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Design, Analysis and Modification in Pattern Design Using the Combination of Aluminium and Acrylic Parts in Wooden Pattern

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Abstract
Foundry industries are still facing lots of problems regarding casting product and their productivity. Here, the attempt is made for the modification of pattern. During the ejection of mold from the pattern, the worker needs to rap hammer on the wooden pattern that causes breakdown of the pattern. Lot of time is required for repairing wooden pattern. So, it needs some modification in the existing pattern for its strength. In order to reduce the time in repairing pattern, complicated parts and delicate parts are replaced by combination of aluminium and acrylic parts in the wooden pattern, to prevent it from breakdown. By doing this, cast product requires less machining process, which ultimately reduces the cost and time. Complicated parts, mounting section and under-cut parts are built with the loosely fitting section of aluminium and acrylic because thin, small and fin sections of wood get easily broken down and have less period of time. Here, a striking section of acrylic is used for striking hammer over it, instead of directly striking on the pattern. In the modified pattern, a guide lock is also developed to help worker during the placement of cope over the drag. Till now, there is no device for core pattern to separate mold cavity from core pattern. So, to overcome this problem, two conceptual designs of the pneumatic device are mention in this paper. Finite element analysis of modified pattern is also carried out with ANSYS, which concludes that modified pattern sustains more than the existing pattern.

Keywords: *Modification in wooden pattern, design, analysis, less maintenance, guide lock, acrylic pad, conceptual design of the pneumatic device*

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INTRODUCTION

The pattern is the main principal tool for the casting process; it is the replica of the object to the cast product. Pattern is used to construct a mold cavity into which molten materials are poured through the sprue, runner and riser during the process of casting.

During the construction of pattern core print and allowances are the additional parts for the pattern. If the component to be constructed is hollow, then we need to construct another pattern called core pattern. They are placed in between the cope and drag during the casting and need to be destroyed after the casting.

Generally, the patterns used for the sand casting are made from wood, metal and alloys, plastic, wax and other materials. During the construction of pattern, the designer needs to design it with accurate dimension considering the quality of the pattern, so that it lasts for longer period of time with same physical properties.

The quality of the final product will depend upon the material used in the pattern, design and construction of the pattern. The final cost of the product of the casting depends upon the cost of pattern, method and process used for making the pattern and its equipment. If the quantity of casting is high, then the expensive pattern is used.

LITERATURE REVIEW

Analysis of design takes too much of time and cost [1]. But, it is necessarily required for the product designer to examine the features and functions of design on casting. It is better to make changes at designing stage rather than during manufacturing or machining stage, because during machining stage, it is very difficult to make changes which are very expensive. Therefore, modern companies prefer designer review committees, which involve concurrent engineering, so that modifications are made at the moment, and manufacturing can be done quickly. Designing atmosphere helps engineers to evaluate the part design for casting. In these software we can judge the process of casting, similar to the designer engineer such as process of casting, molding boxes, core, parting line of component, gates and feeding system, molding layout, and provide suggestions for modification in every process and give ideas to improve the quality and reduce the cost of machining and manufacturing. It also provides the communication channel between concurrent engineer.

Estimated cost of casting model can be a judged from its solid model, quality and features of that component [2]. It is very important for a designer to reduce the cost of product by some modifications; for that some analytical equation are developed to judge the estimated cost of material and labor. A model of parametric was generated for the cost of machining and judge the complex section from the solid model. Estimated costing of casting can be judged from method and process required for casting. The program system is connected to the web which is based on collaborative engineering system called WEBICE. This software interchanges the data of casting with the concurrent engineers over the web and gets the best result for the modification and cost.

Foundry industries are still facing the problem of poor quality and productivity of casting product because of it including of a number of processes [3]. A defect in casting product can be detected even under a highly controlled process; that is why casting is called as the process of uncertainty. To identify the defect and problem regarding to casting, the study is aimed in the research work. This will be very helpful in enhancing the yield of casting. Beside this, optimization of process parameter for each and every cycle of manufacturing of the critical part is intended in the preferred work. To find different types of casting defects and causes of their formation and provide the right guidance to the quality department to find casting defect. The simulation software works as per the engineer decision on the way of casting and related equipment, process design and analysis of each and every process in the manner to modify the design and improve the quality of product and reduce the machining and manufacturing cost [4]. In this paper, an attempt has been made to simulate the process of casting using AUTOCAST software with the goal of identifying the standard size of the feeder required for casting. First, the diameter of feeder is determined using the theoretical casting design calculation.

In AUTOCAST software, there is an inbuilt feeder design modular which can provide a suitable size of feeder system based on solid geometry. Results obtained by simulation suggest the suitable size of feeder dimension so that the casting should be free from the hotspots.

Rapid pattern manufacturing system for the sand casting process [5]. It contains both subtractive and additive techniques through which slab are sequentially bonded and milled using layered tool paths. When the pattern is built in a bottom-up, it removes the requirement of multi-axis operation and prefers small feature in a deep cavity. But, this system develops for achieving large wood and urethane sand casting pattern. This method describes the support structure approach by integrating a flask into the pattern making process.

An adaptive slicing algorithms that optimum keeping the layer modulation to prevent thin portion near peaks, flats and valleys or where interactive with chemical bond sand can make uncertain. This function is implemented on the automatic machine, which has the capacity of generating patterns in numbers of pounds. The primary test of the system in the progression of military equipment.

Casting is an unsteady process, therefore it is used for the mass production [6]. In casting different types, shape and size of the component and as per the requirement are need to be cast. In casting process, gating system considers as an important function in casting. Placement of proper gating system avoids the casting defect. Even, defect in casting product are detected under a highly controlled process, that is why casting is called as process of uncertainty because causes of defect are very difficult to find. Development in casting process simulation techniques can be used in the AUTOCAST software. In this software the gating system is drafted in the 3D model and then gating and cavity is formed, that model is used under the practical analyzed of the casting process for simulation technique, optimization of gating system is a trials and error method. After the completing of simulation process, the concluded designed of gating system is apply on the pattern and the results of the analysis is used for validation for simulation technique.

The placement of proper gating system is required to avoid the casting defect the component, it is the first preference of customer [7]. For analysis purpose, brake disc is used to solve the problem of lower casting yield due to used of a number of gating system used. To get rid of this problem gating system is redesigned for the casting simulation, gating design procedure, gating rule, theoretical and practical significances. Different types of gating system are designed in the 3D model for casting simulation in AUTOCAST-X. After analysis of simulation result, if required result is not getting , then modification are made in designing and 3D model and again simulation process is applied till the desired result for the casting.

The quality of matters is an essential characteristic of a product and process based industry [8]. To improve the product quality in the industry, CAD/CAM software are used for required desire quality of product. In this regard, we use rapid prototyping method. For detail study of the fabrication process of a master pattern of casting using rapid prototyping method and compared it with the current method. To instruct the engineers of industry to implement rapid prototyping technology for reducing the lead timing in the production of standard sand casting product. Future we can study microscopic analysis of casting model. Aside from this we can also focus on the relative study of surface roughness of rapid prototyping model.

OBJECTIVES OF RESEARCH

This research study is carried out based on following objectives:

1. To modify the existing pattern by replacing complicated and delicate parts by combination of aluminium and acrylic parts.
2. To increase the strength of wooden pattern.
3. To reduce the labour work and time.
4. To provide conceptual design of pneumatic machine which separates mold cavity and core box pattern.

Statement of Problem

Need of modification in the existing wooden pattern used in casting industry due to following reasons:

- Repairing of damage in the pattern takes too much of time due to number of machining operations required for reconstructing the pattern, which ultimately increases the cost of product.
- Too much of time is required to eject mold cavity from core pattern box by the worker.
- During the ejection of mold cavity from pattern, hammer needs to strike on pattern which causes breakdown of delicate parts and complicated parts of the pattern.
- Damage of core during the placement of cope over drag: because mounting of cope over drag is very difficult, it requires number of worker as a guide and supporter during the assembly of cope and drag.

CONSTRUCTION AND METHODOLOGY

Design and fabrication of wooden pattern is created on the different parameters. Getting initial part design data set and a general analysis of the cost, lead-time, accuracy, and production volume requirement of the casting, the tool designer must know the best approach for construction of pattern and core boxes required to produce the sand casting.

Headstock of VMC consists of lots of complicated and delicate parts. Headstock of VMC pattern has high maintenance cost. Therefore, it requires some modification to minimize the cost of productivity.

Steps in Designing of Pattern of Head Stock of VMC

Optimization of Head Stock of VMC

Figure 1 shows the head stock of VMC. It fits linearly on the lead screw of VMC machine.

Reconstruct the design of component as per the requirement.

