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Resizable sand-casting mould box

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ABSTRACT
Resizable sand casting mould box, also known as a mould flask, is an essential component in the sand casting process, allowing for the creation of complex and intricate metal castings. This abstract provides an overview of the concept and advantages of a resizable sand casting mould box.
Sand casting is a widely used manufacturing method for producing metal components with complex geometries. It involves creating a mould from compacted sand and pouring molten metal into it to obtain the desired shape. The mould box, or flask, is a crucial element in this process as it holds the sand and defines the shape and size of the casting.
Traditionally, mould boxes are manufactured in fixed sizes to accommodate specific casting requirements. However, a resizable mould box offers several advantages over the conventional fixed-size counterparts. The resizable mould box consists of individual sections that can be easily adjusted and rearranged to achieve different dimensions and shapes. This flexibility allows for greater versatility in casting various part sizes and shapes, reducing the need for multiple fixed-size mould boxes and associated costs.
The resizable mould box typically comprises two halves, known as the cope and drag, which sandwich the sand mould. These halves are connected using adjustable pins, clamps, or other securing mechanisms. By adjusting these connections, the mould box's dimensions can be modified to accommodate different part sizes while maintaining structural integrity and ensuring proper sand compaction.
The advantages of a resizable mould box extend beyond flexibility in size and shape adjustments. It also enables improved mould quality and dimensional accuracy. With the ability to resize the mould box, more precise control over the sand compaction can be achieved, leading to better mould density and reduced defects in the final casting. Furthermore, the resizable nature of the mould box allows for easier mould removal, minimizing the risk of damaging the casting during extraction.
In conclusion, the concept of a resizable sand casting mould box offers significant benefits in terms of versatility, cost-effectiveness, and improved casting quality. By allowing adjustments in size and shape, this innovative approach enhances the sand casting process, enabling the production of high-quality metal castings with complex geometries.

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I. INTRODUCTION

1.1 CASTING PROCESS

- Pattern Shop

Everything in the foundry starts with a pattern. A pattern or tooling is a full-size model of the part you are trying to cast; patterns can be made from various materials such as mahogany, metal, plastic or Styrofoam. It is very important to have a suitable pattern.

Dews Foundry's in- house pattern shop works closely with the foundry to ensure that the proper patterns are built and maintained in order to meet our customers' requirements. Our pattern makers have both skill and vision to take apart from a blueprint and turn it into a physical part. Exeter you need a prototype or production tooling; Dews has the capabilities to meet those needs.

Foundry maintains a very large on site pattern storage with an automated sprinkler system to ensure that your patterns and tooling are protected while in storage at our facility.

Core making is the important branch in the foundry and the choice of core making depends on various factors. To name them are depending on the type of metal to be cast, depending on the requirements of quality in the final product, and on equipment used for production and energy source.

- Core Making

Common technologies involved in core making

There are six most common technologies involved in core making, they are

- Oil as the sand binder
- Green sand
- Hot box
- Cold box

- No bakes
- Shell process

In each of the technologies there are various advantages and drawbacks.

Requirements and features of common technologies in core making

When each of the above technologies is ranked based on the usage of energy per unit of product ranking from greatest to lowest amount the order is oil as the sand binder being the highest followed by green sand, hotbox, cold box, no bakes and shell process being lowest usage of energy in ranking.

That is the rated in percentage the technology of oil as the sand binder uses the maximum energy of hundred percentage and green sand used 85% followed by hotbox with 75%, cold box with 58%, no bakes with 38%.the least energy is made by shell process technology with 35% recorded as usage.

The oil as the sand binder as well as technology uses high energy because it needs high temperature for the process curing and refractory coating and pasting has to be carried out on cores. The hotbox technology gives output as solid cores and needs hot curing for the process of binder setting. The technology of cold box is carried out with the usage of heated sand and amine gas mixture. No bake technology operates at an accurately controlled setting. The least usage energy is by shell process technology in which no coating is necessary.

Process change to a foundry must be taken only after careful projection on various factors being taken into account. Some to name in this direction are processing change results on costs like fixed and variable, investment are capital cost payback needed and so on in a similar way per action towards energy consumption must be made for achieving system efficiency which must also focus on steps towards consistent usage of such energy consumed to be used efficiently.

Some of the steps suggested for work in this aspect are avoiding wastages of shell sand, usage of equipment producing heat only when needed, analyzing and taking steps towards vital defects, making economical usage by switching off unwanted machinery.

Some of the process improvements that could be made at reduced cost towards this direction are taking steps for oven insulation, going for moisture sensors installation.

The high cost up gradations that could be taken in the direction for system efficiency are going for improvements in the drying process by making use of either infrared heating or microwave heating, making use of continuous technique of continuous.

- Sand Preparation

Sand preparation processes must be expertly conceived and conducted to permit reliable, cost effective and environment friendly manufacturing. The sand quality achieved depends on the specific processing technologies used.

There are four main components for making a sand casting mould: base sand, binder, additives, and parting compound.

Moulding sand, also known as foundry sand, is defined by eight characteristics: refractoriness, chemical inertness, permeability, surface finish, cohesiveness, flow ability, collapsibility and availability/cost.

Refractoriness: this refers to the sand's ability to withstand the temperature of liquid metal being cast without breaking down. For example, some sands only need to withstand 650 °C. If casting aluminum alloys, whereas steel needs sand that will withstand 1500°C.Sand with too low refractoriness will melt and fuse to the casting.
Chemical inertness: The sand must not react with metal being cast. This is especially important with highly reactive metal, such as magnesium and titanium.
Permeability: this refers to sand's ability to exhaust gases. This is important because during the pouring process many gases are produced such as hydrogen, nitrogen, carbon dioxide and steam, which must leave the mould otherwise casting defects, such as blow holes and gas holes occurring the casting. Note that for each cubic centimeter (cc) of water added to the mould 16000cc of steam is produced.
Surface finish: the size and shape of sand particles defines the best surface finish achievable, with finer particles producing a better finish. However, as particles become finer the permeability becomes worse.
Cohesiveness: This is the ability of sand to retain a given shape after the pattern is removed.
Flow ability: The ability for the sand to flow into intricate details and tight comers without special processes or equipment.
Collapsibility: This is the ability of sand to easily strip off the casting after it has solidified. Sand with poor collapsibility will adhere strongly to the casting. When casting metals that contract a lot during cooling or with long frizzing temperature ranges, sand with poor collapsibility will cause cracking and hot tears casting. Special additives can be used to improve collapsibility.

Availability/Cost: the availability and cost of sand is very important because for every ton of metal poured, three to six tons of sand is required. Although sand can be screened and reused, the particles eventually become found and require periodic replacement with fresh sand. In large castings it is economical to use different sands, because the majority of sand will not be in contact with the casting, so it does not need any special properties. The sand that is in contact with the casting is called facing sand and is designed for the castings on hand. This sand will build up around the pattern to a thickness of 30 to 100 mm. The sand that fills in around the facing sand is called baking sand. This sand is simply silica sand with only a small amount of binder and no special additives.

