

DESIGN AND ANALYSIS OF BLOW MOULDING DIE

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ABSTRACT: - Blow moulding is the process of forming a molten tube (preform) of a thermo plastic material and placing the preform with in a mould cavity and filling the tube with compressed air to get the shape of cavity and cools the part before removing from the mould. Blow moulding is used to produce hollow objects like PET (POLY ETHYLENE TERE PHTHALATE) bottles or HDPE (HIGH DENSITY POLY ETHYLENE) bottles for storing of water, oil, soft drinks, for house hold use and chemicals in pharmaceuticals use etc.

The main aim of the project is to design and analysis of blow moulding die. The materials used for analysis of die are EN31, Mild Steel and Aluminium. In this will analyse the structural analysis for finding the best material of die by using ANSYS.

Designing of blow moulding die is done with the help of CREO software. The mould is prepared first by modelling the bottle and splitting the core and cavity then converting the core of the mould into STEP or IGES file and importing the file into “ANSYS” software for analysis and finding the best results of die.

KEYWORDS:-CREO, ANSYS.

1. Introduction:

Blow moulding is the process of creating a preform of a thermo plastic material and placing the preform with in a mould cavity and filling the preform with a compressed air to get the shape of cavity and cools the formed shape before removing from the mould. Blow moulding is used to produce hollow objects like PET (POLY ETHYLENE TERE PHTHALATE) bottles or HDPE (HIGH DENSITY POLY ETHYLENE) bottles for storing of water, oil, soft drinks, for house hold use and chemicals in pharmaceuticals use etc.

Die is a tool used in manufacturing industries for forming the form of the bottle. Dies are used to cut the shape of desired objects. Dies ranges from paper clips to the complex shapes used in the automobile industries.

All bottles start as a plastic tube known as “PREFORM” this is heated and blown into a bottle form based on Mould. A bottle is a hollow object with narrow neck which is made up of glass, clay, poly ethylene tere phthalate (PET), HDPE high density poly ethylene, thermo plastics etc.

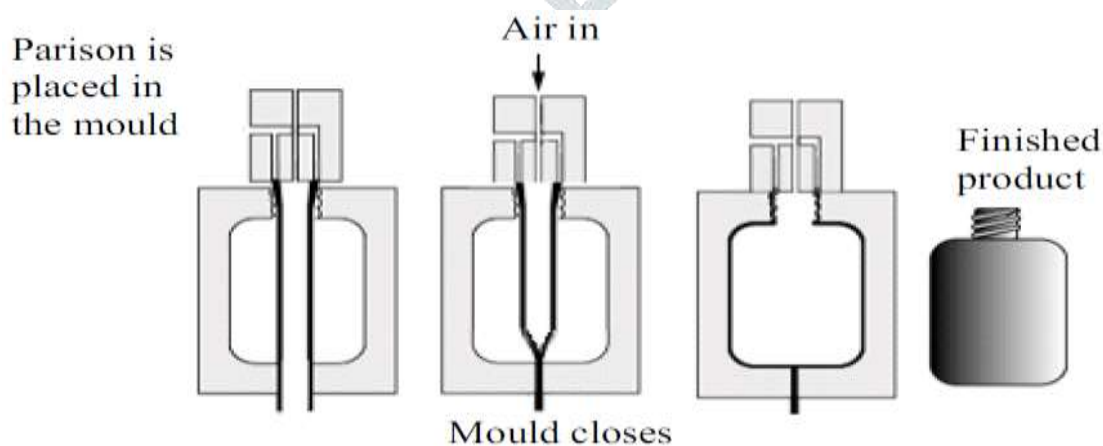


Fig.1.1 Mold Extrusion Process

1.1 Types of blow moulding manufacturing process.

There are three different types of blow moulding:

- Extrusion blow moulding
- Injection blow moulding
- Injection stretch blow moulding

The main differences among them are the method of forming the tube; either by extrusion or injection moulding, the size of the tube and the method of movement between the tube and blow moulds; either stationary, shuttling, linear or rotary.

1.2 Material suitable for blow moulding bottles.

Instances of Blow Molding Polymers in single layer or various layer constructions or blends incorporate such materials as:

- High Density Polyethylene,
- Low density Polyethylene,
- Polypropylene,
- PET,
- PVC,

2. INTRODUCTION TO CREO 3.0

CREO is a multi-stage CAD/CAM/CAE business programming suite created by USA based organization called PARAMETRIC TECHNOLOGY CO-ORPORATION (PTC).

