Design and Analysis of Convertible Bench

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Abstract- *In most metropolises in the world, people's average living area is getting smaller and smaller. More and more young people tend to move to large cities for more opportunities and more active life style. However, this phenomenon decreases the average living area gradually. Now in Beijing China, the average living area is only 21 square meters per person. Moreover, high population density leads many other problems such as high gap between rich and poor, high energy cost and house price. These are common problems in metropolis nowadays. Transformable space saving furniture is one of the options to solve these problems.*

In this report, I will introduce the innovation designs, designed using 3D Design software and analyse the capabilities and boundaries of the particular furniture designed the hard wares, the application and future development, cost and price, and the important markets of transformable space saving furniture. This report will help people to understand the importance and the potential value of transformable space saving furniture in metropolises.

I. INTRODUCTION

A **bench** is a long seat on which multiple people may sit at the same time. Benches are typically made of wood, but may also be made of metal, stone, or synthetic materials. Many benches have arm and back r`ests; some have no back rest and can be sat on from either side. In American public areas, benches are often donated by persons or associations, which may then be indicated on it, e.g. by a small plaque. Benches are used both outdoors and indoors.

Often benches are simply named for the place they are used, regardless of whether this implies a specific design.

- Park benches are set as seating places within public parks, and vary in the number of people they can seat.
- Garden benches are similar to public park benches, but are longer and offer more sitting places.
- Picnic tables, or catering buffet tables have long benches as well as a table. These tables may have table legs which are collapsible, in order to expedite transport and storage.
- Scenic benches are situated to provide a comfortable means of enjoying the contemplation of a beautiful landscape, a busy street scene, or perhaps a specific event.
- Perch benches are usually situated in high traffic areas to enable people to take a quick break.
- A storage bench is a combination of sitting space and a storage box, often used for keeping gardening supplies or grill equipment.
- A form is a backless bench that was used for seating in dining rooms, school rooms and law courts.
- Churchbenches and pews inside places of worship, which are sometimes equipped with an additional kneeling bench. Church benches and pews can come in various styles including traditional modern and curved to match and complement the architectural styles and spaces of places of worship.
- A bench seat is a traditional seat installed in automobiles, featuring a continuous pad running the full width of the cabin.
- a punishment bench is used to have a punishee lie (and often be tied) down on for the administration of a corporal punishment, after which it may be specifically named, e.g. caning bench
- a bench (weight training) is used for fitness exercises, such as the bench press which is named after its use of a bench
- a communion bench is not used as a seat
- A piano bench offers usually one person seating and is height adjustable.
- a spanking bench, such as a caning bench, is specifically designed for a spankee to lie upon, possibly strapped down, while submitting to paining of the posterior
- Swing seats are independently movable, suspended benches, used for play or as a relaxing porch swing.
- Glider Benches are similar to Swing Seats but are not suspended; instead they have a mechanism under the seating area that allows the bench to rock back and forward
- A courting bench (or kissing bench or tête-à-tête): a two-seater with the seats pointing in opposite directions, thus almost facing each other.
- A friendship bench in a school playground is where a child can go when they want someone to talk to.
- The bench in a courtroom, behind which the judge is seated.Bench materials

Benches come in a variety of different materials, but there are some venue standards that account for use, durability, and maintenance patterns.