Types of base sands
Base sand is the type used to make the mould or core without any binder. Because it does not have a binder it will not bond together and is not usable in this state.
Silica sand: Silica (SiO2) sand is the sand found on beaches and is also the most commonly used sand. It is made by either crushing sandstone or taken from natural occurring locations, such as beaches and river beds. The fusion point of pure silica is 1760 °C however sands used have lower melting point due to impurities. For high melting point castings, such as steels, aluminum of 98% pure silica sand must be used. However lower melting point metals, such as cast iron and non-ferrous metals lower purities sand can use (between 94% and 98% pure) silica sand is most commonly used sand because of its great abundance and thus low cost. Its disadvantages are high thermal expansion, which can cause casting defects with high melting point metals, low thermal conductivity, which can lead to unsound casting.
Olivine Sand: olivine is a mixture of ortho silicates of iron and magnesium from the mineral dunite. Their main advantage is that it is free from silica; therefore, it can be used with basic metals, such as manganese steels. Other advantages include a low thermal expansion, high thermal conductivity and fusion point. Finally, it is safer to use than silica; therefore, it is popular in Europe.
Chromate Sand: chromate sand is a solid solution of spinals. Its advantages are low percentage of silica, high fusion point (1850°C) and very high thermal conductivity. Its disadvantages are costliness, therefore it's only used with expensive alloy steel casting and to make cores.
Zircon Sand: zircon sand is a compound of approximately two -third zircon oxide (Zr_2 O) and one third of silica. It has the highest fusion point of all the base sand at 2600°C, very low thermal expansion and high thermal conductivity.

Because of these good properties it is commonly used when casting alloy steels and other expensive alloy.
Other Materials
Modern casting production methods can manufacture thin and accurate moulds of materials superficially resembling paper Mache, such as is used in egg cartons, but that is refractory in nature that are then supported by some means, such as dry sand surrounded by a box, during the casting process. due to the higher accuracy it is possible to make thinner and hence lighter castings, because extra metal need not be present to allow for variations in the moulds. These thin mould casting methods have been used since the 1960s in the manufacture of cast iron engine blocks and cylinder heads for automotive applications.
Binders are added to base sand to bond the sand particles together.

Clay and Water: A mixture of clay and water is the most commonly used binder. There are two types of clay commonly used: Betonies and kaolinite with the former being the most common.

Oil: oils such as linseed oil, other vegetables oils and marine oils used to be binder. However due their increasing cost, they have been mostly phased out. The oil also required careful baking at 100 to 200°C to cure. Resin: resin binders are natural or synthetic high melting point gums. The two common types used are urea formaldehyde and phenol formaldehyde resins. PF resins have a higher heat resistance than UF resins and cost less. There are also cold set resins, which use a catalyst instead of a heat to cure the binder. Resin properties are quite popular because different properties can be achieved by mixing with various additives. Other advantages include good collapsibility, low gassing and have good surface finish on the casting.
Sodium silicate: sodium silicate [Na-SiO,] is a high strength binder used with silica moulding sand. To cure the binder, carbon dioxide gas is used, which creates following reaction:
Additives are added to the moulding components to improve: surface finish, dry strength, refractoriness and "cushioning properties".
Up to 5% of reducing agents, such as coal powder, pitch, creosote and fuel oil may be added to moulding material to prevent wetting, improve surface finish, decrease metal penetration and burn-on defects. These additives achieve these by creating gases at the surface of the mould cavity, which prevent the liquid metal from adhering to the sand. Reducing agents are not used with steel casting, because they can carburized the metal during casting.
Up to 3% of cushioning material ", such as wood flour, saw dust, powdered husks, peat and straw can be added to reduce scabbing, hot tear and hot crack casting defects when casting high temperature metals. These materials are beneficial because burn-off when the metal is poured creates tiny holes in the mould, allowing sand particles to expand. They also increase collapsibility and reduce shakeout time.
Up to 2% of cereal binders such as dextrin, starch, Sophie Lee and molasses can be used to increase dry strength and improve surface finish. Cereal binders also improve collapsibility and to reduce shakeout time because they burn off when metal is poured. The disadvantages of cereal binders are that they are expensive.
Up to 2% of iron oxide powder can be used to prevent mould cracking and metal penetration, essentially improving refractoriness. Silica flour and zircon flour also improve refractoriness; especially in ferrous castings. The disadvantages to these additives are that they greatly reduce permeability.
Parting compound: To get pattern out of mould, prior to casting, parting compound is applied to pattern to ease removal. They can be liquid or fine powder (particle diameters between 75 to 150 micrometers). Common powders include talc, graphite and dry silica: common liquids mineral oil and water based silicon solutions. The latter are more commonly used with metal and large wooden patterns.

- Mould Making

The pattern is placed in the bottom plate and a drag box is located around it. After taking care about the position of the runner, in the gate, etc. The thickness of sand around the casting is carefully chosen. This should be about optimum. Otherwise if the thickness of sand layer around the pattern is too much, it will provide too much of insulation and result in delay in the solidification of casting, and it will create back pressure during the escape of gases that evolve during the casting. If it is too less, it will make the casting cool very fast and a chilling or quenching effect will be produced which may not be desirable at times. It is now time to fill the space between

the pattern and the mould box with sand. However, the sand which is adjacent to the pattern or mould cavity is of different quality than the sand away from it and near to the walls of the mould box. The inner sand called facing sand is finer and the outer sand called backing is coarse. Backing sand is not used for facing because it cannot develop the required surface finish and fine details that are present on the faces of the pattern. A minimum of 30mm and up to 100mm of facing sand should be applied on the inside surfaces to obtain an acceptable mould cavity.
The sand is gently rammed or patted to cover all grooves and fine patterns/markings/slots. Rest of the volume of the drag box is then filled with backing sand and rammed. The top surface is made level by cutting any heap/bump that might have formed on the drag box.
The drag is inverted and the cope half of the two-piece pattern is assembled to the drag half. The Cope box is made to sit on the drag box using alignment and closing pins. Parting powder is sprinkled on the exposed sand surface of the drag box. Gating, sprue, runner, riser etc. are placed at appropriate positions around the pattern. Backing sand is again filled in the copper box and rammed to set. Vent holes are provided for passage of gases.
Then drag and cope are separated. Pattern is removed with at most care being taken so as not to cause any damage to the mould cavity or any intricate profile the cavities inspected for visible scar recess created and is repaired if needed. Coarse, if necessary, are placed either solitary or with the help of core prints.
Drag and cope halves are joined and locked with the help of closing pins. Pouring basin is placed at the sprue's open end. Sufficient load is placed on the scope to prevent its lifting under the action of buoyant force when liquid metal is poured.