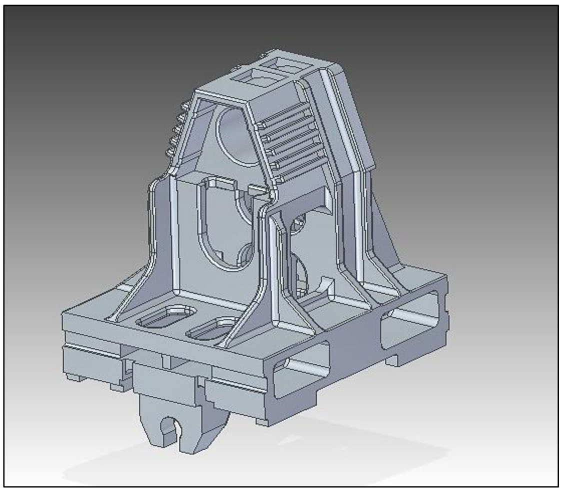


Fig. 1: *Head Stock of VMC.*

Modification and Selection of Complicated Section from the Component

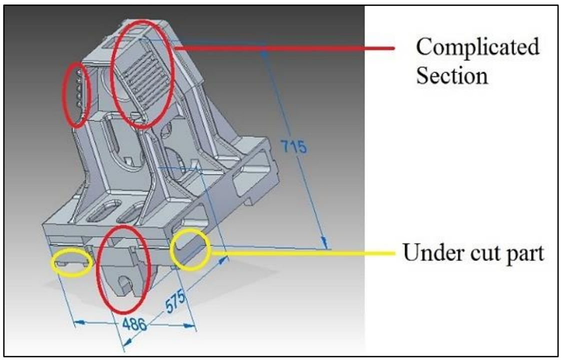


Fig. 2: *Indication of Complicated Section.*

Select a component which has complicated section, under cut parts, mounting section, area which requires prescribe shape and size and thin section part (Figure 2).

Take All Parameters of Complicated Section

Measure all the parameters of component and take individual parameters of complicated parts, under cut parts, mounting section, area which requires prescribe shape and size and thin section part (Figure 3).

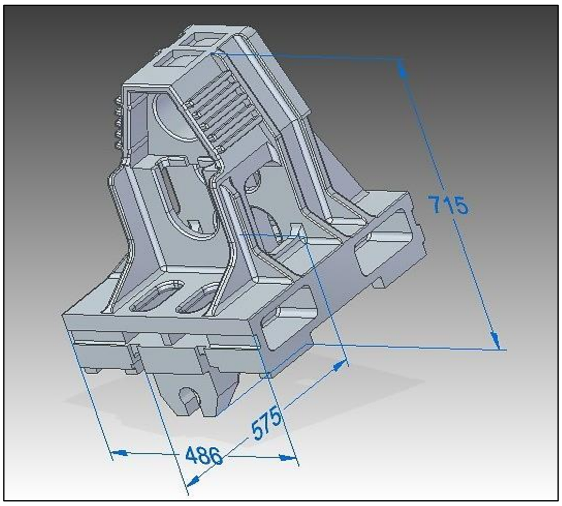


Fig. 3: *Measurement of Component.*

Length of component: 575 mm, Width of component: 486 mm, Height of component: 715 mm, Weight of component: 223 kg.

Selection of Parting Line from the Centre of Bore

Provide reference to all parameters and select the parting line from the centre of bore. Then separate the two halves into equal parts.

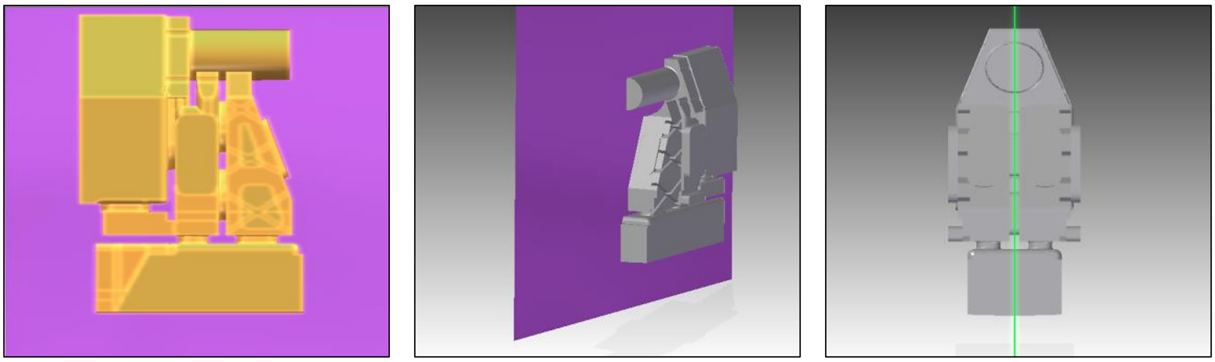


Fig. 4: *Selection of Parting Line from the Centre of Bore.*

During the selection of parting line, keep the core setting in the mold such that it should be feasible; maximum core setting should be at drag part and important metal area should be at the bottom because molten metal at the top of furnace is fine; during pouring, pure metal gets accumulated at the bottom.

The parting line is the surface where the cope, drag and the components are lying. If the surface of the cope and drag are planar, then the parting line is the outline of the cross-section of the part along that plane. It is common that the parting line should be planar. In every casting, small amount of molten metal leaks from the cope and drag section, this small amount of metal is known as flash. If it is along the outer surface, then it must be required to remove by some machining operation. If it is along the edges of the parting line, then it is less visible (Figure 4).

Make Core of Internal Section

If the component is hollow, then we need to make core for internal section. It produces internal cavities and pointing inward angles (Figure 5).

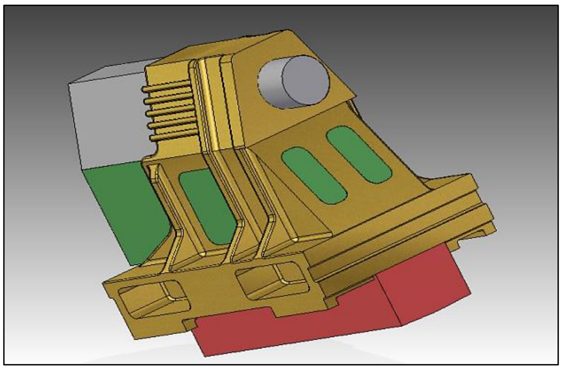


Fig. 5: *Embedded Core of Internal Section of Component.*

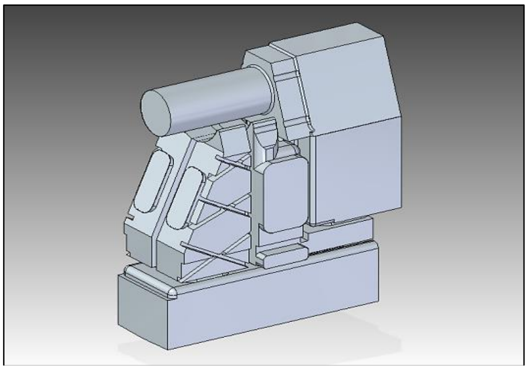


Fig. 6: *Core of the Pattern.*

Make Core Print for Resting the Core

The core print is an added projection on the pattern and it forms a seat in the mold on which the sand core rests during pouring of the mold (Figure 6). The core print must be of adequate size and shape so that it can support the weight of the core during the casting operation.

Drafting of the Complicated Section Drawing

Make draft for the complicated section and vertical surface, so that it can easily separate from the core box. It is very difficult to eject the mold from pattern when surface of mold is perpendicular to the direction of the pattern. As a result, parts of mold stick to the pattern and emphatic ejection will break the part. Hence, every surface of the part is provided with some taper, so that mold can easily eject. The inner surface of the parts is having higher drafting angles, because during the solidification, core may get shrink.

Give Draft Allowance to Both the Parts as per Requirement and Match with Each Other

During the ejection of mold from the pattern, the liability of breakdown of the mold is much decreased, if the pattern has taper in all directions parallel to which it is being ejected, providing tapering to the surface is known as drafting. Drafting is applied to the pattern, so that there is some clearance for the pattern to easily get lifted and ejected.

The size of the drafting depends upon the size of the casting, molding operation and complication of the pattern. Provide draft allowance to both the parts as per the requirement (minimum draft allowance should be 9 mm) and match each other (Figure 7).

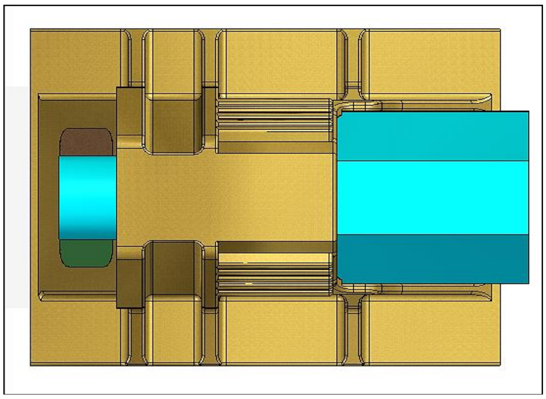


Fig. 7: *Draft Allowance.*

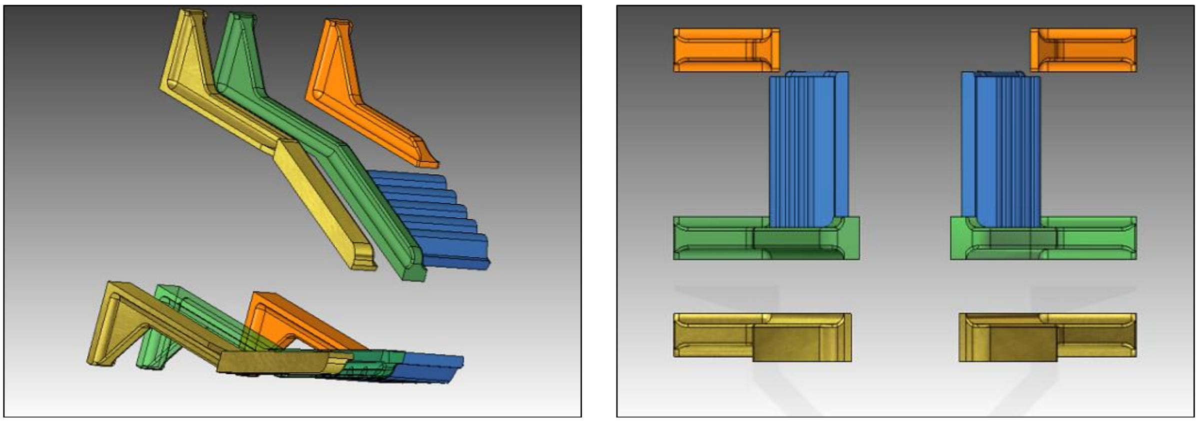


Fig. 8: *Aluminium Parts of Complicated Section.*

Make the Aluminium Part of Complicated Section, Separately

Make the section of complicated part of aluminium separately, with prescribed shape and size (Figure 8). This part is made from machining.

