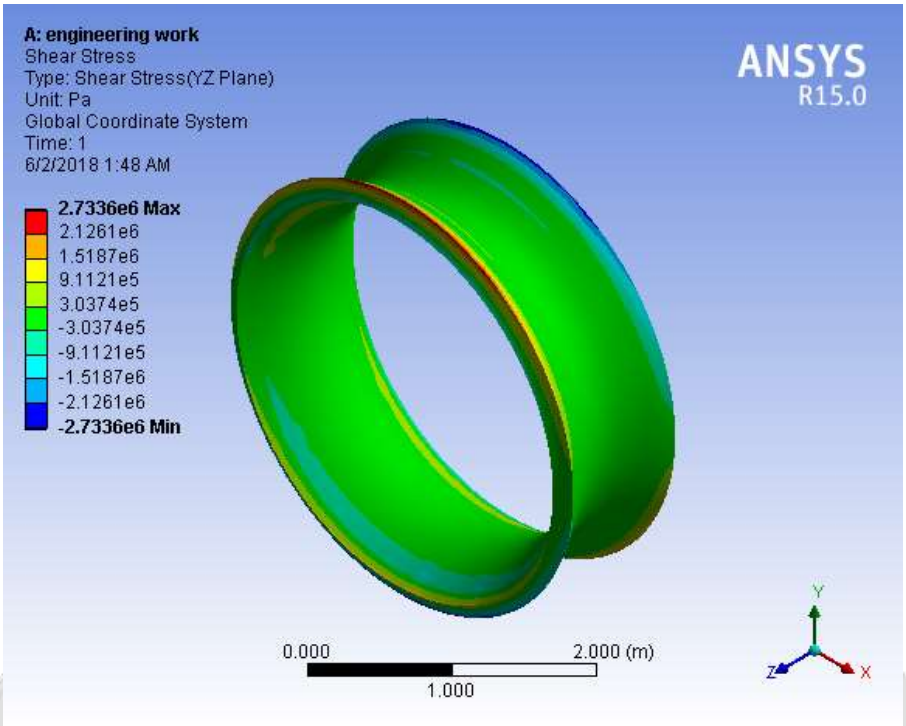

Fig-4 Shear Stress develops.

5. RESULT

The result from ANSYS and EXCEL Sheet Analysis are presented in terms of deformation and shear stress obtained.

Result of Excel analysis and Ansys Analysis

Result	**Excel analysis**	**Ansys Analysis**
Deformation	0.000163 m	0.00017 m
Shear stress	0	0

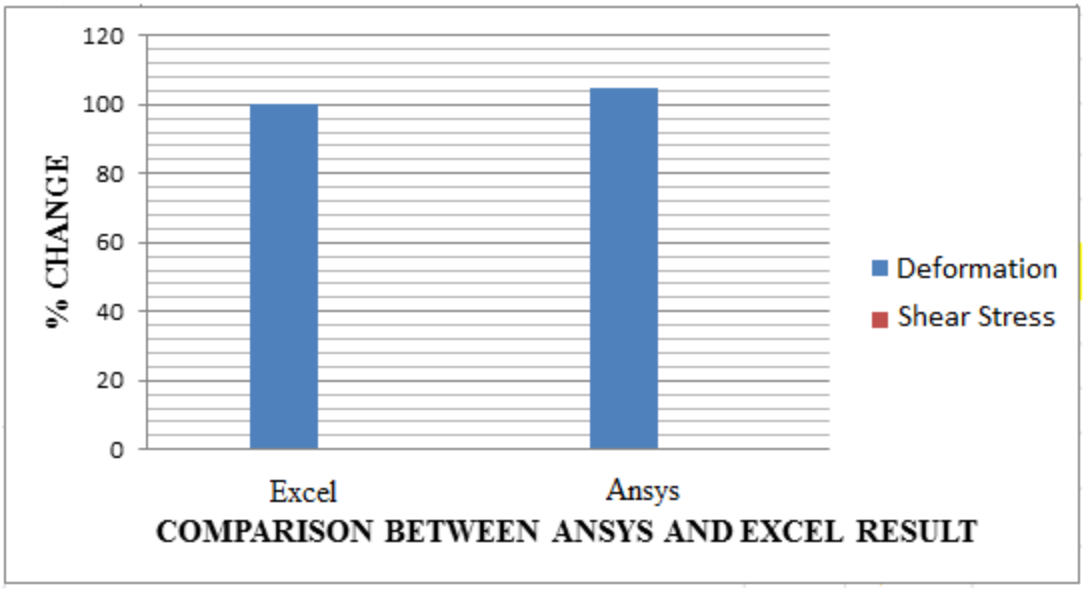

Fig-5 Comparison between ANSYS and Excel Result

5. CONCLUSIONS

1) Both WSM and LSM can be used for design of tunnel segment.
2) Different types of loading and its acting point on different angle of tunnel studies gives Zero degree as Critical point of loading.
3) The resisting moment of the joints shall be not less than 60% of the resisting moment of the segment body.
4) Deformation obtained on EXCEL is 0.000163m and that with ANSYS is 0.00017m,which is nearly greater then EXCEL result.
5) Nearly 5% difference of deformation is obtained.
6) Shear stress in both EXCEL and ANSYS is almost near to ZERO.

6. REFERENCES

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