- Melting

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Melting is poured in the furnace. Virgin material, external scrap, internal scrap and alloying elements are used to charge the furnace. Virgin material refers to the commercially pure form of the primary metal used to form a particular alloy, alloying elements are either pure forms of alloying elements like electrolytic nickel, or alloys of limited composition, such as ferroalloys or master alloys. External scrap is material from other forming processes such as punching, forging or machining. Internal scrap consists of gates, risers, defective castings and other extraneous metal oddments produced within the facility. The process includes melting the charge, refining the melt, adjusting the melt chemistry and tapping into a transport vessel. Refining is done to remove deleterious gases and elements from the molten metals to avoid casting defects. Material is added during the melting process to bring the final chemistry within a specific range specified by industry and/or internal standards. Certain fluxes may be used to separate the metal from slag and/or dross and degassers are used to remove dissolved gas from metals that readily dissolves certain gases. During the tap, final chemistry adjustments are made.

- Pouring

In a foundry, molten metal is poured into moulds. Pouring can be accomplished with gravity, or it may be assisted with a vacuum or pressurized gas. Many modern foundries use robots or automatic pouring machines to pour molten metal. Traditionally, moulds were poured by hand using ladles.

- Finishing

1.2 Problem Definition

To modify a conventional sand-casting mould box to a resizable sand-casting mould box.

1.3 Objectives

The objectives of a resizable sand casting mould box include:

1. Flexibility: The main objective of a resizable sand casting mould box is to provide flexibility in creating moulds of different sizes and shapes. By adjusting the dimensions of the mould box, it allows for the production of various casting sizes, accommodating different part geometries and sizes.
2. Cost-effectiveness: Using a resizable mould box eliminates the need for having multiple fixed-size mould boxes for different casting requirements. This reduces the cost of tooling and storage space needed for storing multiple moulds, resulting in cost savings for the casting process.
3. Improved productivity: Resizable mould boxes enhance productivity by reducing setup time. Instead of searching for or manufacturing a new mould box for each different casting size, the mould box can be easily resized to match the specific requirements. This streamlines the production process and reduces downtime.

4. Versatility: Resizable mould boxes enable the production of both large and small castings within the same foundry setup. This versatility allows for a wide range of casting possibilities, accommodating various part sizes and configurations.
5. Space optimization: With a resizable mould box, the foundry can optimize space utilization by eliminating the need for storing multiple fixed-size mould boxes. This is particularly beneficial for foundries with limited space, as it allows for the efficient use of available area.
6. Adaptability to design changes: In case of design modifications or changes in the casting requirements, a resizable mould box offers the advantage of quick adjustments. Instead of creating a new mould from scratch, the existing mould box can be resized to accommodate the revised design, saving time and resources.

Overall, the objectives of a resizable sand casting mould box revolve around flexibility, cost-effectiveness, productivity, accuracy, versatility, space optimization, and adaptability to design changes, enabling efficient and high-quality casting production.

II. LITERATURE REVIEW

2.1
A sand casting mould box, also known as a mould flask, is an essential tool used in the sand casting process. It is designed to hold the sand mould in place and create the desired shape for the casting.
The mould box typically consists of two halves, known as the cope and drag. The cope is the top half, and the drag is the bottom half. These halves are securely fastened together during the casting process.
The mould box is usually made of a durable material such as cast iron, steel, or aluminum. It needs to withstand the forces and temperatures involved in the casting process.
To create a sand mould, the mould box is filled with a prepared sand mixture. The sand is compacted and shaped inside the mould box to create the desired cavity for the casting. Patterns or cores may also be placed inside the mould box to create intricate features or internal cavities in the casting.
Once the sand mould is prepared, molten metal is poured into the mould cavity, filling the space left by the pattern or core. After the metal has solidified and cooled, the mould box is opened, and the sand mould is broken away from the solidified casting.
Sand casting mould boxes come in various sizes and configurations, depending on the size and complexity of the casting being produced. They may be fixed in size or designed to be adjustable and resizable to accommodate different part sizes and shapes.
Overall, the sand casting mould box is a critical component in the sand casting process, providing the structure and shape necessary to create metal castings of various sizes and complexities.

Research Papers:

1. On the design of flask equipment for LGM.

Date of Publication: July 2016
Publisher: ResearchGate
Author: Volodymyr Doroshenko

2. DESIGNING FOR DOMESTICATION OF YAMAHA CY80 ENGINE PISTON MANUFACTURING TECHNOLOGY AND EVALUATION OF ALUMINUM ALLOY (4032-T6) FOR FUNCTIONALITY

Date of Publication: January 2015
Publisher: ResearchGate

III. EXISTING SYSTEM AND SPECIFICATION

3.1 Existing system
- Study of existing mould boxes

The existing system is a one in which the industry maintains and tracks all the mould boxes which consume a lot of space and there is no source through which space can be made.
Thus maintenance of the mould is also a tedious job.

Disadvantages of existing system:

- ❖ Fixed size
- ❖ Cost increases based on size of boxes as they have to buy more boxes
- ❖ Boxes are stacked and more space is utilised and less space is left for utilisation

3.2 Study of existing mould boxes

COMPANY NAME	GLOW CAST	VIMAL ENTERPRISES	GOKUL FERROCAST
SIZE	19 INCHES*19 INCHES	19 INCHES*19 INCHES	19 INCHES*19 INCHES
WALL THICKNESS	8mm	12mm	18mm
MATERIAL USED	MILD STEEL	DUCTILE CAST IRON	GREY CAST IRON
CURRENT AGE	10 YEARS	7-8 years	11 years

TABLE 1

COMPANY NAME	GLOW CAST	VIMAL ENTERPRISES	GOKUL FERROCAST
IMAGES			

3.3 COMPARISON OF DIFFERENT MATERIALS

CAST IRON VS MILD STEEL

	Cast Iron	Steel
Carbon content	2% to 4%	Less than 2%
Melting Point	2200 degree Fahrenheit	2500 – 2800 degrees Fahrenheit
Strength	More Compressive strength	More Tensile strength
Castability	Easy to cast because of low shrinkage and good flowability	Less easy to cast than cast iron as it has low flowability and more shrinkage.
Corrosion Resistance	More corrosion resistant	Not as resistant as Cast iron
Impact Resistance	More impact resistant	Less impact resistant
Cost	Cheaper because of the lower material cost, labor, and energy needed to produce the final product	More expensive than cast iron, although there are cheaper alternatives, like prefabricated steel forms like; rods, bars, beams, and tubes.
Applications	Pipe fittings, washers, farm equipment, machine parts, mining hardware, hand tools, and electrical fittings.	Infrastructure, vehicles, electrical appliances, rockets, tools, and weapons.

Metals are used extensively in manufacturing. Additionally, a lot of producers use metals like iron and steel due to their strengths, durability, and capacity to maintain sheen over a lengthy period of time.

Cast iron and steel, for example, look similar, but they are not the same metals. In other words, they both have distinctive qualities that might be advantageous or detrimental to a production process.

Carbon Content

The main difference between cast iron and carbon steel is the carbon content. Cast iron contains over 2% carbon, while steel contains less than 2% carbon. However, steel can also contain other elements like chromium. The addition of these elements results in steel of different qualities and grades.

Melting Point

Cast iron has a lower melting point than steel. Its melting point is 2200 degree Fahrenheit, while that of steel ranges between 2500-2800 degree Fahrenheit. The low melting point of iron makes it easy to mould into any form or shape.