Make the Pattern of Wood for the Component

First make the pattern of wood roughly with the wooden blocks and then do machining work for accurate shape and size of component.

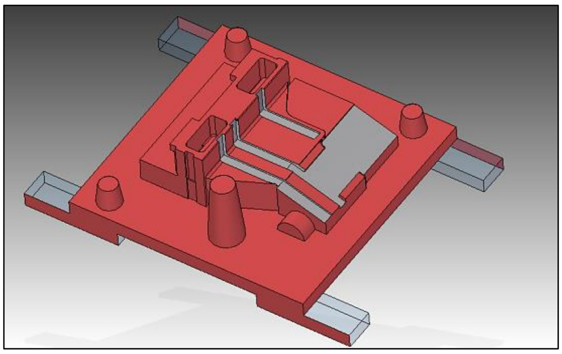


Fig. 9: *Wooden Pattern with Vacant Space.*

Leave the Vacant Space for Aluminium Part of Complicated Section

As per the shape and size of component, build the wooden pattern block roughly and leave the vacant space for the aluminium section (Figure 9).

Mount the Aluminium Part of Complicated Section on Wooden Pattern

Mount the aluminium part of complicated section on the vacant space of wooden pattern. This aluminium part gets fixed in the slots made in the wooden pattern with the help of screws and nuts (Figure 10).

Simulation of Pattern in Ansys and Creo Software

For the simulation of pattern, Ansys and Creo software are used.

Mathematical Calculation

Calculation of force acting on pattern by hammer during the separation of pattern from the mold cavity:

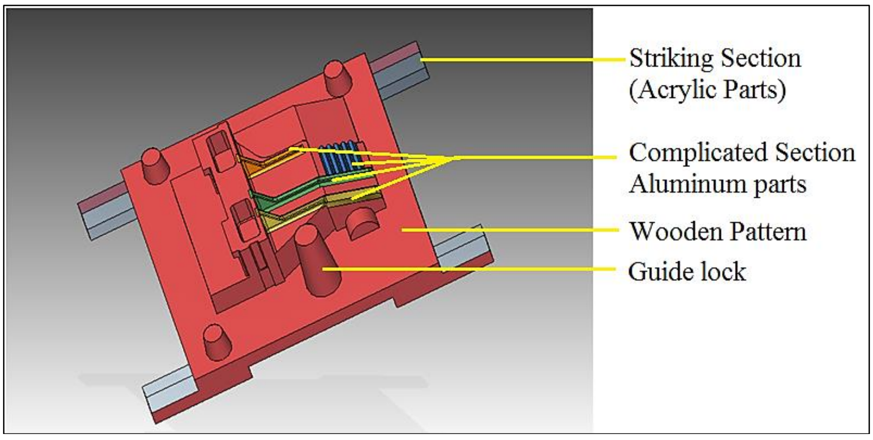


Fig. 10: *Modified Pattern.*

Force Applied on Pattern

Mass of hammer (m) =500 g=0.5 kg,
Initial velocity (u) =24 m/s,
Final velocity (v) =0 m/s,
Time of application of force (t) =0.01 sec,

- Acceleration = rate of change in velocity
  $=\frac{v-u}{t}=\frac{0-24}{0.01}$
  $=-2400$ m/s,
- Force applied on pattern by hammer (F)
  =m×a
  =0.5×(–2400)
  =–1200 N

Here, negative sign of force shows the direction of hammer.

CONCEPTUAL DEVICES

Conceptual Design of Pneumatic Device

Here, pneumatic device is used instead of hydraulic device because in foundry, air compressors are used for most of equipments and hydraulic device makes the places too much dirty (Figure 11).

Purpose

The main purpose behind designing this device is to increase the production of mold, till now there is no such device used in industries which is used for separating core pattern and small size pattern from mold. From this device, we can avoid the break-down of pattern and minimize labor time.

In this device, there is no need of special kind of base and no need of fixing the base with nut and bolt as required in rotary mold making system, and it is very cheap as compared to rotary mold making system.

Working

First, core box pattern is placed on base plate. Adjust the detachable plate and slider plate as per the size of core pattern box; supply the air to the pneumatic cylinder through inlet valve of the cylinder, so that piston of cylinder gets expanded. Insert the base of pattern in to the hook of pneumatic cylinder. Then on releasing the air from the outlet valve of pneumatic cylinder pattern can be separate from the mold. To remove the pattern from another side, base plate need to be rotate using rotating disc. Now supply the air to pneumatic cylinder through inlet valve, adjust the slider plate and fix the hook.

Specifications of Device

1) Main body;
2) Four pneumatic cylinders =80 mm bore size;
3) Two cylinder inlet valve;
4) Four slider plates of length =1250 mm,
   width =30 mm,
   height =150 mm;
5) Two detachable plates of
   length =3000 mm,
   width =20 mm,
   height =100 mm;
6) One rotating disc;
7) Four pistons;
8) Four fixing plates; and
9) Eight rolling wheels.

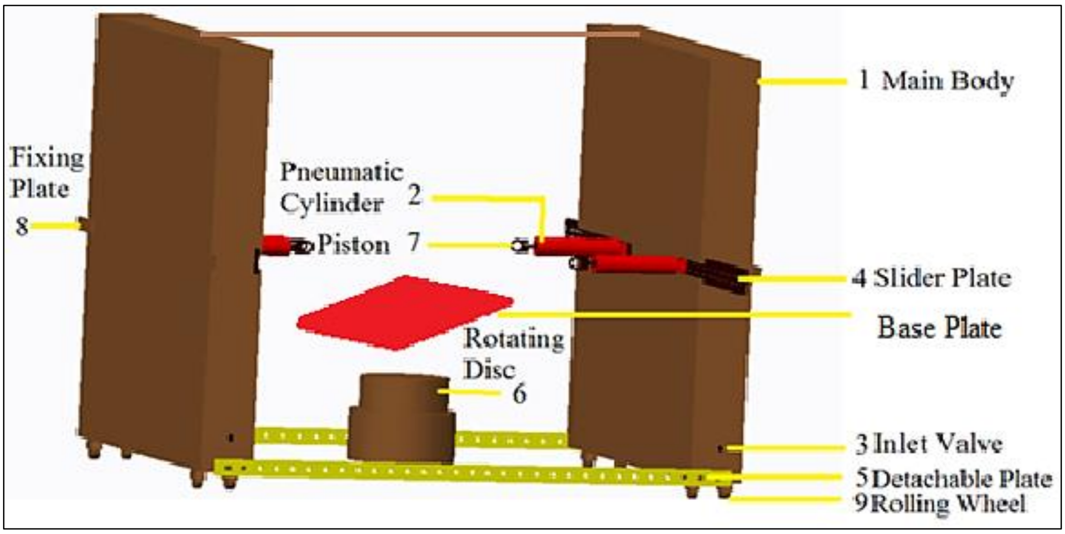
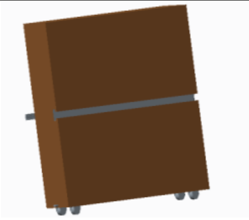
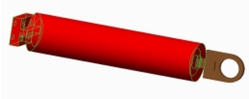
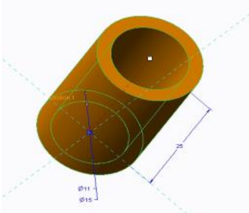
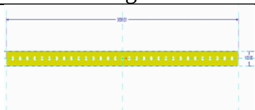
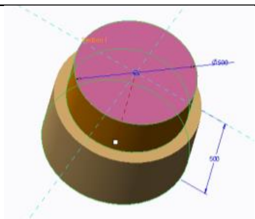
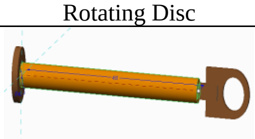
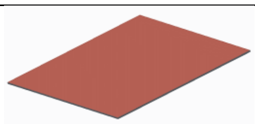


Fig. 11: *Conceptual Device for Separating Pattern from Mold.*

Specification of Parts of Conceptual Device (Table 1)