- Aluminium: Aluminium benches are often found in outdoor, side line settings at recreational venues like sports fields or courts and as a compliment to bleacher systems. The material affords for a lightweight, corrosive-free bench, so it is a portable and economical option for indoor or outdoor settings.
- Concrete: Concrete benches are very heavy and are a more permanent furnishing. They are often installed in facilities that are not expected to change or transition often, if at all, such as military bases, state parks and official buildings. Concrete is very durable, so it is appropriate for any climate. Concrete can be composed of many different materials to afford benches different accents, depending on what it is composed of.
- Fiberglass: Fiberglass is a versatile material so fiberglass benches can come in a variety of designs and finishes or colors. The material is great for indoor or outdoor use because it will not corrode or rust, is very low maintenance, and can be manufactured to compliment any facility. Common places where fiberglass benches are installed include food courts, restaurants, and office buildings.
- Powder-coated steel: Powder coated steel benches are often found lining entryways for different venues, like retail centers, medical facilities and country clubs. While powder-coat is a common finish on many commercial site furnishings, it is often featured on strap metal benches because of its anti-corrosive qualities and ability to strongly bond to heavy duty steel constructions. Powder-coated benches also come in a variety of colors and designs, from classic strap metal benches to extremely intricate designs.
- Recycled plastic: Recycled plastic benches are low maintenance, available in a variety of colors and styles, and are appropriate for any environment, including typically-corrosive salty, ocean side facilities. Recycled plastic components can vary based on the manufacturer, but it is commonplace that a high percentage is post-consumer material and will contribute to LEED certification. For these reasons, they are commonly found at a wide range of venues, including convention centers, office buildings, universities, retail centers, schools and stadiums.
- Thermoplastic: Thermoplastic is an environmentally friendly coating for metal benches. Thermoplastic benches are very commonplace, located in facilities ranging from schools, parks, recreational spaces and office buildings. The material itself is graffiti resistant and easily repairable, as opposed to other metal coatings and, with a thorough coat, will help a metal bench withstand a variety of climates. There are endless color options and six different common pattern styles: expanded metal, perforated metal, strap style, welded wire, diamond pattern and rod style. Expanded metal is often seen in casual park settings, featuring a lattice-like look while strap style can be commonly featured trail side or embellishing a sidewalk.
- Wood: Wood benches are a very high maintenance option because they need to be regularly treated with an insect repellent or coated with polyurethane or similar coating to maximize the life of the material. They are typically found along walking trails and state parks, while high-quality wood products like teak, redwood and mahogany are commonly found in residential furniture lines, resorts and restaurant settings. Other common lumber furnishing materials include oak and southern yellow pine.

II. FEATURE-BASED

Just as an assembly is composed of number of individual piece parts, a SolidWorks model also consists of individual constituent elements. These elements are called as Features. The features are applied directly to the work piece as soon as they are created.

Features can be classified as either sketched or applied.

Sketched Features: These are created directly upon a 2D sketch. Generally the sketch is transformed into a solid by extrusion, rotation, sweeping or lofting.

Applied Features: These are created directly on the solid model. Fillets and Chamfers are examples of this type of features.

Parametric:

The dimensions and relations used to create a feature are captured and stored in the model. This enables not only to capture your design intent, but also to quickly and easily make changes to the model.

In the revolved body, hole size is reduced parametrically since all the circles are driven by relations and dimension. A change in one hole reflects the others.

Driving dimensions: These dimensions are used while creating a feature. They include the dimensions associated with the sketch geometry, as well as those associated with the feature itself.

Relations: This includes information, such as parallelism, tangency, and concentricity. By capturing this in the sketch, SolidWorks enables you to capture your design intent up front, in the model.

III. SOLID MODELING

A solid model is the most complete type of geometry model used in CAD systems. It contains all the wireframe and surface geometry necessary, to fully describe the edges and the faces of the model.

In addition it has the information called „the topology" that relates the geometry together. An example of topology would be which faces (surfaces) meet at which edge (curve). This intelligence makes operation such as filleting as easy as selecting an edge and specifying a radius.

Fully associative:

A SolidWorks model is fully associative with the drawings and the assemblies that reference it. Changes to model are automatically reflected in the associated drawings and assemblies. Similarly, you can make changes in the drawing or assembly, and those changes will be reflected in the model.

Constraints:

Geometric relationships such as parallel, perpendicular, horizontal, vertical, concentric and coincident are some of the constraints supported in SolidWorks.

In addition, equation can be used to establish mathematical relationships among parameters. By using constraints and equations, you can guarantee the design concepts, such as through holes or equal radii that are captured and maintained.

Design Intent

Design intent is your plan about how the model should behave when it is changed. For example, if you model a boss with a blind hole in it, the hole should move when the boss is moved.

To use the parametric modeller SolidWorks efficiently, you must consider the design intent before modelling. Several factors contribute to how you capture your design intent and they are:

- Automatic Relations
- Equations
- Added relations
- Dimensioning

Difference between Current and existing model

- Product Development of existing model
- A normal table can be used as a seating or relaxing table at the house holds.
- current design includes convertibles that is helpful to change position of the table instantly form bench to table.