CREO is the norm in 3D item configuration, highlighting industry-driving efficiency instruments that advance prescribed procedures in plan while guaranteeing consistence with industry and friends' principles. Incorporated Pro/ENGINEER CAD/CAM/CAE arrangements permits to plan quicker than at any other time, while augmenting development and quality to eventually make outstanding items.

CREO offers an answer for Part configuration, shape configuration, styling, surfacing, get together plan and perception to make, adjust, and approve complex creative shapes. CREO upholds numerous phases of item plan whether began from 2D portrayals. CREO can peruse and item STEP design documents for figuring out and surface reuse.

2.1. DIFFERENT MODULES IN CREO 3.0

- Sketcher
- Part design
- Sheet metal design
- Surface design
- Mould design
- Assembly
- Drawing

3. INTRODUCTION TO ANSYS WORK BENCH

ANSYS is an Analysis programming this was created by ANSYS, Inc. is an American Computer-helped designing programming engineer settled south of Pittsburgh in Cecil Township, Pennsylvania, United States. Ansys distributes designing examination programming across a scope of disciplines including limited component investigation, underlying examination, computational liquid elements, express and implied techniques, and warmth move.

The organization was established in 1970. By John A. Swanson as Swanson Analysis Systems, Inc. (SASI). Its main role was to create and showcase limited component examination programming for underlying physical science that could reproduce static (fixed), dynamic (moving) and warm (heat move) issues. SASI fostered its business in corresponding with the development in PC innovation and designing necessities. The organization developed by 10% to 20 percent every year, and in 1994 it was offered to TA Associates. The new proprietors took SASI's driving programming, called ANSYS, as their leader item and assigned ANSYS, Inc. as the new organization name

3.1 Types of analysis

- Static
- Dynamic
- Thermal

3.2 GENERAL PROCEDURE TO CONDUCT ANALYSIS:

In general, a finite element solution may be broken into the following three stages. This is a general guideline that can be used for setting up any finite element analysis.

1. **Preprocessing: defining the problem;** the major steps in preprocessing are given below:

- Define key points/lines/areas/volumes
- Define element type and material/geometric properties
- Mesh lines/areas/volumes as required

The amount of detail required will depend on the dimensionality of the analysis (i.e. 1D, 2D, axis-symmetric, 3D).

2. **Solution: assigning loads, constraints and solving;** here specify the loads (point or pressure), constraints (translational and rotational) and finally solve the resulting set of equations.

3. **Post processing:** just see:

- Lists of nodal displacements
- Element forces and moments
- Deflection plots
- Stress contour diagrams
-

4. INTRODUCTION TO MATERIALS

4.1 Mild Steel Material

With regards to taking commendation for its adaptability and Cost-viability, few can convey as incredible an exhibition as Mild steel. The world's most normal type of steel, its Applications are immense on consistently uses, and it very well may be Cut to estimate and altered to appropriate here required.

4.2 Grade Used in Mild Steel

Grade used for Dies - MILD STEEL IS 2062 E-250-BR

Chemical composition % of the Product of grade E250BR

Nominal thickness from 63 to 100 (mm)

C	Si	Mn	N	P	S
max 0.22	0.40	1.50	max 0.012	max 0.045	max 0.045

4.3 EN-31 Material

EN 31 is an astounding high carbon combination steel which offers a high proportion of hardness with compressive strength and scraped spot obstruction. This Grade is frequently utilized for wear opposing machine constituents and for press instruments which don't advantage an additional complex agreeable.

4.4 Chemical composition of EN-31 100Cr6

C	Si	Mn	CR	P	S
max 1.22	0.350	0.750	max 1.6	max 0.05	max 0.05

4.5 ALUMINIUM Material

Aluminum is a superb material for machine parts Aluminum is noteworthy for its low thickness and its capacity to oppose consumption through the wonder of passivation. Aluminum and its amalgams are

essential to the aeronautic trade and significant in transportation and building ventures, for example, building veneers and window outlines. The oxides and sulfates are the most valuable mixtures of aluminum.

4.6 Chemical composition of Aluminum Alloy A360

C	Si	Mn	Fe	Ni	Zn
max 0.6	10	0.350	max 1.3	max 0.5	max 0.5

5. LITERATURE REVIEW:

As ahead of schedule as the 1880's there was a protected technique for expelling a Celluloid polymer into a preform and blow shaping a section. Early strategies and materials to blow plastics into shapes were exceptionally unrefined and not reasonable for large scale manufacturing. It wasn't until the last part of the 1930's that the principal business machines and items were created for the assembling of blow shaped jugs. The significant occasion that set off and energized the early long stretches of business blow shaping was the advancement of low and high thickness polyethylene appropriate for blow embellishment and shopper bundles.