Table 1: *Specification of Parts of Conceptual Device.*

Sr. No.	Parts	Dimensions	Weight (kg)
1	 Main Body	Length =2500 mm Width =300 mm Height =2500 mm	1835.64
2	 Pneumatic cylinder	Bore size =80 mm Cylinder force =4000 N Load weight =20 kg	18.69+5.69=24.38
3	 Inlet valve	Outer Diameter =15 mm Inner Diameter =11 mm Height =25 mm	0.0158
4	 Sliding Plate	Length =1250 mm Width =30 mm Height =150 mm	41.75
5	 Detachable Plate	Length =3000 mm Width =20 mm Height =100 mm	43
6	 Rotating Disc	Rotating disc =500 mm Base disc =600 mm Height =500 mm	158.71
7	 Piston Rod	Bore size =80 mm Stroke size =450 mm Overall size =approx 555 mm	5.69
8	 Base Plate	Length =2000 mm Width =2000 mm Height =20 mm	575.29

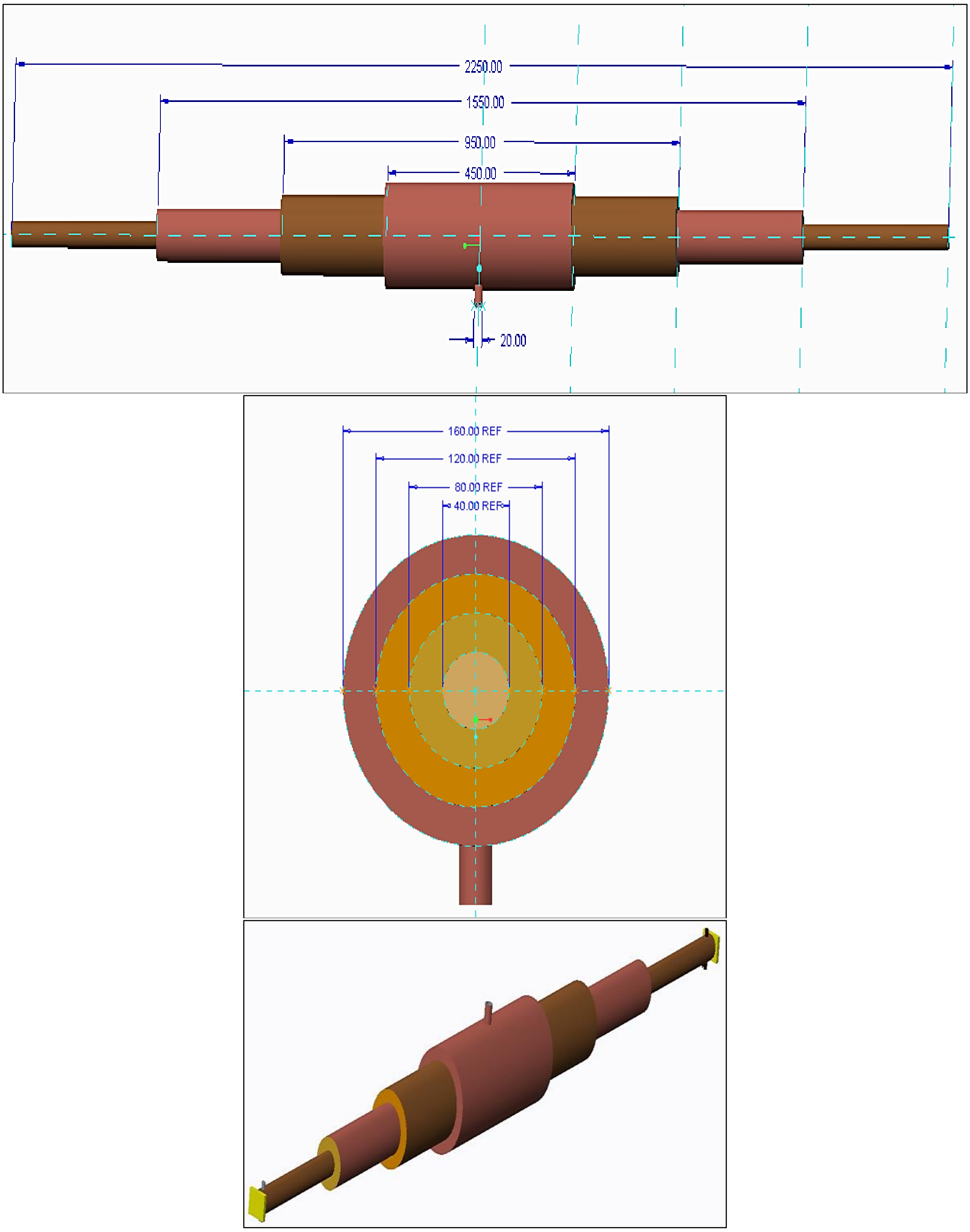


Fig. 12: *Telescopic Pneumatic Cylinder Device.*

Conceptual Design of Telescopic Device

This type of device is based on pneumatic and hydraulic system and can be used for separating pattern (Figure 12). It provides an exceptionally linear motion from a very compact retracted length. Its length depends on the number of stages it has.

Telescopic cylinders are also referred to as telescoping cylinders and multi-stage telescopic cylinders. It is based on Pascal law. Telescopic cylinders are designed with a series of steel cylinders of progressively smaller diameters nested within each other.

The largest diameter sleeve is called the main or barrel. The smaller inner sleeves are called the stages. The smallest stage is often called the plunger or piston rod.

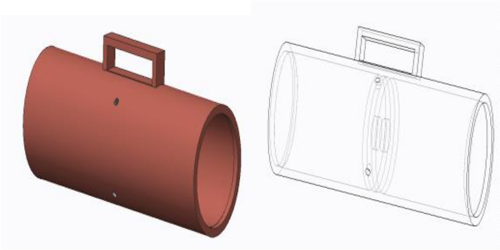
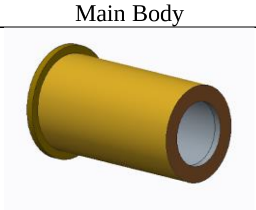
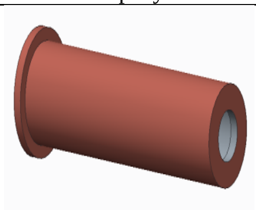
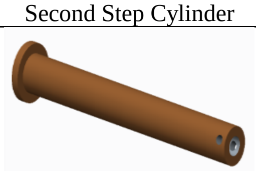
This device can be carried out and placed in between two patterns and used for separating mold from pattern. As the pressure in cylinder gets increased step by step, each shell of the telescopic device gets enlarged in length and exerts the force on pattern, so that it can be removed from the mold.

Specifications of Telescopic Device

1) Length of telescopic pneumatic device =2250 mm
2) Length of telescopic pneumatic device with connected supporting part =2270 mm
3) Outer Width of telescopic pneumatic device =160 mm
4) Weight of the device =48

Specification of Parts of Conceptual Device (Table 2)

Table 2: *Specification of Parts of Conceptual Device.*

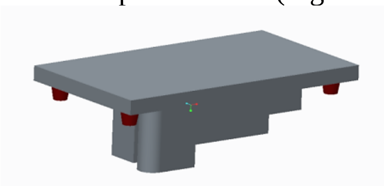
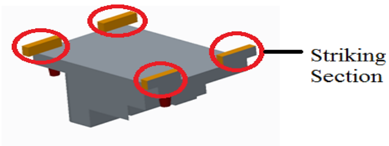
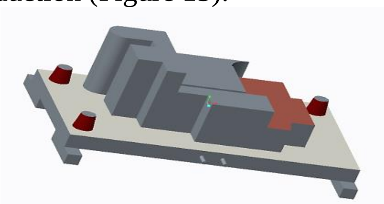
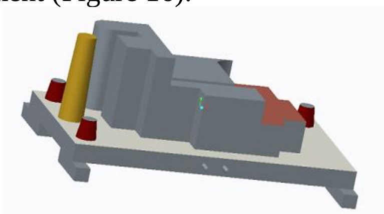
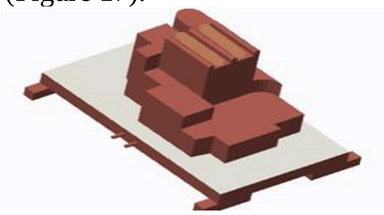
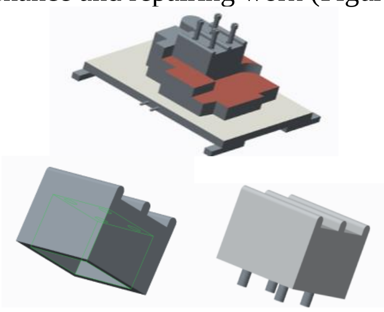
Sr. No.	Parts	Dimensions	Weight (kg)
1	 Main Body	Length =450 mm Outer diameter =160 mm Bore diameter =139.12 mm	19.27 kg
2	 First Step Cylinder	Length =250 mm Outer diameter =120 mm Bore diameter =100 mm	7.30 kg
3	 Second Step Cylinder	Length =300 mm Outer Diameter =80 mm bore Diameter =60 mm	5.50 kg
4	 Third Step Cylinder	Length =350 mm Outer Diameter =40 mm bore Diameter =20 mm	2.70 kg

MODIFICATIONS IN PATTERN

In order to apply modifications in the existing design of wooden pattern, following changes are made:

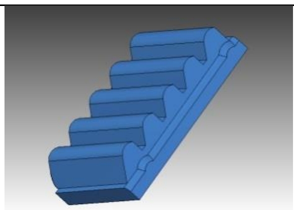
- Replacement of complicated parts with aluminium parts.
- Modification in size of lock: An extra lock added to pattern whose size should be greater than the size of core, so that there is no problem during the placing of cope over the drag and it also helps in guiding the cope during the placement over the core and drag.
- Placing a striking section of acrylic on outer side of wooden pattern: it would help in separating the mold from the pattern and preventing from damage due to directly striking on the pattern.