Steps Involved for converting an development

- Design of model by using Modelling Softwares
- Convertion of CAD Design models into Stereolothiography files
- By using RPT Techniques we can manufacturing the product
- In RPT Techniques FDM Process are using for product development in 3D Printing

Bench in Closed Module

APPLYING STRUCTURAL ANALYSIS OF MODEL 1

4.0 Case 1 FEA analysis of Table position 1

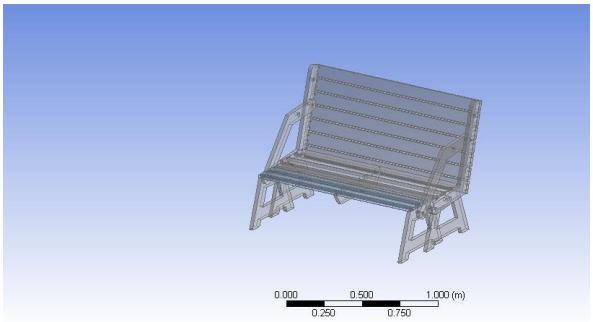


Fig1.1:Imported Model fromSolid works to Ansys

Table 1: Mesh

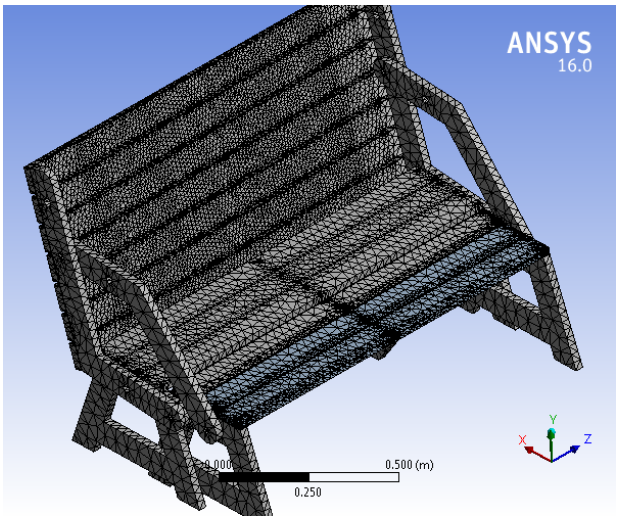


Fig 1.5:Discretised 3D model

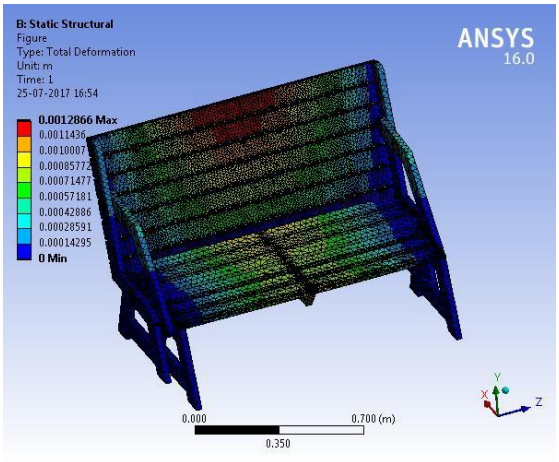
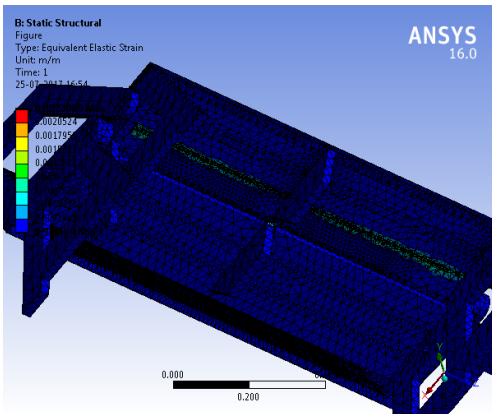
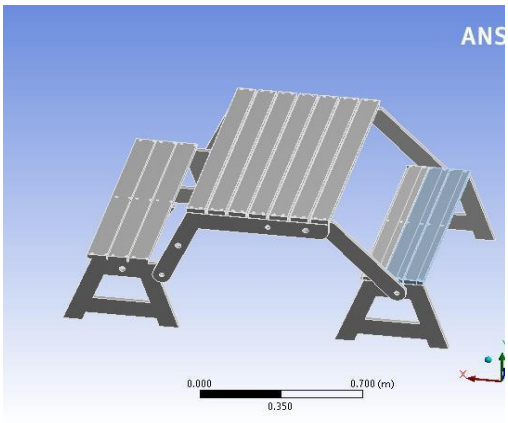