Strength

Both materials are strong, but their strength varies. Cast iron has more strength than steel. On the other hand, steel has more tensile strength than cast iron, which allows it to bend without necessarily breaking. To clarify, compressive strength makes iron very hard, making it resistant to dents and bending. On the downside, it breaks when under excessive pressure.

Castability

Cast iron is easier to cast than steel. The reason is that it has more flowability and does not shrink. On the other hand, steel is less fluid, reacts to the mould material, and shrinks when it cools. To clarify, steel has a relatively high viscosity. The ease of casting iron makes it the perfect material for detailed ironwork structures.

Corrosion Resistance

While both look similar, cast iron resists corrosion and rust better than steel. However, these metal materials are not susceptible to corrosion. If you leave them exposed and unprotected, both materials will undergo oxidation, which would lead to decomposition.

Impact Resistance

Steel is better at resisting impact better than cast iron. This is especially true for sudden impacts. With sudden impacts, steel does not bend, break or deform as quickly as cast iron.

Cost

Cast iron is cheaper than steel because of the lower cost of material needed to produce cast iron. Furthermore, producing raw steel requires more labor and energy consumption.

Applications

Both materials have different applications. Cast iron is ideal for making pipe fittings, washers, farm equipment, machine parts, mining hardware, electrical fittings, and hand tools. On the other hand, steel is perfect for making tools, weapons, electrical appliances, vehicles, and infrastructure.

Advantages of Cast Iron

- Good casting ability
- Available in large quantities, making production relatively inexpensive.
- It has a high compression strength
- Cast irons have good machinability
- Good anti-vibration property
- It has excellent wear resistance
- Low-stress concentration
- High resistance to deformation
- High durability

Disadvantages of Cast Iron

- Prone to corrosion and rust
- Low tensile strength
- High impact resistance
- High weight-to-strength ratio
- High brittleness

Advantages of Steel

- Increased flexibility in design, as you can choose the alloy element you want to combine with steel

- Increased strength
- Resistant to corrosion
- Easy machining

Disadvantages of Steel

- More expensive than cast iron
- Less resistant to impact

3.4 Material Used

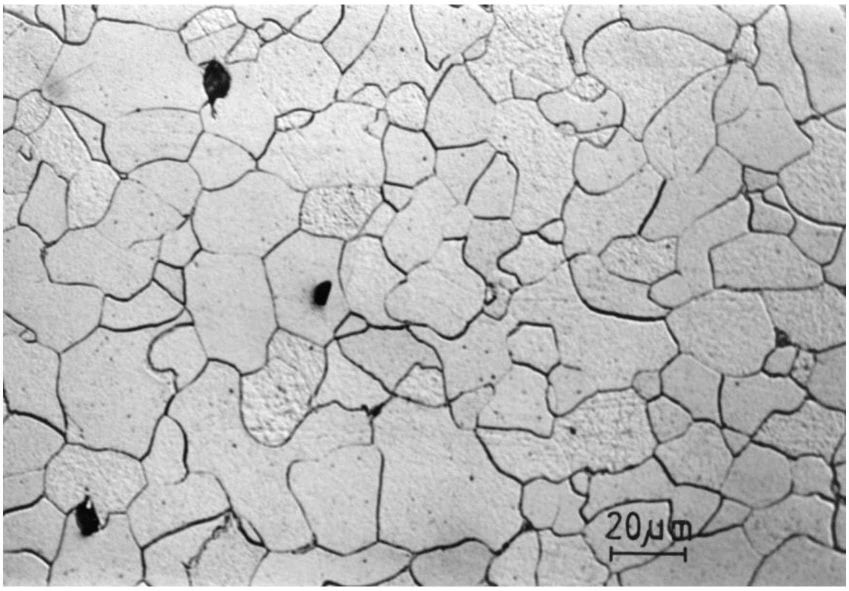
3.4.1 Cast Iron

A family of iron-carbon alloys with a carbon concentration more than 2% is called cast iron. Its comparatively low melting temperature is what makes it valuable. White cast iron has carbide impurities that allow cracks to pass straight through, grey cast iron has graphite flakes that deflect a passing crack and start countless new cracks as the material breaks, and ductile cast iron has spherical graphite "nodules" that prevent the crack from progressing. These alloy constituents all have an impact on the colour of the fractured material. The two main alloying components of cast iron are silicon (Si), which makes up 1-3 wt%, and carbon (C), which ranges from 1.8 to 4 wt%.

Cast iron tends to be brittle, except for malleable cast irons. With its relatively low melting point, good fluidity, castability, excellent machinability, resistance to deformation and wear resistance, cast irons have become an engineering material with a wide range of applications and are used in pipes, machines and automotive industry parts, such as cylinder heads, cylinder blocks and gearbox cases. It is resistant to damage by oxidation but is notoriously difficult to weld.

The earliest cast-iron items were found by archaeologists in what is now Jiangsu, China, and date to the 5th century BC. In ancient China, cast iron was employed in construction, agriculture, and combat. During the Reformation in England and Burgundy in the 15th century AD, cast iron was used to make cannon. Large-scale manufacture was necessary to produce the quantity of cast iron utilised for cannons. The Iron Bridge in Shropshire, England, was the first cast-iron bridge and was constructed in the 1770s by Abraham Darby III. Buildings were also constructed using cast iron.

Microstructure of Cast Iron



Production

Cast iron is made from pig iron, which is the product of melting iron ore in a blast furnace. Cast iron can be made directly from the molten pig iron or by re-melting pig iron, often along with substantial quantities of iron, steel, limestone, carbon (coke) and taking various steps to remove undesirable contaminants. Phosphorus and sulfur may be burnt out of the molten iron, but this also burns out the carbon, which must be replaced. Depending on the application, carbon and silicon content are adjusted to the desired levels, which may be anywhere from 2–3.5% and 1–3%, respectively. If desired, other elements are then added to the melt before the final form is produced by casting.

Cast iron is sometimes melted in a special type of blast furnace known as a cupola, but in modern applications, it is more often melted in electric induction furnaces or electric arc furnaces. After melting is complete, the molten cast iron is poured into a holding furnace or ladle.

IV. DESIGN

4.1 Proposed System

- ❖ Here, we put an emphasis on minimising the number of boxes and enhancing space utilisation..
- ❖ We also emphasise the fact that when the number of boxes falls, so does the price..
- ❖ Minimises sand usage as well.

4.2 Requirement Specifications

After the broad investigation of the issues in the framework, we are acclimated with the prerequisite that the present framework needs. The requirement that the system needs falls into the category of Hardware and Software requirements. The requirements are listed below:

4.2.1 Specifications

Hardware Specification:

- Carbon steel socket head cap screws

Software Specification:

Softwares used -

- Catia
- Ansys

- Operating system : Windows/MacOS.
- Programming Language : C, C++, and Java

4.3 **Part assembly** is the foundation of our design. We have L-shaped fixed plates with four corners. Corner plates are fixed, whereas side centred plates are in a variety of sizes. M12 carbon steel bolts are used to attach these plates and sides together.