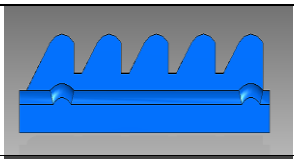
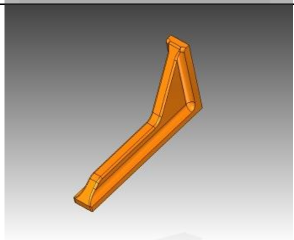
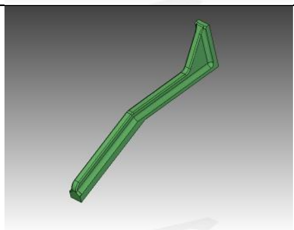
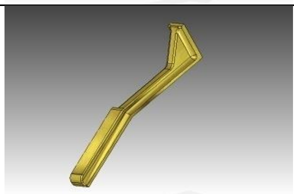
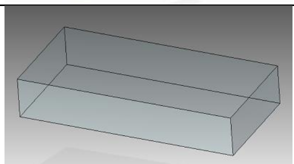
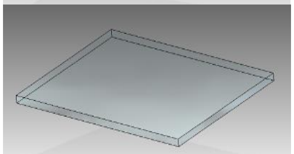
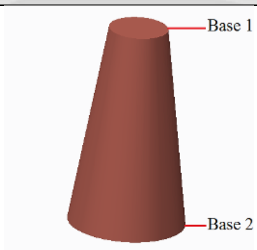
Comparison between Existing Pattern and Modified Pattern

	Before	After
1)	There is no striking section, worker applies hammer anywhere on pattern; due to that, pattern gets damaged and it takes lot of time to get it repaired, till then, they have to keep hold on the production of this pattern aside (Figure 13).  ***Fig. 13:*** *Current Pattern Having Wooden Pad Orno Pads.*	Placing of striking section of acrylic part, so that it prevents from being damaged from striking of hammer abruptly. Even these blocks of acrylic provide support to the pattern (Figure 14).  ***Fig. 14:*** *Modified Pattern with Acrylic Pad.*
2)	There is problem during the placing of cope over core and drag. Many times core print gets damaged during placing of cope; this results in less production (Figure 15).  ***Fig. 15:*** *Current Pattern having No Guide Lock.*	Here, an extra lock is placed in pattern, whose size depends upon the size of core. These locks also guide the cope during the placement (Figure 16).  ***Fig. 16****: Modified Pattern with Guide Lock.*
3)	In wooden pattern, complicated parts get easily broken down during the process of removal of mold cavity from pattern as a result of hammer striking, or handling it without care. Due to moisture content, wood gets variation in shape and size (Figure 17).  ***Fig. 17:*** *Wooden Pattern.*	Here, aluminium section is used for complicated section and mounting section with screws and nuts. So, that there is less requirement of machining process and less maintenance and repairing work (Figure 18).  ***Fig. 18:*** *Modified Pattern with Aluminium and Acrylic Parts.*

Specifications of Modified Parts of Pattern (Table 3)

Table 3: *Specifications of Modified Parts of Pattern.*

Sr. No.	Modified Products	Material	Dimension	Weight
1		Aluminium	Length =155.16 mm Width =135 mm Height =35 mm	1.67 kg

				
2		Aluminium	Length =251.2 mm Width =40 mm Height =111 mm	0.768 kg
3		Aluminium	Length =472 mm Width =40 mm Height =111 mm	1.43 kg
4		Aluminium	Length =472 mm Width =40 mm Height =111 mm	1.65 kg
5	 	Acrylic Sheet	Length =410 mm Width =130 mm Height =30 mm Length =500 mm Width =300 mm Height =20 mm	2.23 kg 3.57 kg
6		Wood	Base 1 =95 mm Base 2 =140 mm Height =260 mm	2.02 kg

Properties of Acrylic material
Density =1190 kg/m3,
Poisson's ratio =0.400,
Young modulus =1930.532 Mpa,
Coefficient of thermal expansion =0.0001.

Properties of Birch wood
Density =711 kg/m^3,
Poisson's ratio =0.426,
Young modulus =16500 Mpa,
Coefficient of thermal expansion =0.

Modified Core Pattern
Figure 19 shows the core pattern box, which consist of aluminium and acrylic parts. In this pattern, lots of critical and complex parts are present. Therefore, all small and thin section are made from aluminium section.

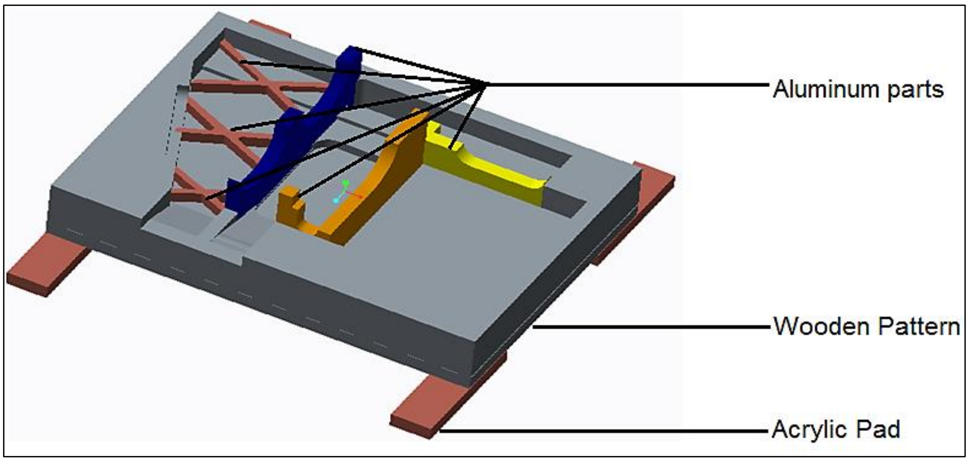
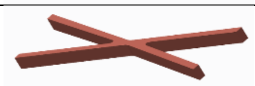
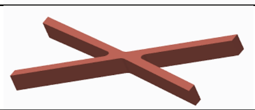
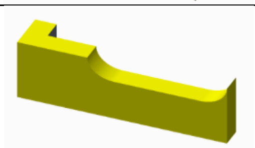
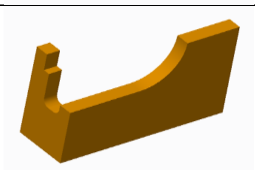
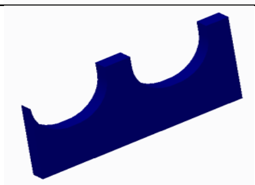


Fig. 19: *Modified Core Pattern.*

Specifications of Modified Parts of Core Pattern (Table 4)

Table 4: *Specification of Modified Parts of Core Pattern.*

Sr. No.	Modified Products	Material	Dimension (mm)	Weight (kg)
1		Aluminium	Length =180 Width =103 Height =25	0.253
2		Aluminium	Length =168.57 Width =92.04 Height =25	0.235
3		Aluminium	Length=101.82 Width =53.85 Height =25	0.124
4		Aluminium	Length =195 Width =20 Height =75	0.73
5		Aluminium	Length =250 Width =20 Height =150	1.91
6		Aluminium	Length =315 Width =20 Height =145	1.68
7		Acrylic	Length =200 Width =60 Height =30	0.503

ANALYSIS OF PATTERN

Analysis and simulation of the modified pattern is being done to check the strength and stability of pattern. Thus, ANSYS is being used for structural analysis.

Force on Acrylic Striking Pad of Pattern

Dimensions of Striking Pad

Length =410 mm=4.10

Width =130 mm=1.30

Height =40 mm=0.40

Area =L×W×H

=2.132 m^2

Force, pmax =1200 N

Stress=$\frac{p_{max}}{A}$ =$\frac{1200}{2.132}$ =562.85 N/m^2

Force on Wooden Pattern

Length =1030 mm

Width =1030 mm

Height =30 mm

Area =31.827×10^6 mm^2

Analysis of Main Pattern

Here, aluminium and acrylic parts are used for complicated parts in birch wooden pattern. Force is applied only on striking pad of acrylic (Table 5).

Table 5: *Analysis of Acrylic Pad on Applied Force.*

Sr. No	Operation	Result
1	Total Force	1200 N
2	Max. Deformation	5.8×10^{-5} mm
3	Max. Stress	0.31 MPa

Total Force

Here, 1200 N force of hammer is applied on an acrylic block of modified pattern (Figure 20).

Maximum Deformation

After applying 1200 N force on acrylic block, maximum deformation was found to be 5.82×10^{-5} mm (Figure 21).