Fig 1.6: Total deformation



4.1 Case 2



1.0 Fig 1.9:Open Model Simulation 1.1

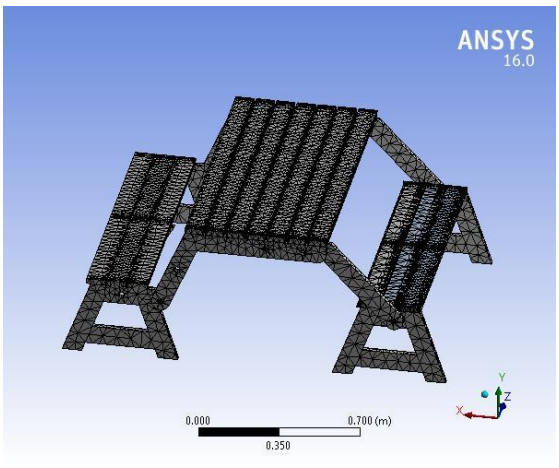


Fig 1.10: Total deformation

Table7
Total Deformation

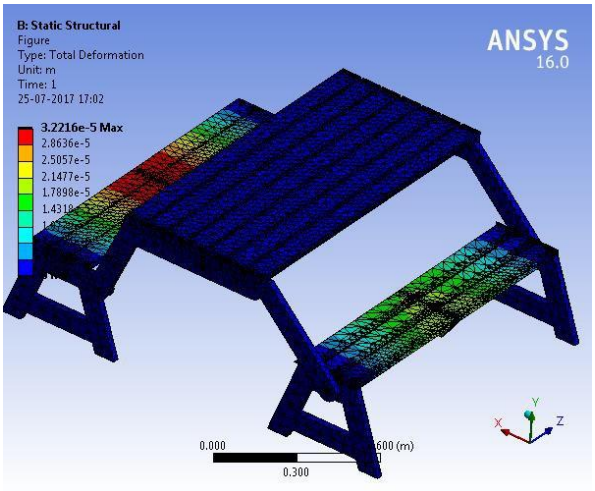


Fig 1.11: Total defamation

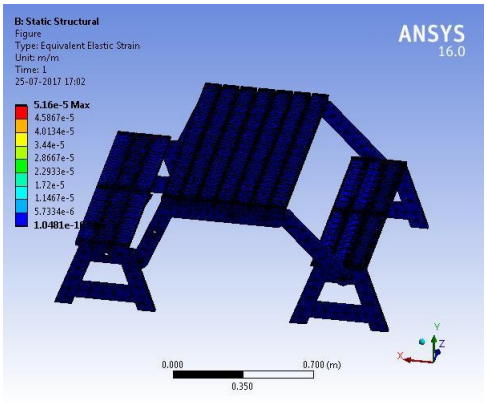


Fig 1.12: Equivalent Elastic Strain

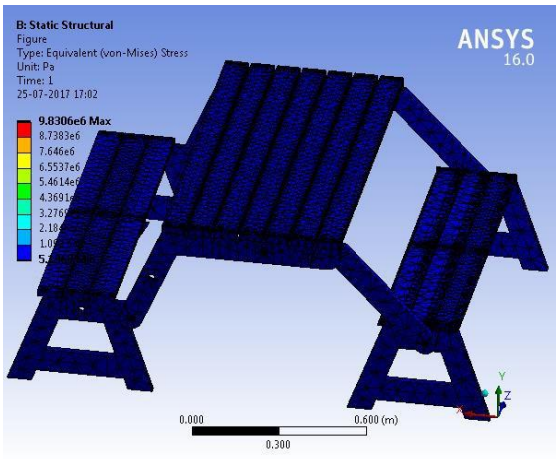


Fig 1.13: Equivalent (von-Mises) Stress

Fig 1.11: Designed Model Bench

4.2 Case 3

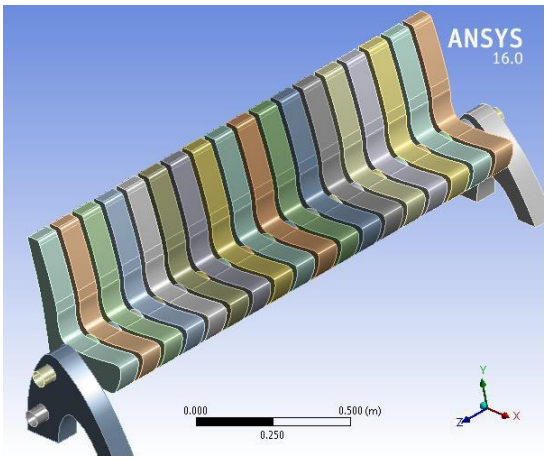


Fig 1.15: Analysis on the bench

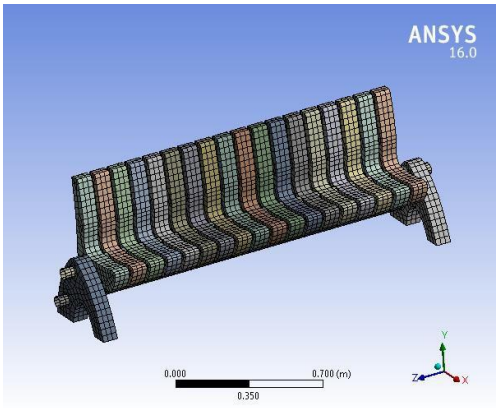


Fig 1.16: Mesh

Table:12
Total Deformation
Note : Time (s) Considering Load acts on area per second