4.3.1 Corner Plates

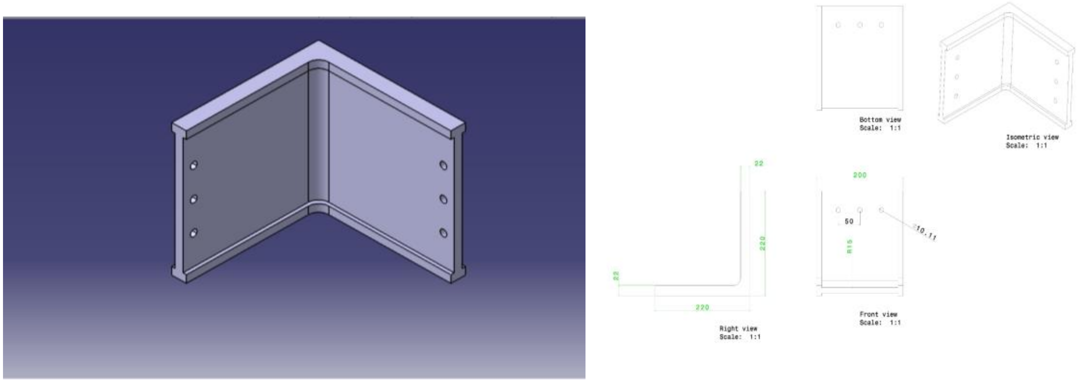


Figure1

4.3.2 Side Plates

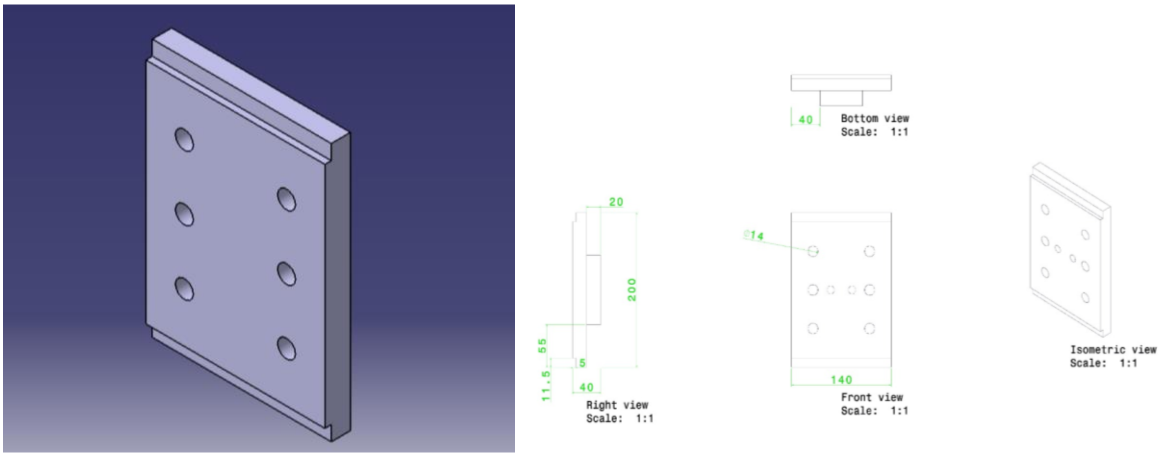


Figure 2 :16 inches * 16 inches Side plate

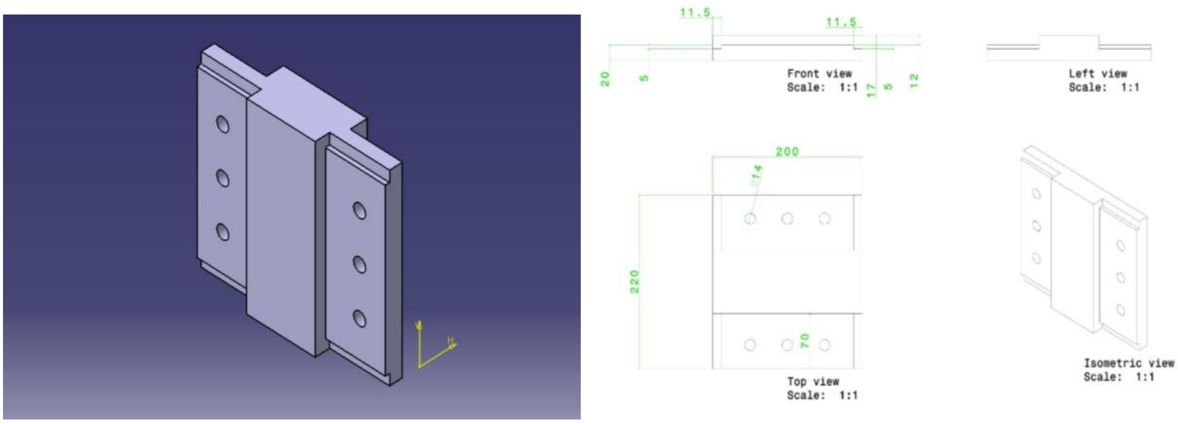


Figure 3: 19 inches * 19 inches Side plate

4.3.3 Part Assembly of 16 x 16 inches mould box

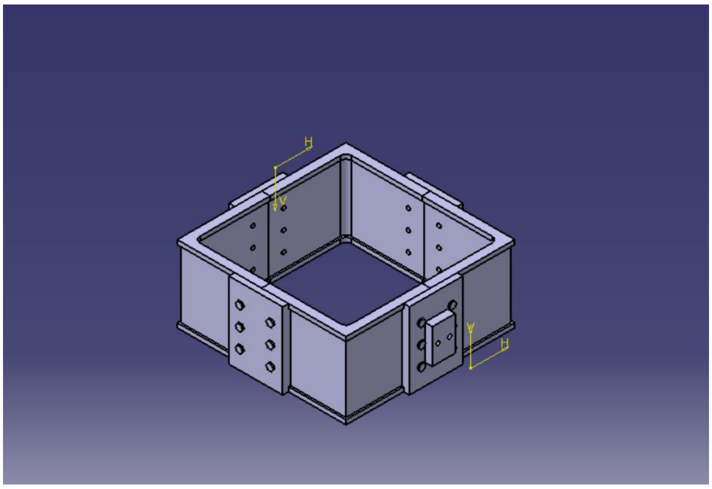


Figure 4

4.3.4 Part Assembly of 19 x 19 inches mould box

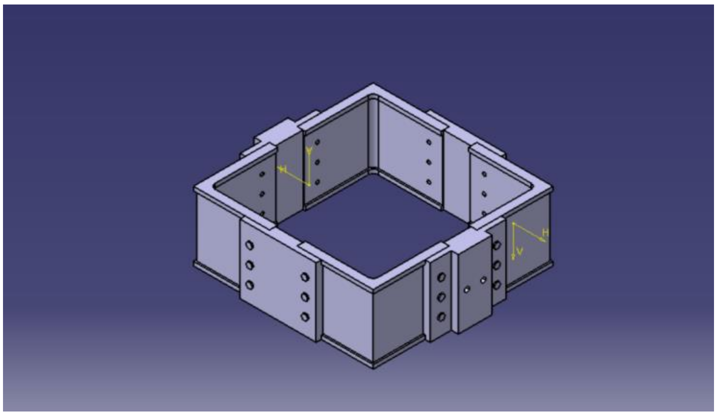


Figure 5

V. VIBRATIONAL ANALYSIS

LabVIEW, short for Laboratory Virtual Instrument Engineering Workbench, is a powerful graphical programming environment widely used in various industries and research fields for controlling instruments, collecting and analyzing data, and creating virtual instruments. It was developed by National Instruments and provides a visual programming approach, allowing users to create programs by connecting icons or graphical representations of functions and data flow.The key concept behind LabVIEW is its graphical programming language called "G," which stands for the G programming language. G allows users to build applications by connecting various virtual instruments, components, and functions graphically, using a drag-and-drop interface. This visual approach makes LabVIEW particularly user-friendly and accessible, even for those without extensive programming experience.