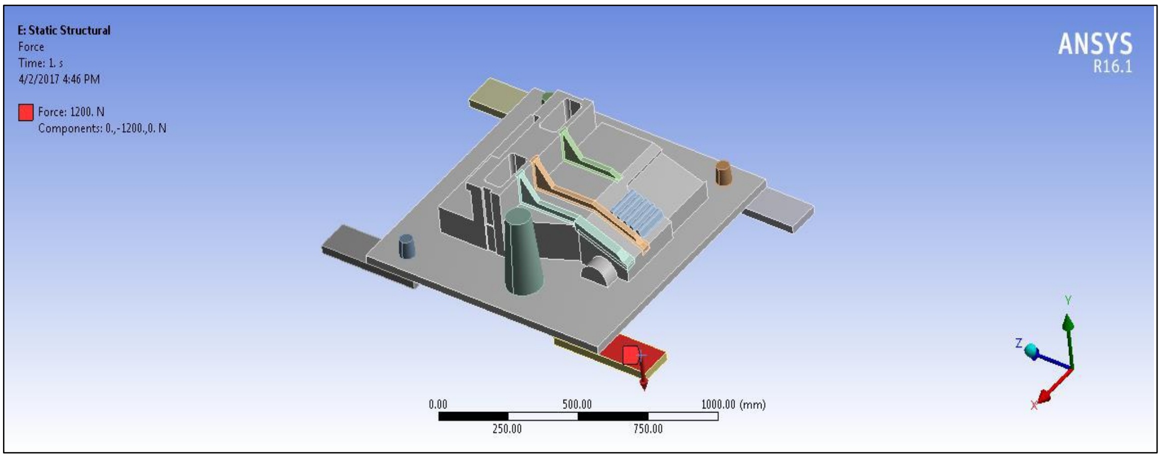


Fig. 20: *Force Applied on Acrylic Pad.*

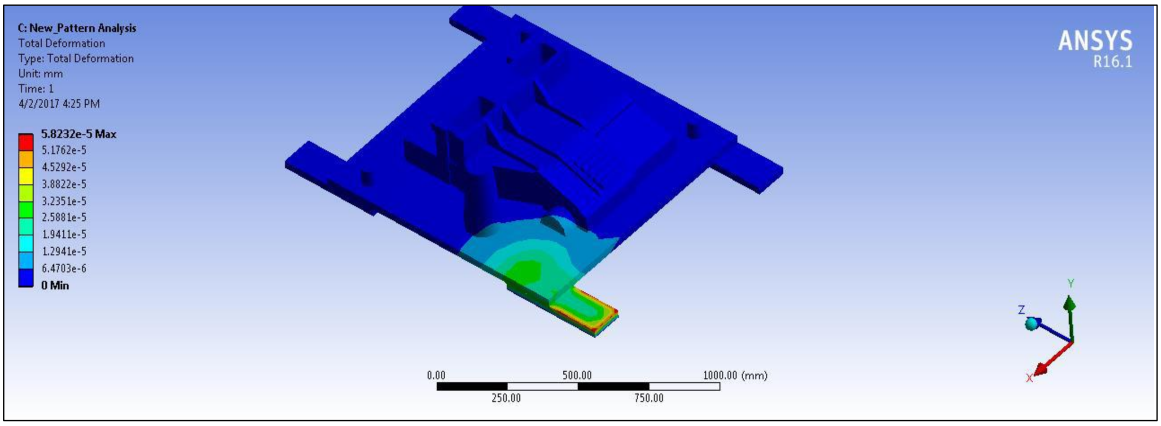


Fig. 21: *Deformation of Acrylic Pad.*

Maximum Stress

After applying 1200 N force on acrylic block, maximum stress was found to be 0.31 MPa (Figure 22).

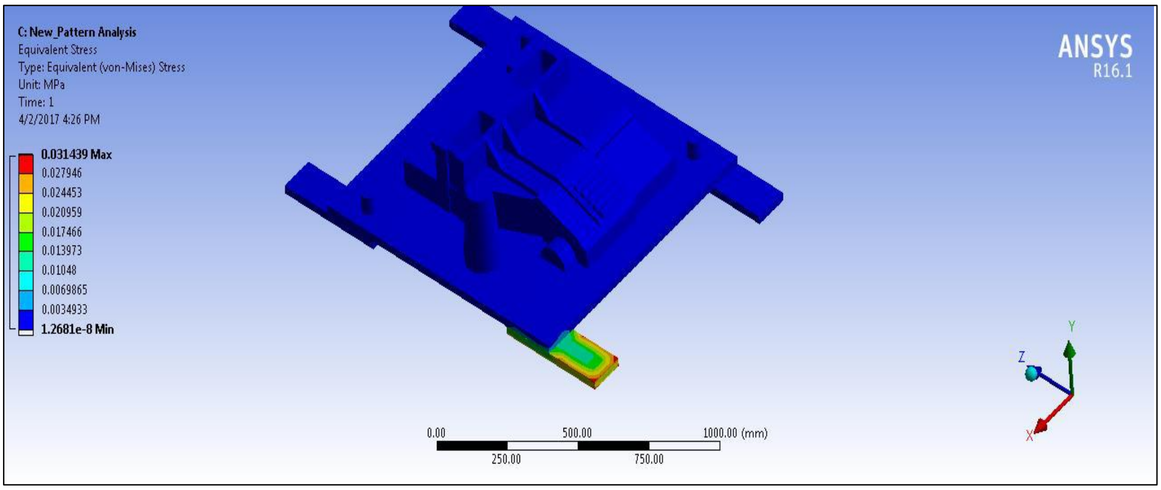


Fig. 22: *Stress on Acrylic Pad.*

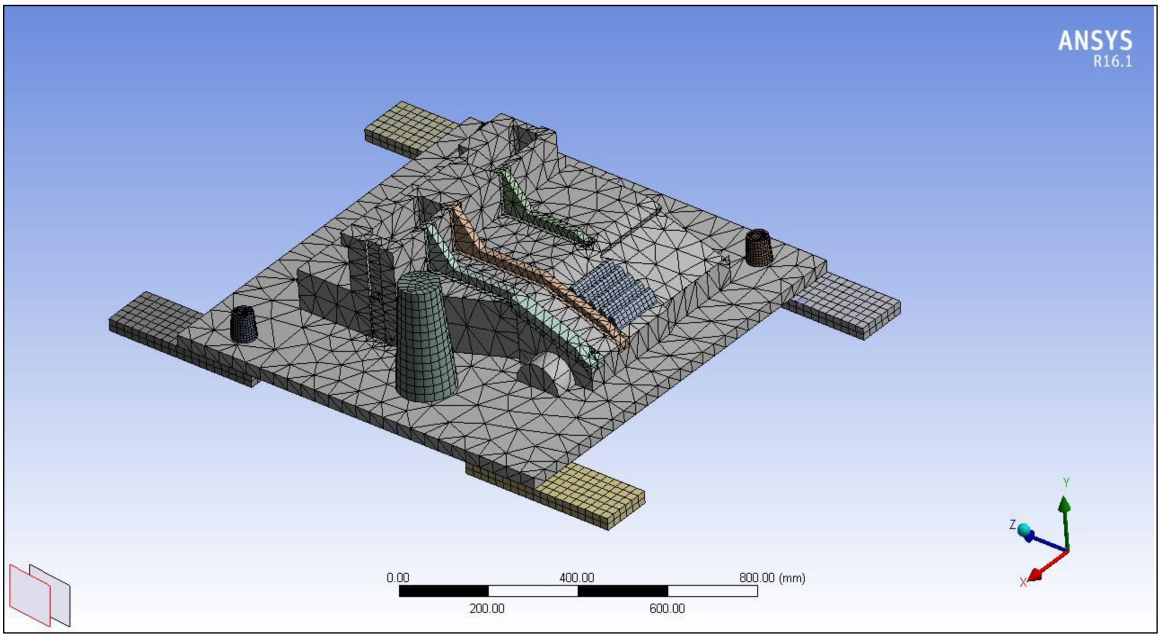


Fig. 23: *Meshing of Pattern.*

Here, aluminium and acrylic parts are used for complicated sections in wooden pattern and force is applied on the bottom side of pattern (Table 6).

Table 6: *Analysis of Modified Pattern.*

Sr. No.	Operation	Result
1	Total Force	1200 N
2	Max. Deformation	5.13×10^{-3} mm
3	Max. Stress	0.55 MPa

Meshing of Pattern

After the modified pattern is generated in Ansys, fine mashing is done to find a better result (Figure 23).

Type of meshing : Tetrahedron
Number of nodes : 43029
Number of elements : 13574

Applying fine meshing will help to get the desired result in the Ansys.

