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Analysis and Design of Low-Cost Circular Tube Housing

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Abstract: Our country is having shortage of housing. We want house which should be safe, serviceable, durable and economical. There is an urgent need to explore a building material that is structurally efficient but at the same time, should be lightweight, eco-friendly, cost effective and especially the ones that can perform the desired functions. In present days projects are time dependent. Cost of materials and labor has gone. Up so, eco-friendly materials are in search. There is a need to study the prevailing technology – New method of construction from circular drainage pipe (Circular tube housing). So that an Affordable house can be constructed. Based on the above an architectural design will be designed. Also, comparative study about low-cost design will be made and we will arrive to some conclusion which should suit to our nation

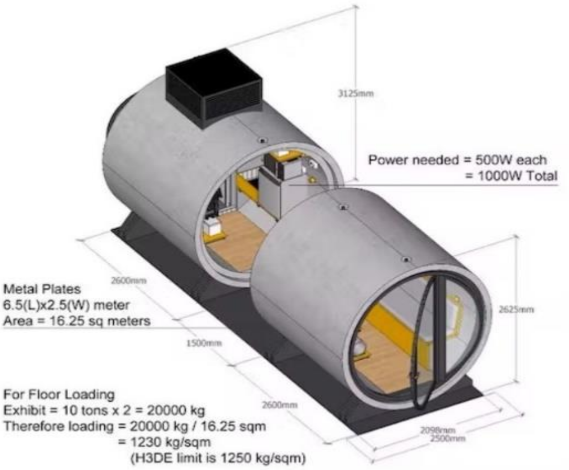
Index Terms - **Circular Tube Housing, Low-Cost Construction Method, Opod Housing, House Design with Circular Drainage Pipe.**

I. INTRODUCTION

Housing is one of the basic human needs along with food, Clothing and education. Mankind has been evolving different kinds of shelter with the changing civilizations and time. Like any other developing country there is a huge growing requirement of building Materials in India due to housing shortage. As per National Building Organization (NBO) Estimates, the existing housing shortage of 24.7 million units {2007} mainly for the low-Income groups in urban India. Estimated urban housing shortage in 2012 is 26.53 million while the housing shortage of rural India in 2012 is 42 million units. Thus, total estimated housing shortage for Urban & rural India in 2012 is 68.53 million units. According to an UN estimate over 0.53 million people in developing countries is houseless. A recent study undertaken by the UNCHS reveals that over 100 million people live in a state of absolute homelessness. The economic survey of India for 2012-17 indicates that in 2012, there were about 0.53 million homeless households in the country and the number has further grown in the intervening period. As per one estimate, in 1993, there were three million Homeless households in the country. From earlier time human had been constructing houses for their safety. From the time he started understanding the physiological needs, he started making changes in the planning and materials. Primitive men started using caves as their shelter and with the passage of time he started thinking of small huts made of grass and mud and from hut to houses having wooden roof and from that to concrete buildings. There are different types of housing, caves, Grass huts, house with mud roof, house with Mangalore tile, precast brick panel system, precast rc channel unit, precast rc plank and joint system, concrete block for masonry etc.

II. DESIGN CONCEPT

This is a structure which is used in Hong Kong nowadays due to less land. It provides an alternative for young people who are unable to afford conventional. The design utilizes a strong concrete structure to house an apartment for one or two persons with living, cooking and bathroom inside 100 square feet (9.29 square meters). Each tube house is equipped with smartphone locks for online access and space saving micro-living furniture. They can be stacked to become a low-rise building as a modular community in a very short time and can be located and relocated in different sites conveniently. The home uses leftover concrete water pipes that have been produced, which are readily available at low costs. These 2.5-metre-diameter concrete water pipes are large enough for people to live inside. Originally designed for underground use, they are strong enough and safe for human living, with inherent good thermal and fire insulation properties. Two tubes are combined to form a fully kitted out 100-square-foot apartment for one to two persons. The first tube is used for living and sleeping, while the second tube contains a small kitchen and bathroom as well as space-saving furniture to maximize the interiors. The modular homes can be stacked as a low-rise building and easily relocated to different sites in the city. They can be deployed under flyovers, on top of existing buildings, and within gaps between buildings in the city. These tubular structures being piled up on top of one another, creating affordable starter homes for young people in vacant city-center locations across Hong Kong. People could live happily in the tubes for one to two years. And all the furniture area foldable. Because each tube is only 2.5 meters different.