LabVIEW offers a vast range of features and capabilities, making it suitable for a wide range of applications. It supports data acquisition and control systems, signal processing and analysis, simulation, measurement automation, and more. It provides extensive libraries of pre-built functions and tools for performing tasks such as data logging, signal generation, and instrument control.One of the significant advantages of LabVIEW is its ability to interface with hardware devices and instruments from various manufacturers. This capability allows users to integrate different instruments seamlessly and control them within the LabVIEW environment, making it a popular choice in fields such as scientific research, engineering, and industrial automation.

LabVIEW also supports the creation of user-friendly graphical user interfaces (GUIs) to interact with programs and display data in real-time. The built-in GUI tools enable developers to design custom interfaces using various controls, indicators, and visualization elements.

In summary, LabVIEW is a powerful and versatile programming environment that simplifies the development of applications for data acquisition, control systems, and analysis. Its graphical programming approach, extensive library of functions, and hardware integration capabilities make it a popular choice for engineers, scientists, and researchers working in diverse fields.

5.1Data flow program design:

Data flow program design is a fundamental concept in LabVIEW that governs how data is processed and flows through a LabVIEW program. In LabVIEW, the data flow programming paradigm is based on the principle that code execution is driven by the availability of data rather than by control structures like loops or conditionals.In a data flow program, you create a graphical representation of the program by connecting nodes, called "objects," together using wires that carry data between them. Each object represents a function or operation that processes or transforms data. The flow of data through the program is determined by the connections between the objects.

5.2 Graphical Program Design:

Graphical program design refers to the process of creating software applications or systems using graphical representations, often in the form of diagrams or visual elements. It emphasizes the use of graphical elements to represent program components, their relationships, and the flow of information or control between them. This approach provides a visual representation that aids in understanding, designing, and communicating the structure and behavior of a program.

There are several graphical programming languages and tools available for graphical program design, and LabVIEW, as mentioned earlier, is one such example. However, I will provide a general overview of graphical program design principles and concepts.

5.3 Lab view Environment:

Lab VIEW programs are known as a virtual instrument or a VIs because their exterior and operation try to be like physical instruments and multimeters. LabVIEW contains a wide ranging set of utensils for attaining analyzing, displaying and storage data as well as an instrument to help you troubleshoot codes.
When opening LabVIEW the primary comes to the “Getting started ” box. In command to generate a new VI, select “Blank VI” or in command to generate a new LabVIEW project select “Empty project”.
When you built-up a blank VI, an untitled front panel window gives the idea. This window demonstrates the front panel and is unique of the two labVIEW windows you use to figure a VI. The other window can be exploited by pressing ctrl+T to enclose the block diagram.

5.4 Front panel:

The Front Panel in LabVIEW is the user interface of a LabVIEW program. It provides a graphical representation of controls (input elements) and indicators (output elements) that allow users to interact with the program. The Front Panel is where you design the visual aspects of your LabVIEW application and define how users can input data and view output results. For our project we are getting the acceleration and force plots with respect to time in the front panel.

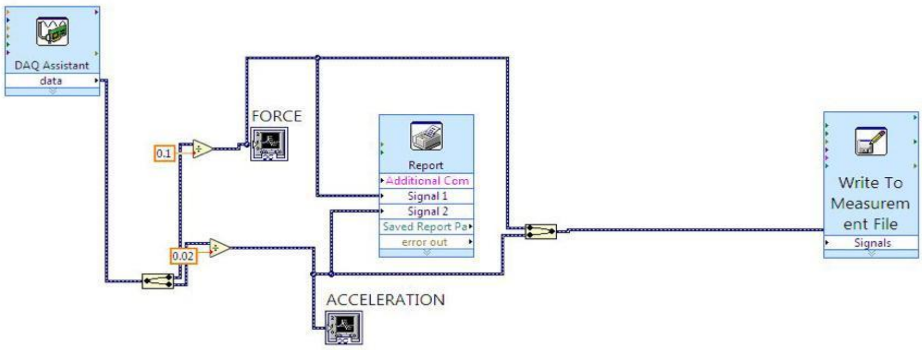


Figure 6

VI. STATIC ANALYSIS

6.1 CALCULATION OF VARIOUS PARAMETER

MODEL	DARPA 300	450	700	900
Static Squeeze Force (Kgf)	5500	8000	15000	20000
Dynamic Squeeze Force (Kgf)	16500	24000	45000	50000

The dynamic squeeze force of the rammer is taken into account when calculating the pressure on the inner walls of the mould box since it is greater than the static squeeze force.

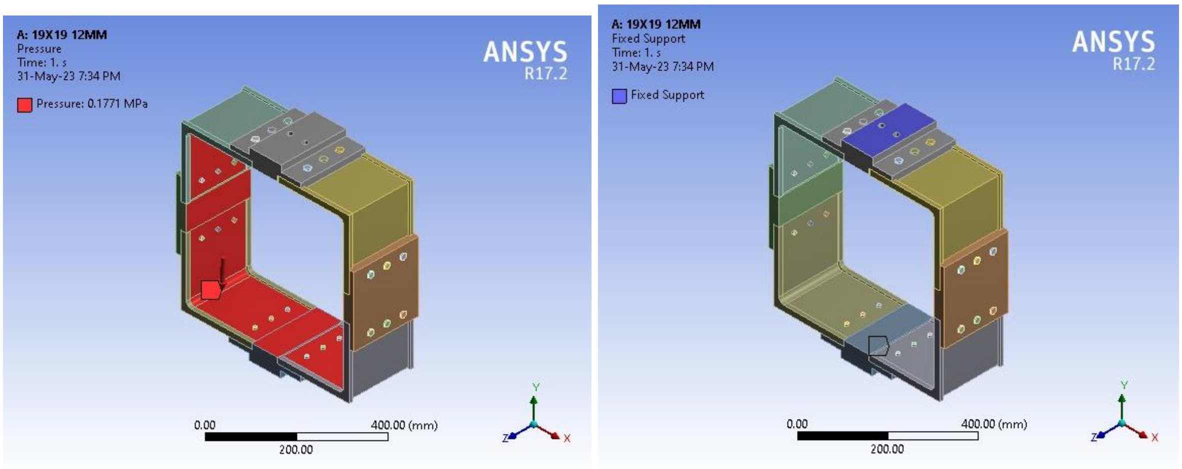


Figure 7 Boundary conditions

The mould box and jolt squeeze machine are both clamped at this point, and when ramming is carried out, pressure from the sand is applied to the interior walls of the mould box.