These are probably the most widely recognized shapes utilized in shopper bundling and other commonplace kinds of blow-formed parts, including like.

- Industrial bulk containers
- Home appliances.
- Lawn, garden and household items.
- Medical supplies and parts, toys.
- Automotive-under the hood parts

The significant occasion that set off and filled the early long periods of business blow forming was the advancement of low and high-thickness polyethylene appropriate for blow trim and purchaser bundles.

K. GiridharReddy, K. Rajagopal [1] The ideas of Blowmoulding is a cycle used to create empty articles from thermoplastic. The essential blow forming measure has two crucial stages. Initial, a preform of hot plastic gum in a to some degree cylindrical shape is made. Second, compacted air is utilized to grow the hot perform and press it against shape pits. The pressing factor is held until the plastic cools. Blow shaping interaction is utilized for which has slender divider areas. In this proposal, blow form configuration is to be accomplished for a jug having 0.5mm thickness. This thickness can't be filled in pressure infusion shaping. So blow shaping is considered for pet container plan. The form is ready by first displaying the part, removing center and cavity and producing CNC program. Blow shape instrument configuration is done in Pro/Engineer as indicated by HASCO norms. A model of the pet jug utilizing blow shape configuration is additionally included Structured four-point rakish contact metal roller utilized in propeller shaft of an airplane. This bearing can bolster outspread and hub loads .They arranged the plan of heading and determined the working hours. Subsequent to displaying the determined the bearing life is working hours with the assistance of dynamic examination. They further broke down that by expanding the quantity of balls, diminishing ball measurement and changing the contact point, the life in working hours can be expanded.

DR CH S Naga Prasad al [2] In this postulation a pet jug is displayed in PRO-ENGINEER (CREO). The assembling of pet jug pass on is planned and arranged model for the container and the pre structure. This plan of pet jug withstands the pressing factors when soda pop is filled in the jug. The pressing factor esteems are taken from norms of Coco – Cola Company.

Chakrit Suvanjumrat, Nathaporn Ploysook1, and Ravivat Rugsaj [3] In this examination proposed the blow shaping reproduction technique for deciding of a cross-segment thickness of containers. The limited component strategy (FEM) was utilized to mimic the expulsion blow forming cycle of the mind-boggling shape bottles. The full container state of blow forming measure had been endeavored to reenact with a rectangular shape bottle for contrasting and the cross-segment method. Especially, the actual investigation of the expulsion blow shaping cycle was performed to confirm the FEM. The cross-area method was acquired a deviation result not exactly the full container shape reenactment. The normal mistake of full jug shape reenactment was 32.35% while the cross-area recreation got a normal blunder of 17.02% when they were contrasted and the exploratory information of the blow forming measure. The FEM

of blow forming reproduction utilizing the cross-area procedure which was created in this exploration had been tracked down the agreeable technique to decide the underlying thickness of the parison moving through the expulsion kick the bucket. It was advantaged to shape bites the dust of the expulsion blow forming measure to accomplish the perplexing state of jugs.

Milind H. Mahajan, Girish M. Lonare [4] The plan of blow molds, Parison and the particular of cycle boundaries are significant and it is consolidated of science, craftsmanship and expertise. A little change in bite the dust and shape configuration, kick the bucket temperature and blow pressing factor can extraordinarily impact on the embellishment results, plastic framing conduct, materials boundaries, the liquid consistency and nature of the items. To approve these boundaries and speed up the plan endorsement, model tooling is required and it exorbitant and requires some investment.

To decrease lead time and costs, Finite Element Modeling (FEM) investigation is required. It will foresee and for all intents and purposes help the blow shaping interaction plan and extremely valuable to help the foundry business particularly in planning another item, upgrade of existing items and recognize the deformities. By contributing blow pressing factor and temperature trademark information, this investigation can reproduce and imagine the blow shaping interaction for accomplishing a uniform divider thickness in the end result.

Saeed Bagherzadeh, F R Biglari and K Nikbin [5] In this paper, the investigation of the stretch-blow forming (SBM) cycle of polyethylene terephthalate (PET) bottles is concentrated by the limited component strategy (FEM). In this reenactment, attributable to the evenness of jug calculation, the parts are considered as an axisymmetric model. A hyperplastic constitutive conduct was aligned utilizing material information accessible in writing in variation high temperatures and strain rates and was utilized in the mathematical reenactment. Hydrostatic pressing factor with show heat move has been utilized rather than a blowing interaction. Examinations of mathematical outcomes with trial perceptions exhibit that the model can anticipate a general pattern of thickness dissemination, particularly in areas between 30mm to 90mm from the container base. In any case, a few contrasts can be found in districts 10mm and 125mm. These outcomes can be utilized for a general forecast of jug properties like last container thickness and an imperfection free creation since they are administered by direction and crystallinity, which are profoundly temperature and strain subordinate. Additionally, with meaning of the basic region in bottle framing, the parametric examinations are directed on the impact of rubbing condition, heat move coefficient, and beginning pre-blowing air entrance time delay on bottle thickness. Through the examination, unmistakably the proposed model is material for reenacting the stretch-blow shaping interaction of PET containers, and is equipped for offering supportive information in the creation of jugs and the plan of an ideal preform.