There are some disadvantages with the circular housing. Following are the methods which can reduce the major problems up to a great extent.

- **Thermocoal covering**

One of the main problems regarding circular OPOD tube is that no insulation is provided for the design. For reducing the temperature covering whole section with a thermocol. Thermocol is sandwiched between two circular tubes, one after another. So the thermocoal not only resist the heat from the sun but also reflect the rise to the atmosphere.

- ***Use of plants***

Often people aren't aware of the impact that their garden has on the heat of their home. Your garden can be used to plant trees which act as a shade for your home. Not only that but they also look good. The Hybrid Poplar is one of the fastest growing trees which can be up to 50 feet fully grown. They are popular because they grow around 8 feet per year. Another popular pick is the Northern Catalpa. It doesn't grow as fast as the Hybrid Poplar however it has an exceptionally thick canopy of leaves which can provide great cover for your home and keep the heat off. Remember that if you want to benefit from passive solar heating during those cold winter months, then don't plant trees on the south side of your building.

- ***Swap Your Lights***

Incandescent lights can waste up to 90% of their energy in heat. So, when you see them up there on your ceiling, they really should be providing you only with light rather than warming your home! Switch out the incandescent lights for an energy saving light also known as a compact fluorescent light. Not only will it help to keep your house cooler, but it will also save you some money on your electricity bill! Ventilation windows or slits can provide sufficient airflow inside tubular housing, which can both keep the interior cool and prevent excess moisture from building up. Consider adding a vent or two at each end of the circular housing to set up a cross-ventilation system that can serve as a natural form of climate control

- **Add Ventilation**

Ventilation windows or slits can provide sufficient airflow inside tubular housing, which can both keep the interior cool and prevent excess moisture from building up. Consider adding a vent or two at each end of the circular housing to set up a cross-ventilation system that can serve as a natural form of climate control.

- **Usage of circular solar panel instead of battery back**

Use of solar panel around the tube help to get electricity unlimited in the daytime. Circular solar panel is good if we consider the design.

III. Analysis using Ansys

ANSYS is an engineering simulation software provider founded by software engineer John Swanson. It develops general-purpose finite element analysis and computational fluid dynamics software.

FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company can verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. There are generally two types of analysis that are used in industry: 2-D modeling, and 3-D modeling. While 2-D modeling conserves simplicity and allows the analysis to be run on a relatively normal computer, it tends to yield less accurate results. 3-D modeling, however, produces more accurate results while sacrificing the ability to run on all but the fastest computers effectively. Within each of these modeling schemes, the programmer can insert numerous algorithms (functions) which may make the system behave linearly or non-linearly. Linear systems are far less complex and generally do not consider plastic deformation. Non-linear systems do account for plastic deformation, and many also can test a material all the way to fracture. Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variation.

Procedure for ansys analysis

Static analysis is used to determine the displacements stresses, stains and forces in structures or components due to loads that do not induce significant inertia and damping effects. Steady loading in response conditions are assumed. The kinds of loading that can be applied in a static analysis include externally applied forces and pressures, steady state inertial forces such as gravity or rotational velocity imposed (non-zero) displacements, temperatures (for thermal strain).

- Preparatory work prior to analysis.
- Preprocessor modeling through the preprocessor:

Defining: define cell types, constants, material properties, etc. Modeling: create model in work page; or build directly with external software, then import. Meshing: (to recommend smart grid divisions). Checking: check that the model is correct before saving. (Note: because ANSYS has no return key, it is recommended that the Save As command be used after the implementation of each of these key steps. This will prevent errors in the modeling or solving processes, and facilitate the call)

- Solving by Solution:

Select the type of analysis; set analysis options.