6.2 16 INCHES X 16 INCHES

CASE 1 - 8mm thickness

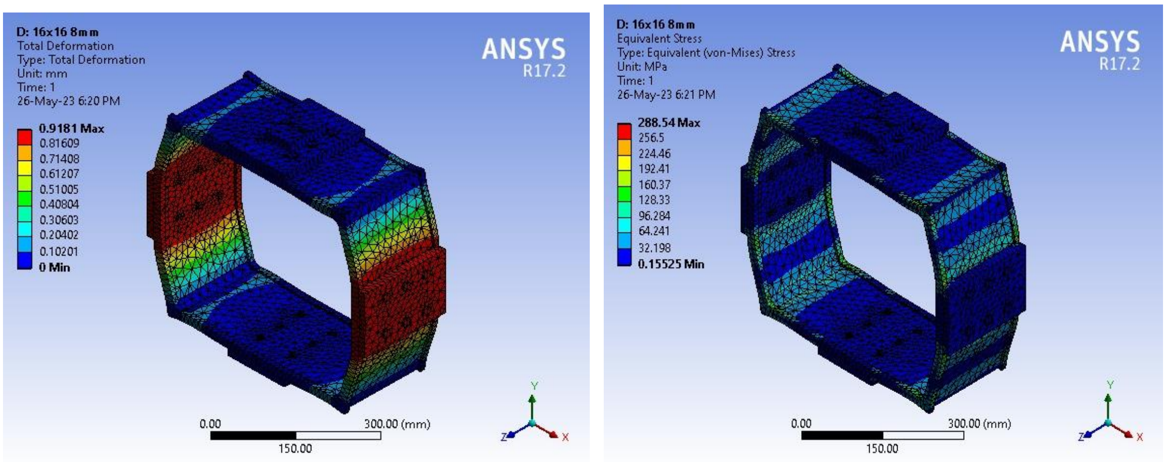


Figure 8 :The stress analysis and total deformation images are shown above for **16x16-inch** box with an **8-mm** wall thickness

CASE 2 - 12mm thickness

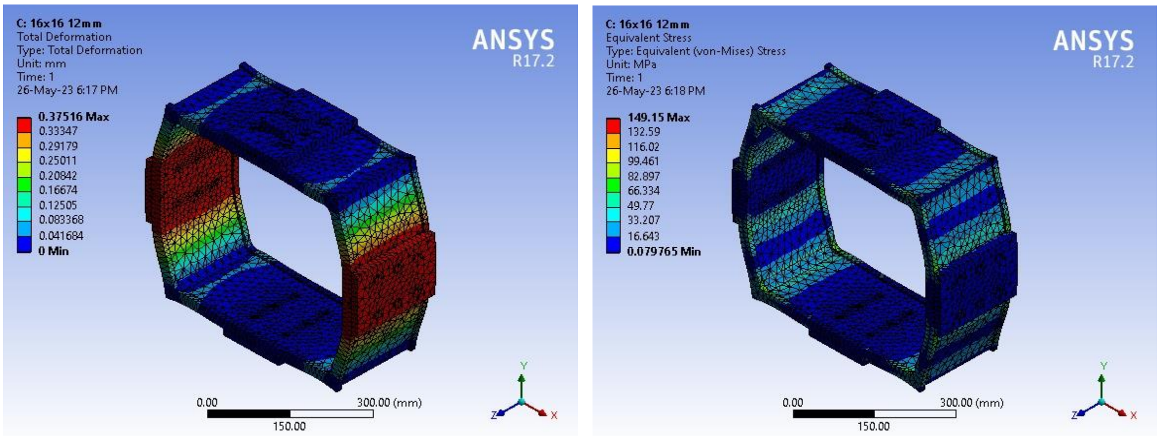
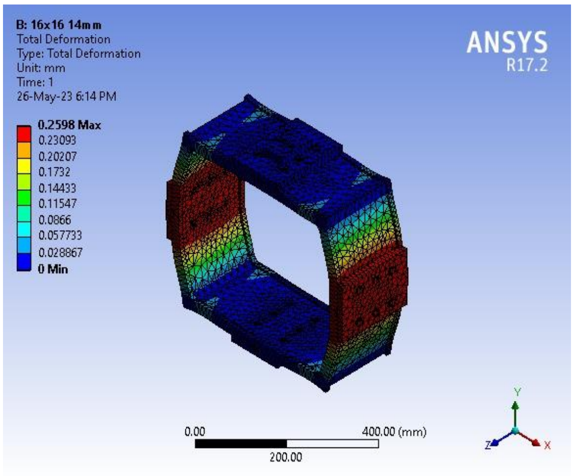


Figure 9:The stress analysis and total deformation images are shown above for **16x16-inch** box with an **12-mm** wall thickness

CASE 3 - 14mm thickness



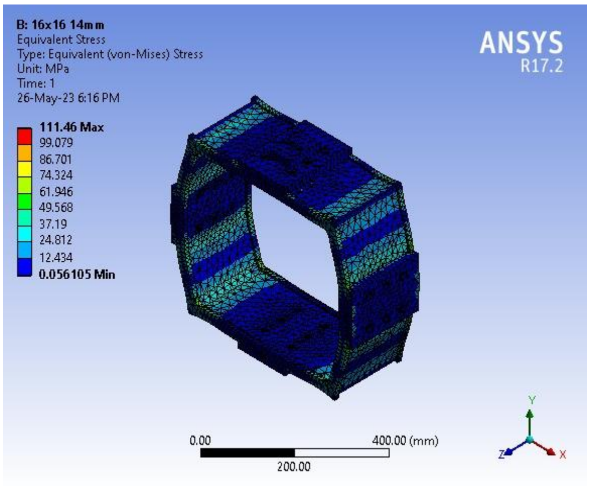
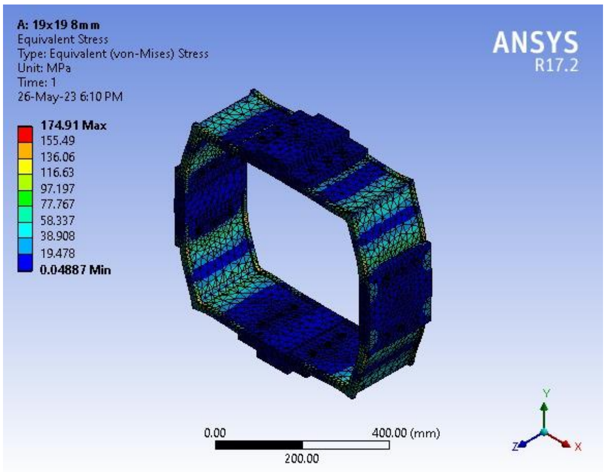


Figure 10 :The stress analysis and total deformation images are shown above for **16x16-inch** box with an **14-mm** wall thickness.