6. DESIGNING OF BOTTLE IN CREO 3.0:

- Select the new and tick the part, solid then change the name to “bottle” and untick the use default template and click on ok , then select “ mmns_part_solid” click ok, then CREO 3.0 user interface will open.
- Select the sketch, select the front plane in model tree and then select the reference and select the bottom plain and select the center plain then will get construction lines

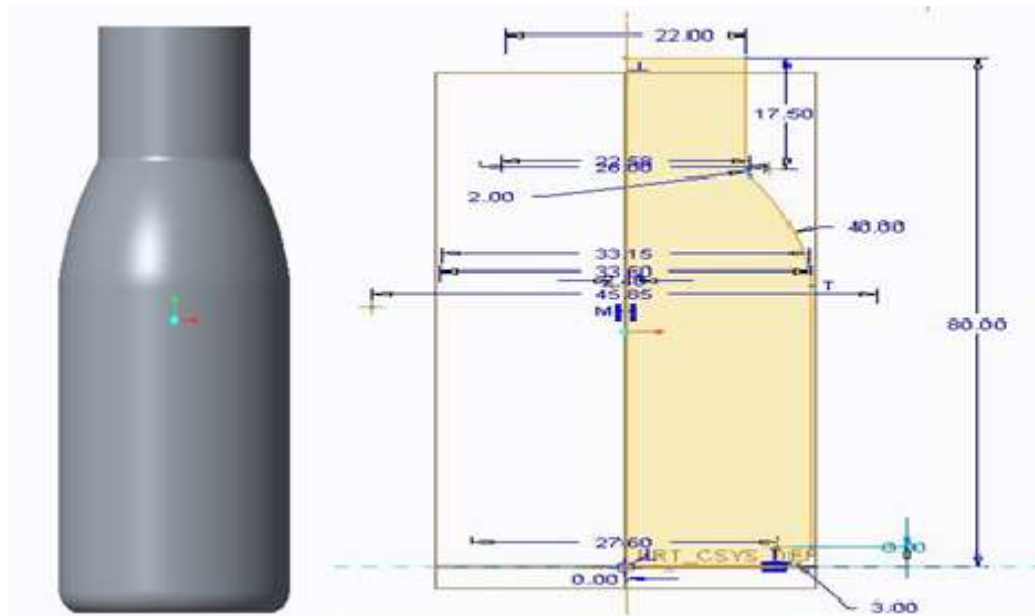


Fig.6.1 Bottle design and dimensions

- Then select line and draw the below shown sketch in the diagram, by using line and arc and change the dimensions according to the sketch by double clicking the dimensions and enter the value and select ok.
- After that enter into the part design then select the revolve option select ok then the shape of bottle will come, see the below figure for reference. Select the sketch, select the front plane in model tree and then select the reference and select the bottom plain and select the center plain for drawing the construction lines.
- Then select line centerline and draw it in center vertically for revolve axis.
- Then draw the below shown sketch in the diagram, by using line and arc, for closing the activated command hold roller of mouse, for revolving the 3D model.
- select the left click and move the mouse then 3D model will revolve, just change the dimensions according to the sketch by double clicking the dimensions and enter the value and select ok.
- After that enter into the part design then select the revolve option select ok for getting the shape of bottle.
- Then apply the fillets wherever required and give the values of fillet and click ok.
- Measure the ml of bottle by going to the analysis in CREO ribbon and select the mass properties, if capacity of the bottle is matched.
- See the above figure shown after completion of bottle design based on the dimensions.
- Select the sketch, select the front plane in model tree and then select the reference and select the bottom plain and select the center plain for getting construction lines.
- Then select line center line and draw it in center vertically for revolve axis.
- Then draw the sketch in the diagram, by using line and arc, for closing the activated command hold roller of mouse, for revolving the 3D model.