Time [s]	Minimum [m]	Maximum [m]
1.	0.	1.9921e-001

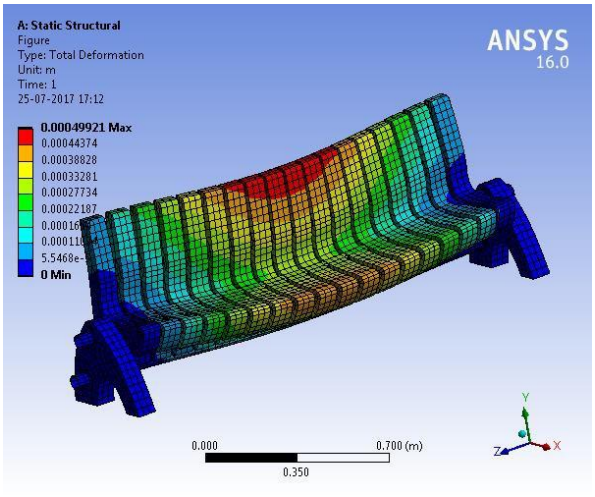


Fig 1.17: Total Deformation

Time [s]	Minimum [m/m]	Maximum [m/m]
1.	2.8721e-013	3.2287e-001

(A6) > Equivalent Elastic Strain > Figure

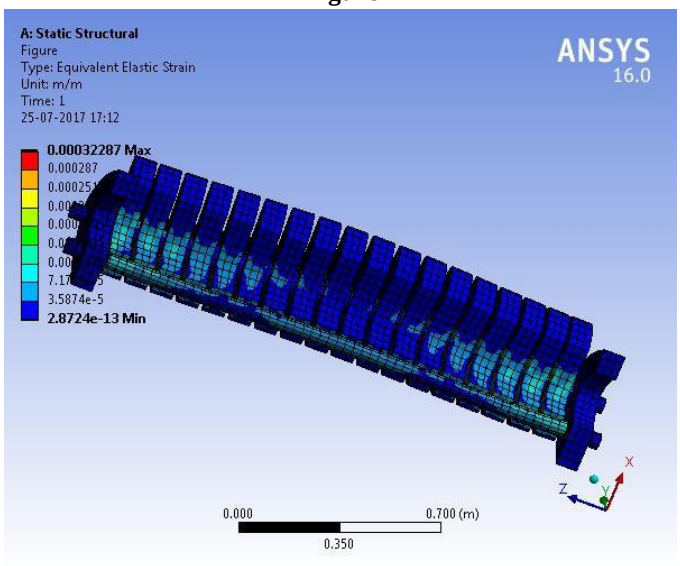


Fig 1.18: Equivalent Elastic Strain

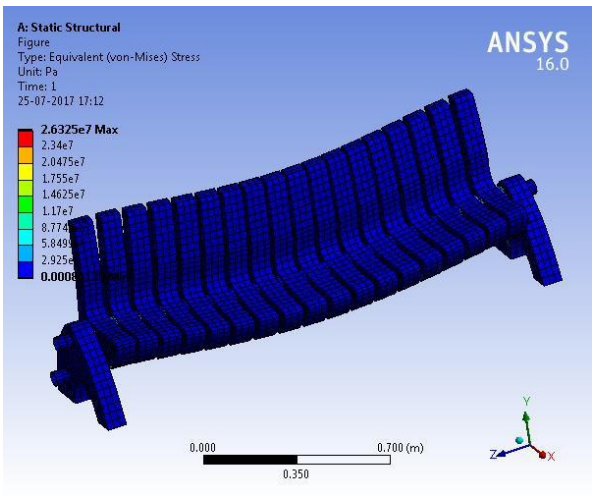


Fig 1.19: Equivalent (von-Mises) Stress

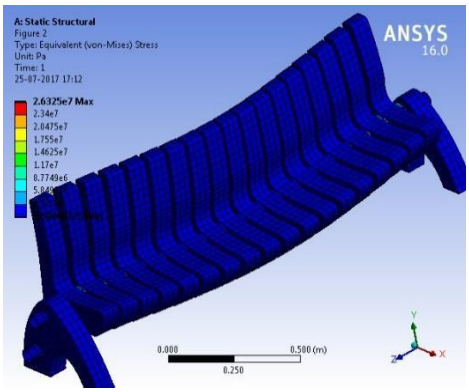


Fig 1.20: Equivalent (von-Mises) Stress

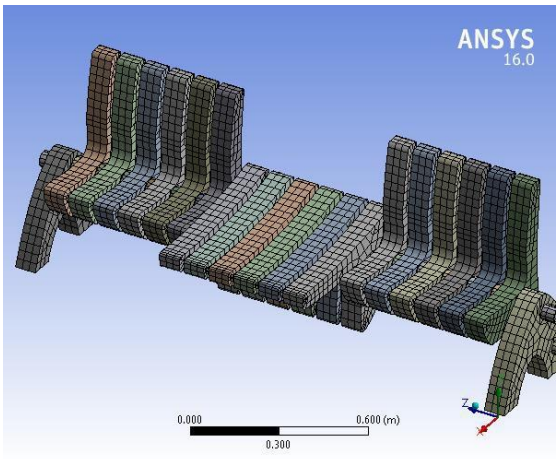