6.3 19 INCHES X 19 INCHES
CASE1 - 8mm thickness



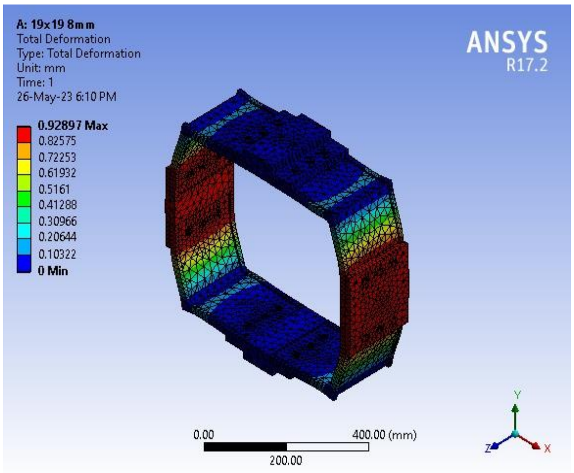
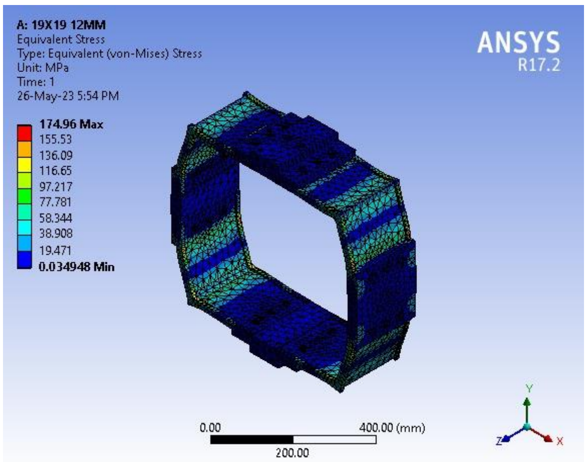


Figure 11 :The stress analysis and total deformation images are shown above for **19x19-inch** box with an **8-mm** wall thickness

CASE 2 - 12mm thickness



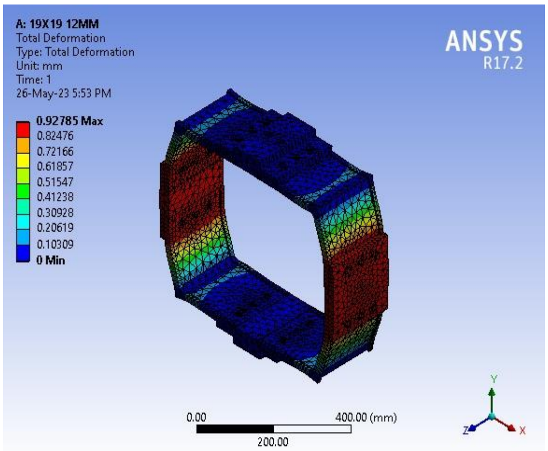


Figure 12 :The stress analysis and total deformation images are shown above for **19x19-inch** box with an **12-mm** wall thickness

CASE 3 - 14mm thickness

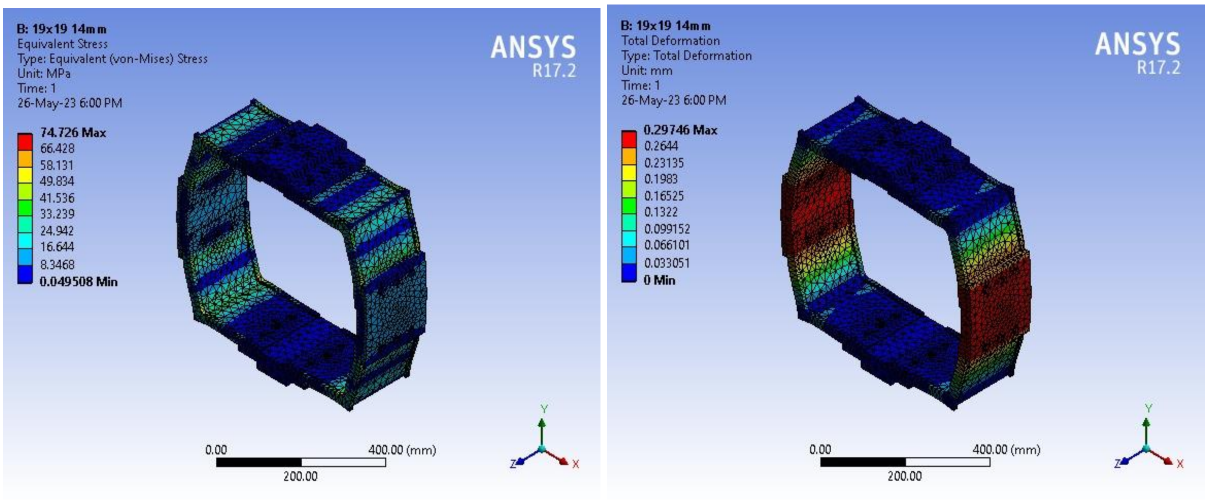


Figure 13 :The stress analysis and total deformation images are shown above for **19x19-inch** box with an **14-mm** wall thickness

16INCHESX16INCHES			
Thickness	8mm	12mm	14mm
Max Stress (Mpa)	288.54	149.15	111.46
Min Stress (Mpa)	0.1552	0.079	0.0561
Max Deformation (mm)	0.9181	0.37	0.2598
Min Deformation (mm)	0	0	0
19INCHESX19INCHES			
Thickness	8mm	12mm	14mm
Max Stress (Mpa)	174.91	173.8	74.726
Min Stress (Mpa)	0.04887	0.0349	0.049
Max Deformation (mm)	0.92897	0.92785	0.297
Min Deformation (mm)	0	0	0

Table 2

VII. RESULTS

VIII. CONCLUSION AND FUTURE SCOPE

In conclusion, the introduction of a resizable sand casting mould box presents a transformative advancement in the field of sand casting. The ability to adjust the size and shape of the mould box offers enhanced flexibility, cost-effectiveness, and improved casting quality.

By eliminating the need for multiple fixed-size mould boxes, manufacturers can reduce costs associated with mould box inventory and maintenance. The resizable mould box allows for the production of a wide range of part sizes and shapes with a single mould box, saving both time and resources.

Moreover, the resizable mould box enables more precise control over sand compaction, resulting in higher mould density and reduced defects in the final casting. The improved mould quality and dimensional accuracy contribute to overall casting integrity and performance.

Additionally, the ease of mould removal provided by the resizable mould box minimizes the risk of damaging the casting during extraction. This not only saves time and effort but also ensures the preservation of the casting's structural integrity.

Overall, the introduction of a resizable sand casting mould box brings significant advantages to the sand casting process. It empowers manufacturers with greater flexibility, cost savings, improved casting quality, and simplified operations. With these benefits, the resizable mould box has the potential to revolutionize the sand casting industry and contribute to the production of high-quality metal castings.

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