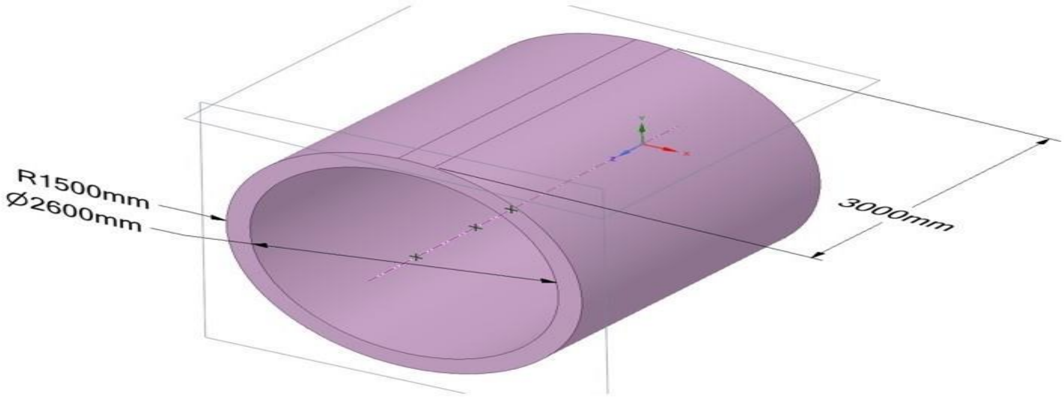
Apply additional load and constraints. Set load step options. Solving: (the default solver option can be used, if the load step has been set to select for solving, according to the load step options-solver).

- Viewing results via General Postprocessor:

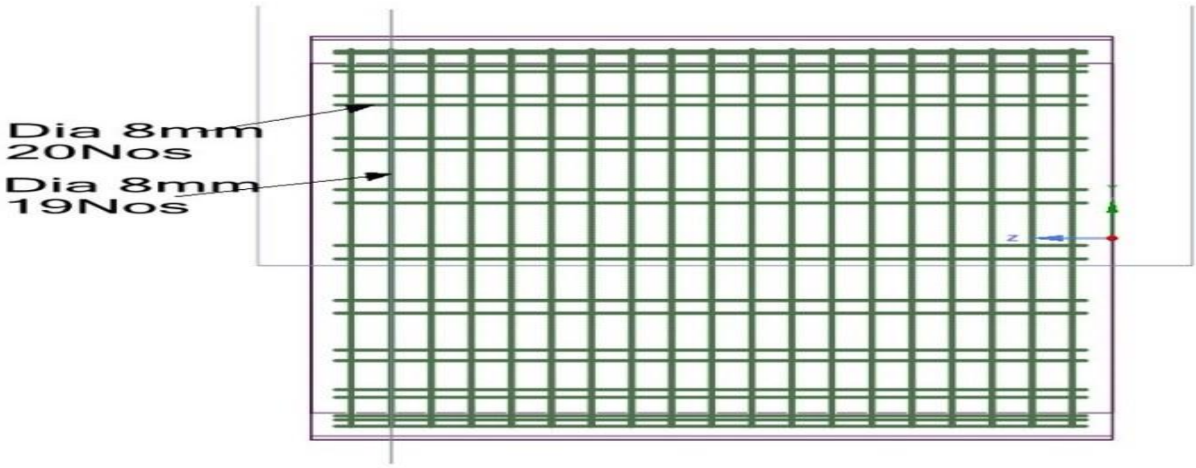
After solving, review the model's analysis of data, deformation maps, stress map, displacement map, etc.

Loads in a structural analysis

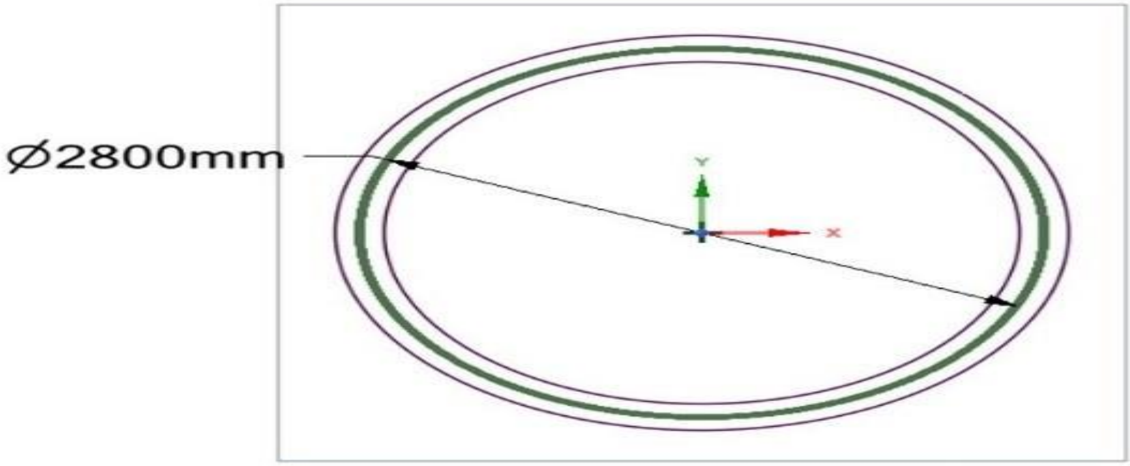
Static analysis is used to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time.