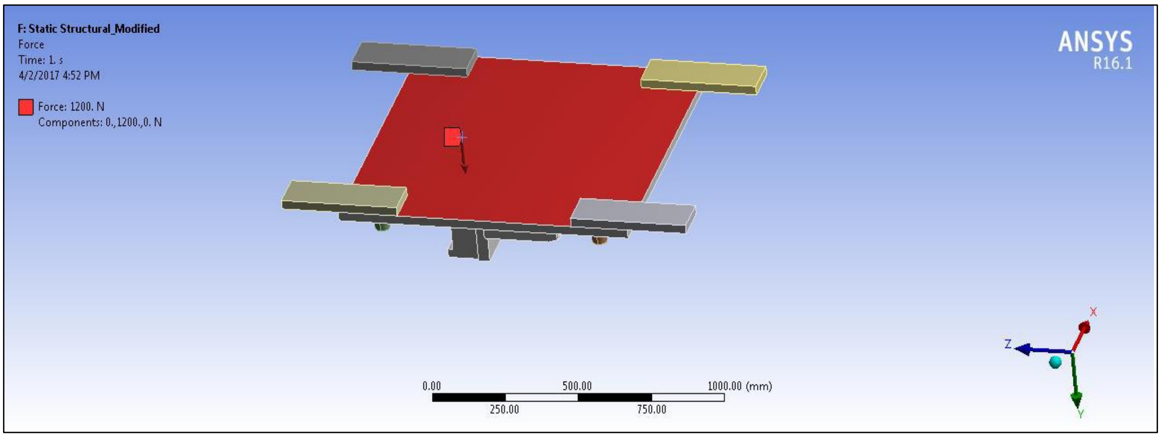


***Fig. 24*: Force Applied on Bottom Side of Modified Pattern.**

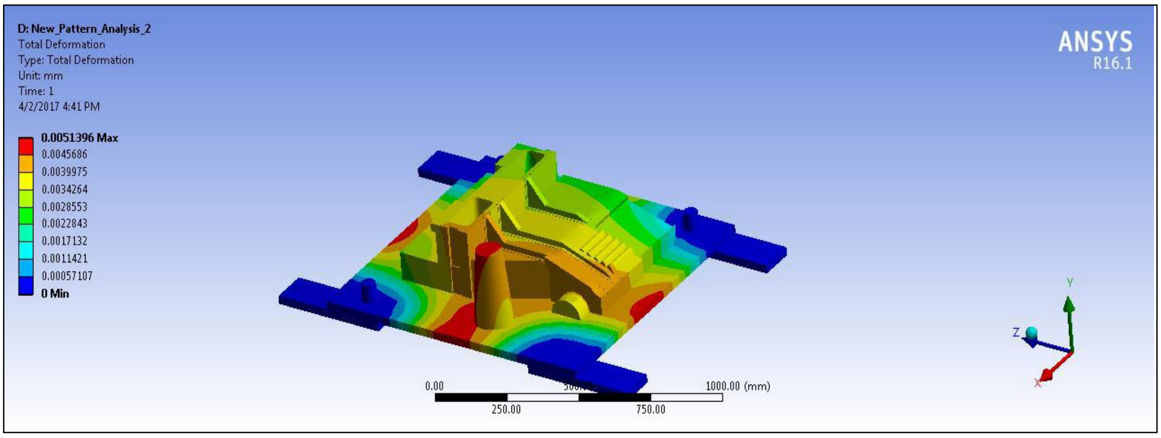


***Fig. 25:* Deformation of Modified Pattern.**

Total Force

Here, 1200 N force of hammer is applied on the bottom side of modified pattern (Figure 24).

Maximum Deformation

After applying 1200 N force on bottom side of the pattern, maximum deformation was found to be 5.13×10^{-3} mm (Figure 25).

Maximum Stress

After applying 1200 N force on bottom side of the pattern, maximum stress was found to be 0.55 MPa (Figure 26).

Analysis Results

- Design methods are compared, checked and validated by finite element method.
- Solid Edge and Creo is used for drafting and modelling the assembly.
- Ansys is used for finite element analysis.
- Analysis results of modified pattern sustain within limit.

Table 7: *Analysis of Force Applied on Acrylic Pad.*

Sr. No.	Operation	Result
1	Total Force	1200 N
2	Max. Deformation	2.09×10^{-3} mm
3	Max. Stress	0.162 MPa

Analysis of Core Pattern

Here, aluminium and acrylic parts are used for complicated sections in wooden pattern and force is applied on the acrylic block of pattern (Table 7).

Total Force

Here, 1200 N force of hammer is applied on an acrylic block of modified pattern (Figure 27).

Maximum Deformation

After applying 1200 N force on acrylic block, maximum deformation was found to be 2.09×10^{-3} mm (Figure 28).

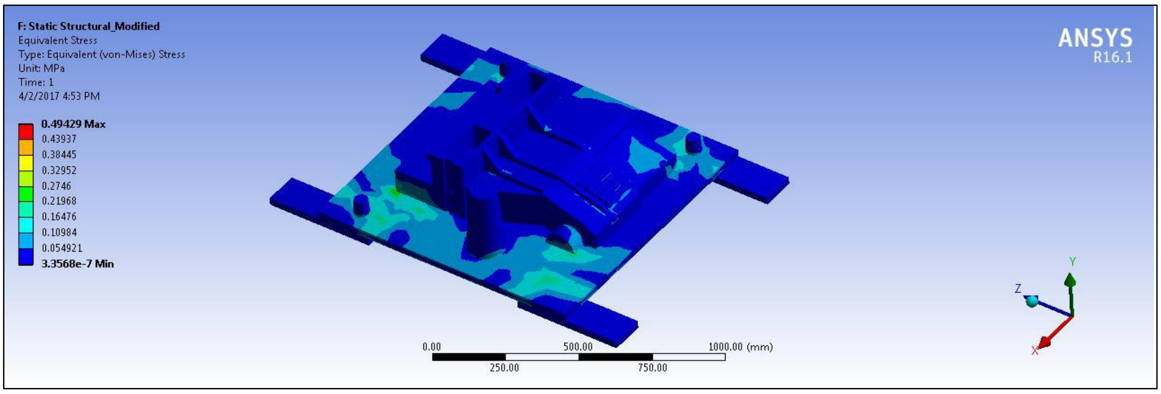


Fig. 26: *Stress on Modified Pattern.*

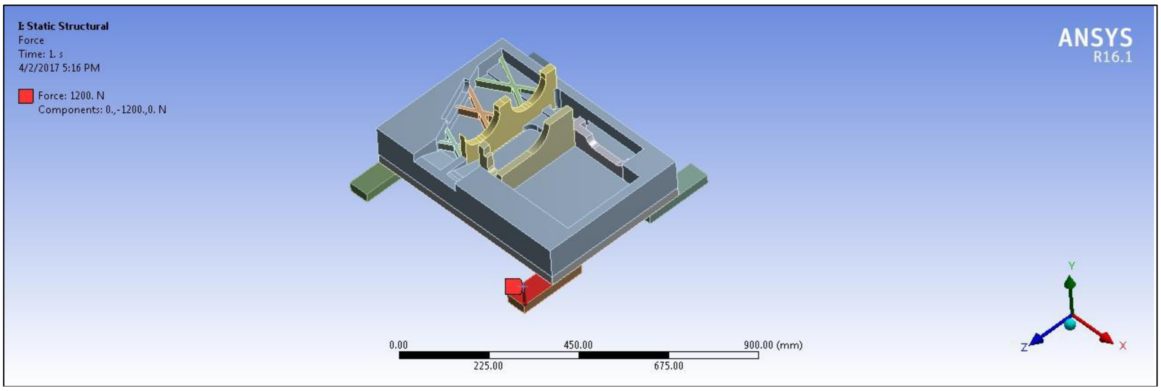


Fig. 27: *Force Applied on Core Pattern Box.*

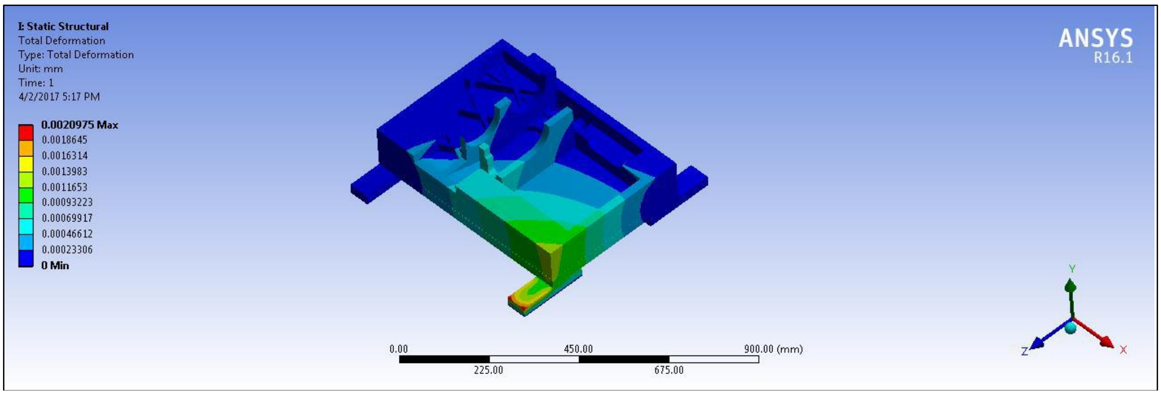


Fig. 28: *Deformation of Acrylic Pad.*

Maximum Stress

After applying 1200 N force on acrylic block, maximum stress was found to be 0.162 MPa (Figure 29).

Table 8: *Analysis of Modified Core Pattern.*

Sr. No	Operation	Result
1	Total Force	1200 N
2	Max. Deformation	5.03×10^{-3} mm
3	Max. Stress	0.49 MPa

Here, aluminium and acrylic parts are used for complicated sections in wooden pattern and force is applied on the bottom side of pattern (Table 8).