Fig 1.22: Mesh

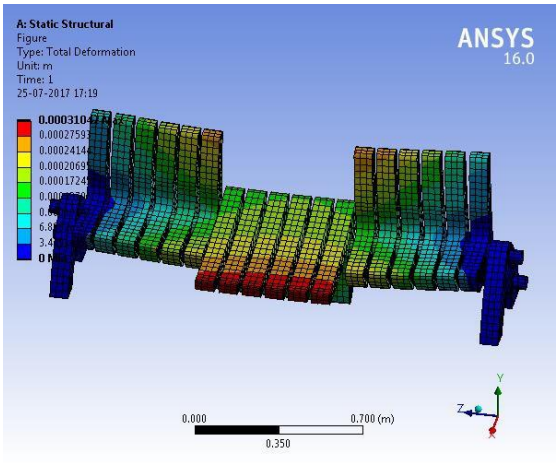


Fig 1.23: Total deformation

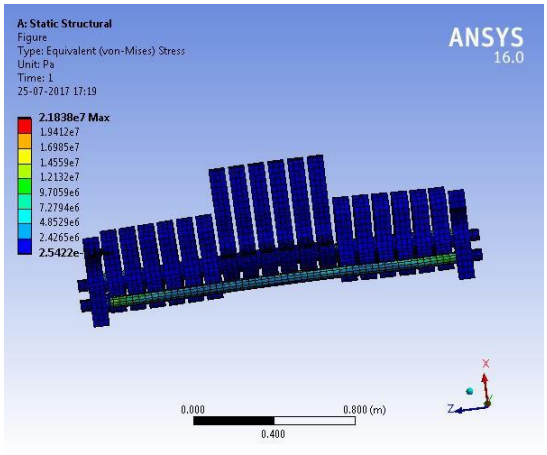


Fig 1.26: Equivalent (Von-Mises) Stress

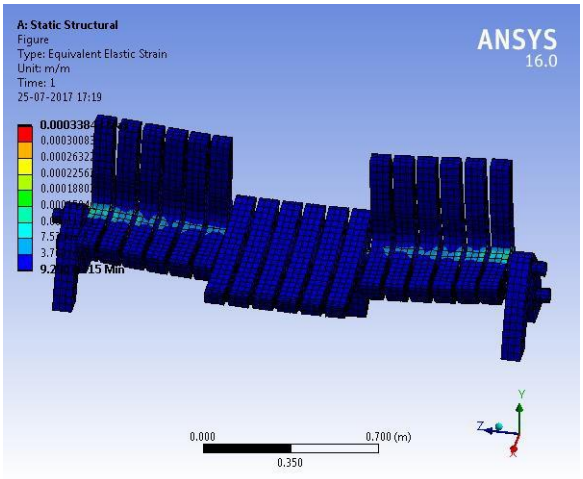


Fig 1.21: Equivalent Elastic Strain

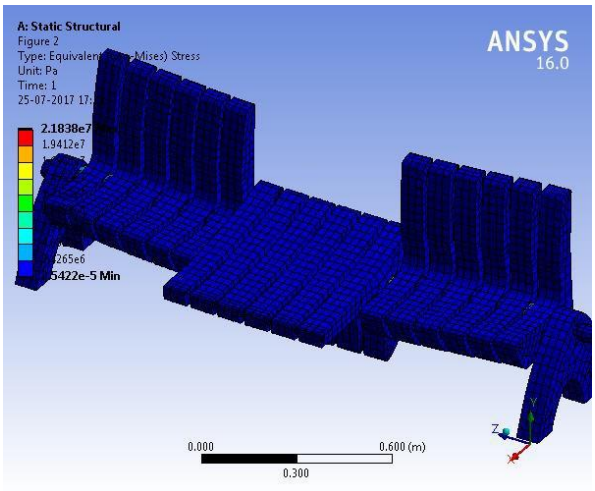


Fig 1.27: Equivalent(Von-Mises) Stress

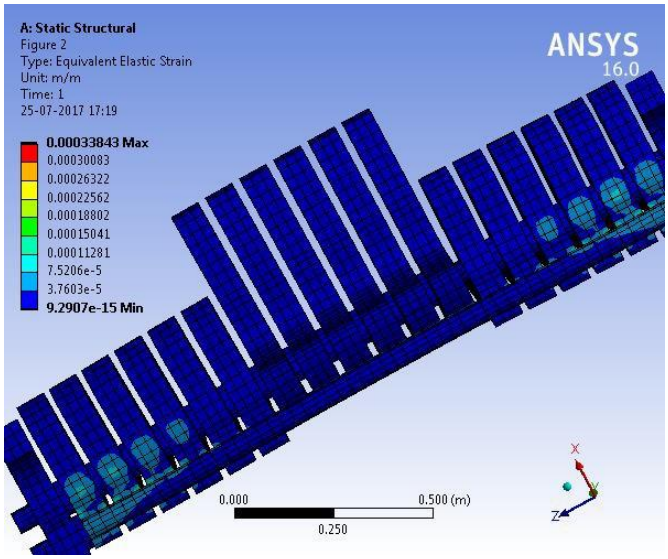


Fig 1.25: Equivalent Elastic Strain

Table: 22.10
Isotropic Relative Permeability

Relative Permeability
10000

IV. CONCLUSION

Transformable space saving Product is an innovative product that has much opportunity for future development, and a huge potential market in metropolises. The designs of transformable table can be even more variable than those of the the above 2 designs have been designed and analysed to its potential from the finite element analysis the Stress and Strain acting on both the models in both the positions are acting minimally and tends to possess more life

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