Gematrical model

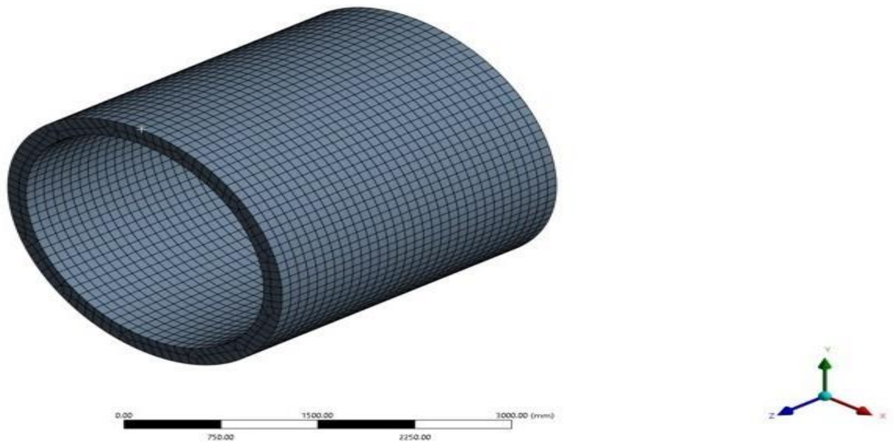


Bar details

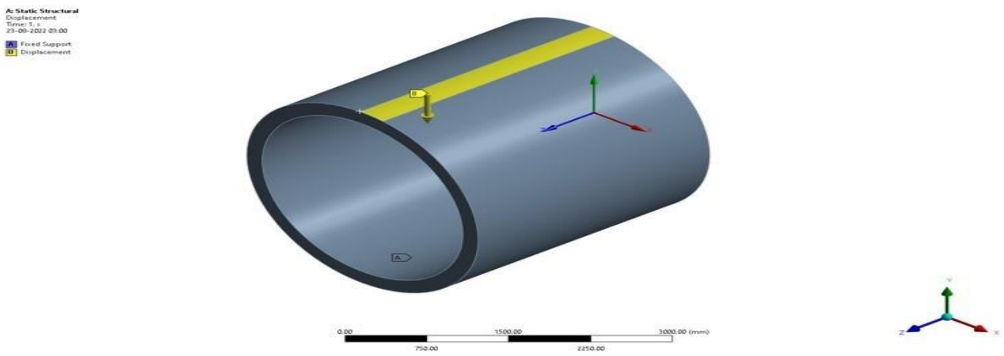


Cross section details

Meshed geometry



Boundary condition



A=fixed support (bottom)