Meshing of Pattern

After the modified pattern is generated in Ansys, fine mashing is done to find better result and applying fine meshing will help to get the desired result in the Ansys (Figure 30).
Type of meshing: Tetrahedron
Number of nodes: 11751
Number of elements: 3927

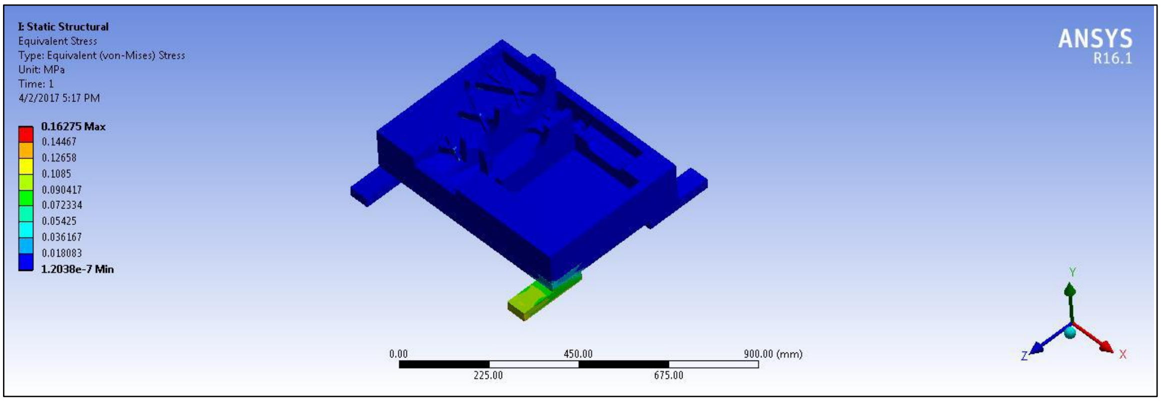


Fig. 29: *Stress on Acrylic Pad.*

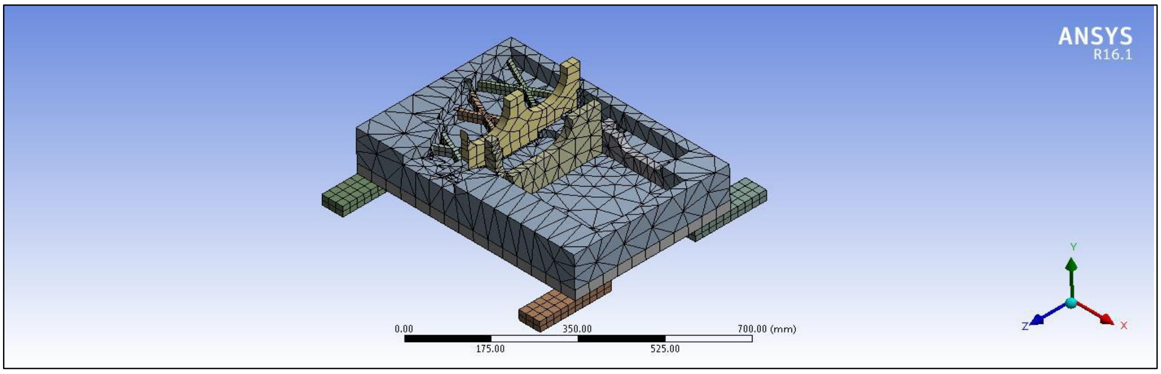


Fig. 30: *Meshing of Core Pattern.*

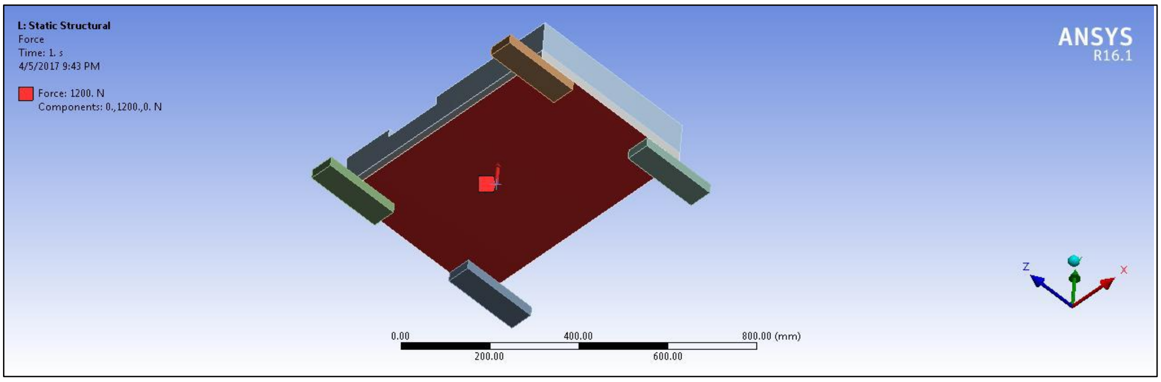


Fig. 31: *Force Applied on Modified Core Pattern.*

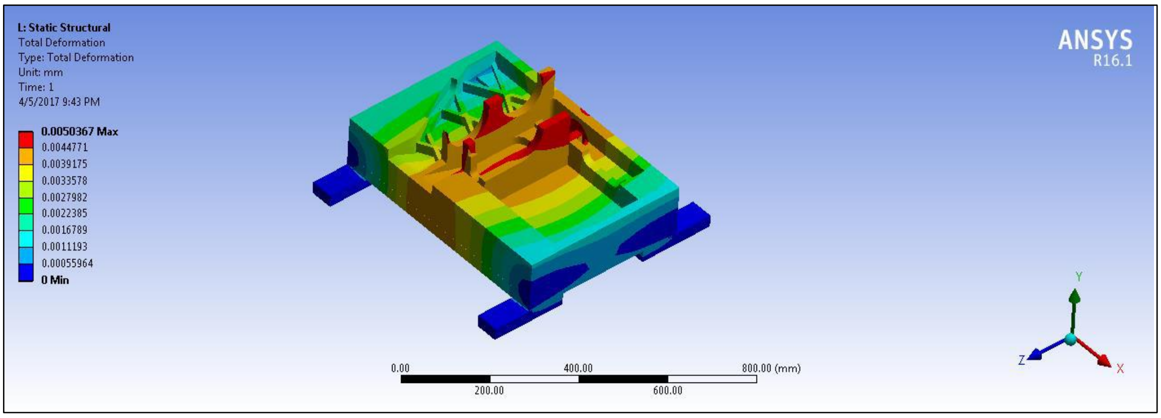


Fig. 32: *Deformation of Modified Core Pattern.*

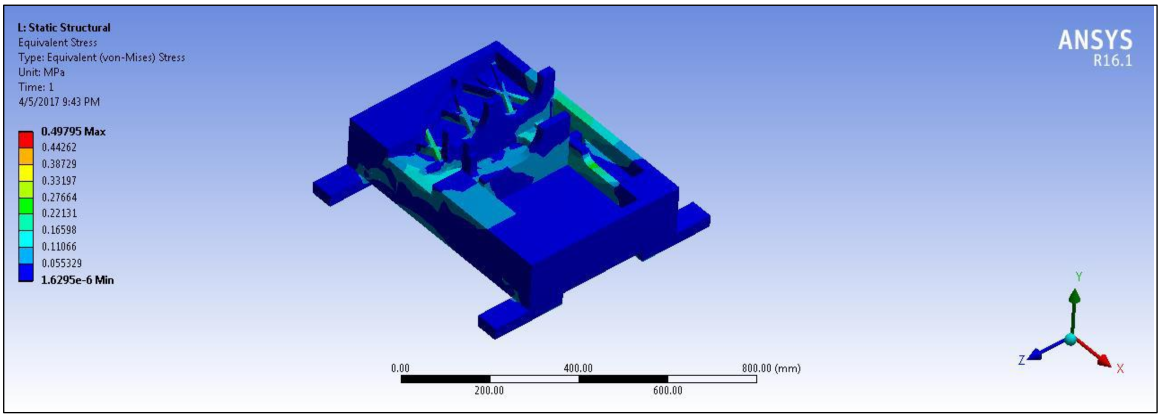


Fig. 33: *Stress on Modified Core Pattern.*

Total Force

Here, 1200 N force of hammer applied on the bottom side of modified pattern (Figure 31).

Maximum Deformation

After applying 1200 N force on bottom side of the pattern, maximum deformation was found to be 5.03×10^{-3} mm (Figure 32).

Maximum Stress

After applying 1200 N force on bottom side of the pattern, maximum stress was found to be 0.49 MPa (Figure 33).

Analysis Results

- Design methods are compared, checked and validated by finite element method.
- Solid Edge and Creo is used for drafting and modelling the assembly.
- Ansys is used for finite element analysis.
- Analysis results of modified pattern sustain within limit.

CONCLUSION

- From the above analysis, we can analyze that modified pattern sustains more than the existing pattern.
- Modified pattern has less deformation as compared to existing pattern.
- By making the combination of aluminium and acrylic parts in wood pattern, following advantages are found:

1) We can increase the strength of pattern.
2) Better finishing surface of mold:
    1) Less possibility of breakdown of thin parts,
    2) Reduce the machining operation and time,
3) Reduce the maintenance operation and time,
4) Reduce the labor work,
5) Which ultimate reduce the cost as compared to the wooden pattern.

- This type of pattern even stays for long period of time as compared to wooden pattern. So, we can apply this modification in casting foundry for long time stability of pattern.

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