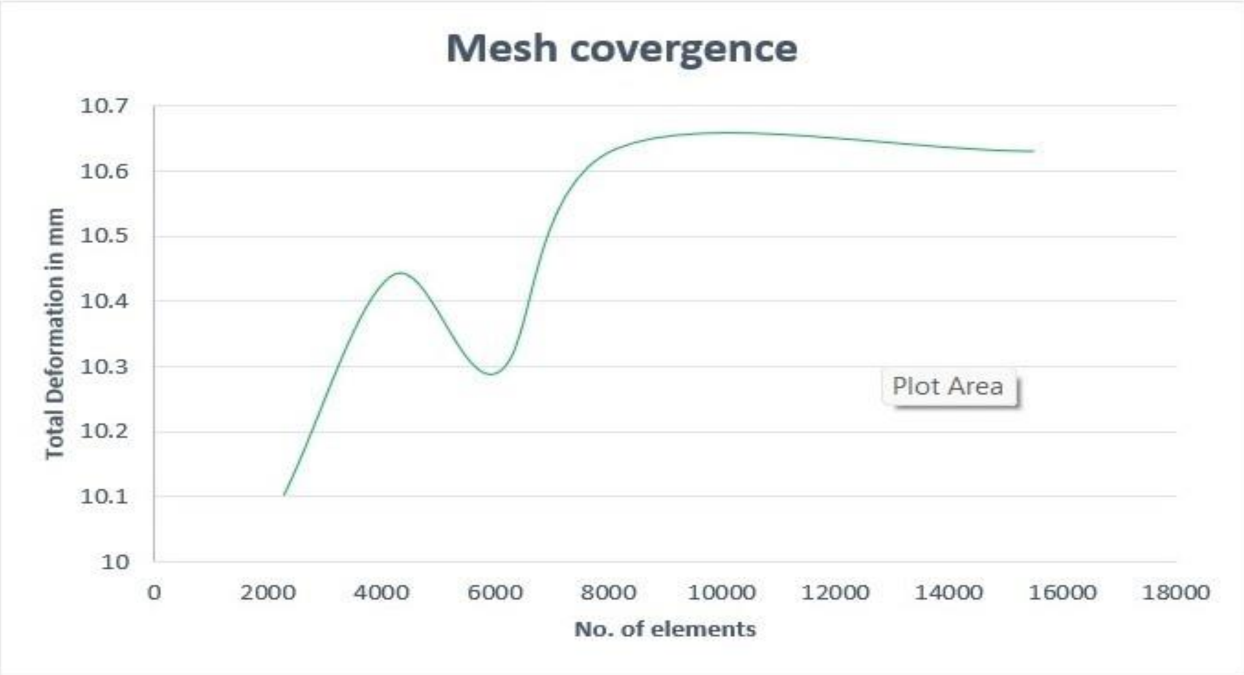
B=prescribed displacement (top) 10mm

Concrete M20 grade

Isotropic Elasticity	
Derive from	Youngs modulus and Poisson's Ratio
Young's Modulus	21167 MPa
Poisson's Ratio	0.18
Bulk Modulus	11024 MPa
Shear Modulus	8968.9 MPa
Menetrey-Willam	
Menetrey-Willam Base	
Uniaxial Compressive Strength	20 MPa
Uniaxial Tensile Strength	2.7846 MPa
Biaxial Compressive Strength	23.594 MPa
Dilatancy Angle	30 degrees
Softening	
Active Table	Linear
Plastic Strain at Uniaxial Compressive Strength	0.001
Ultimate Effective Plastic Strain in Compression	0.001
Relative Stress at Start of Nonlinear Hardening	0.4
Residual Compressive Relative Stress	0.2
Plastic Strain Limit in Tension	0.01
Residual Tensile Relative Stress	0.2

MESH Convergence study

Sl No	Element size(mm)	No:of elements	Number of nodes	Total deformation(mm)
1	180	2293	36566	10.103
2	150	4208	17837	10.44
3	120	6070	26561	10.291
4	100	8140	36566	10.634
5	80	15500	70204	10.63

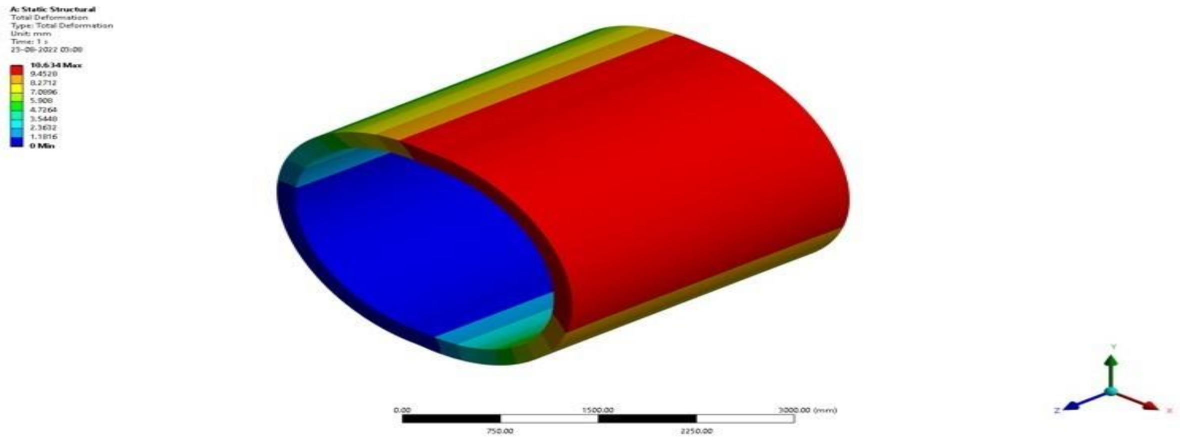


From the mesh convergence study select the element size as **100mm**

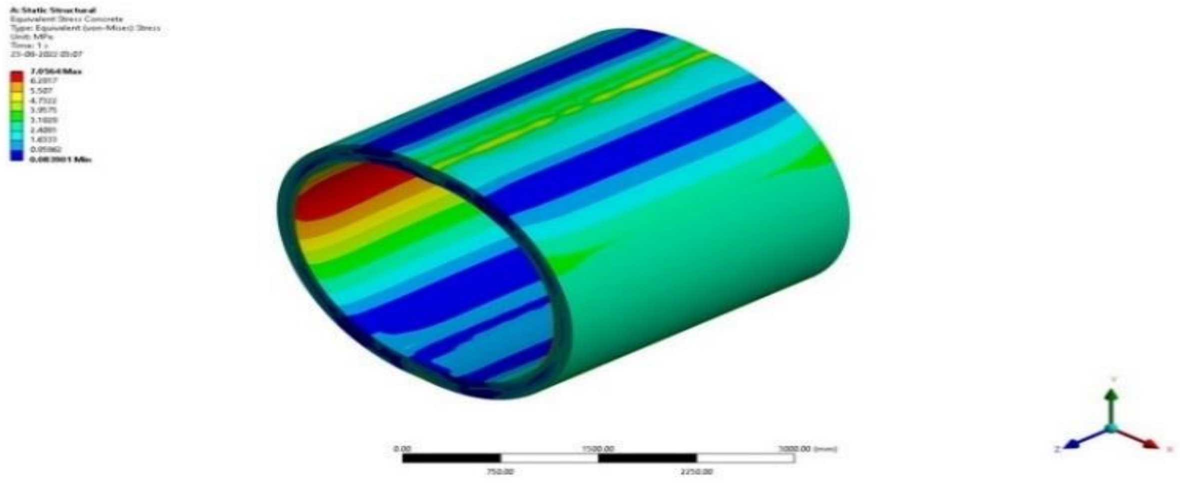
Element type: Hex 20

Element order: Program controlled

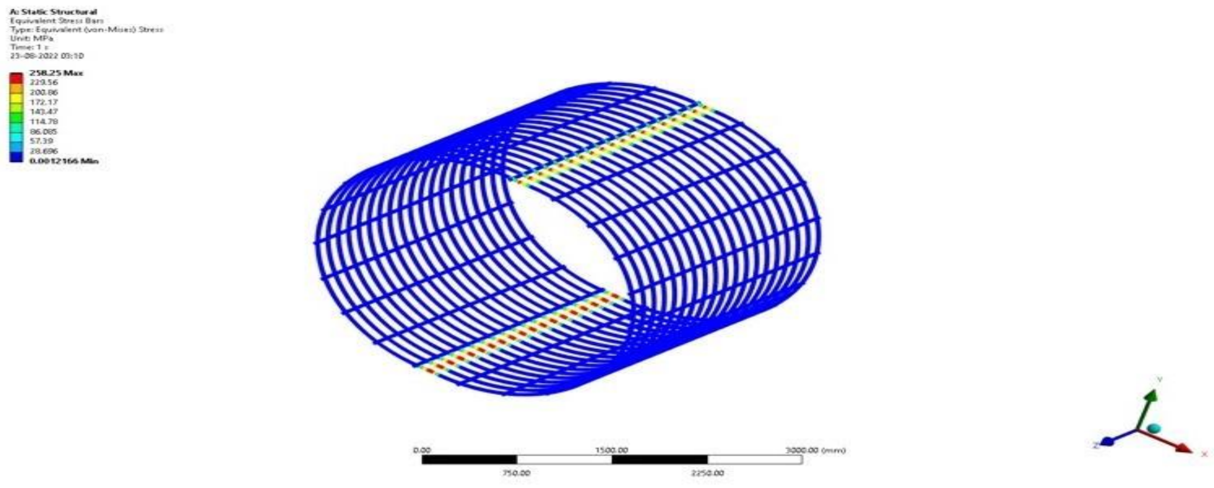
Total deformation



Equivalent stress of concrete



Equivalent stress bars



Ultimate load = 316.57kN

Conclusion

Circular house design with drainage pipe is a great idea for the people who don't have houses or people who are living in slum. This project helps to conclude that drainage circular pipe can withstand up to 316.50KN without any crack formation. We can use this technology for low cost future construction works and it will be very helpful in the case of shortage of land.

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