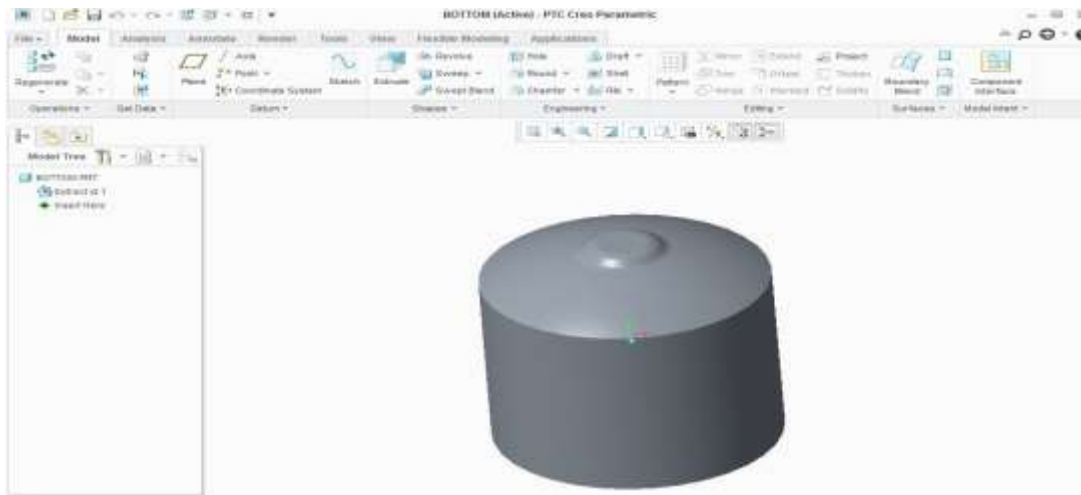
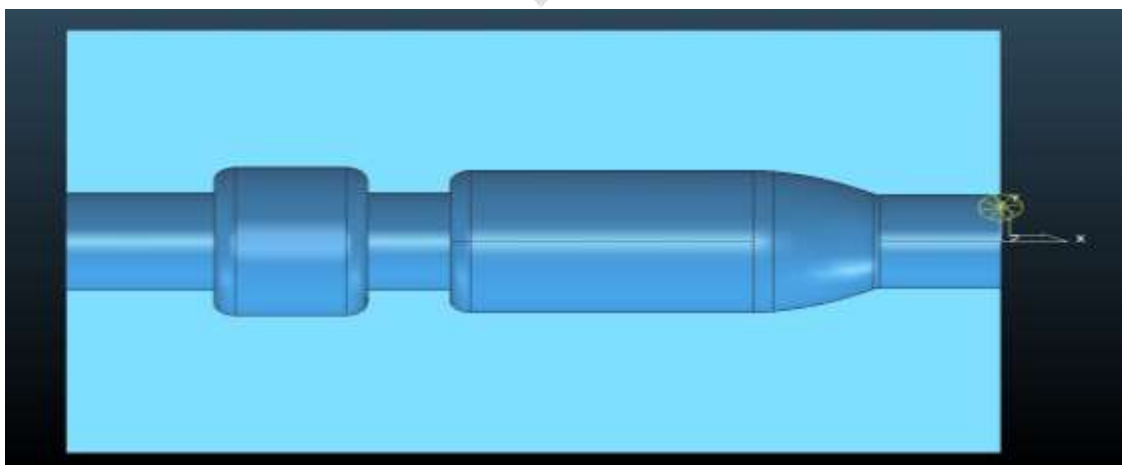


Fig.6.2 Bottom of the bottle dies

- Select the left click and move the mouse then 3D model will revolve, just change the dimensions according to the sketch by double clicking the dimensions and enter values and select ok.
- After enter into the part design then select the revolve option select ok for getting the shape of bottle.
- Then apply the fillets where ever required and give the values of fillet and click ok.
- Measure the ml of bottle by going to the analysis in CREO ribbon and select the mass properties, if ml is matched.
- See the above is the figure shown after completion of bottle design based on the dimensions.
- Then go for preparation of mould otherwise change the dimensions without changing the shape.
- Go for mould creation in CREO by going to new and select the manufacturing in that tick on Mould creation and then enter into the mould design.
- Select the reference select the model select import then select open.
- Select the create mould creation and give name and click ok.
- Select any plane and draw the rectangle for drawing the mould and extrude and draw circle from bottom and extrude and split the mould.

• **Fig.6.3 Complete sectional design**



- Below is the shape of side 1 and side 2 it is like a core and cavity of the bottle based on the design by using mould design according to the requirement.

- Above is the shape of bottom after splitting the core, cavity, save the design, and close the software.

7. Preparing the Analysis for materials

In this project, considered the three different materials Mild steel IS 2062 BR, EN-31 and Aluminum A360.

Table 7.1 Material Input Properties

Property	Aluminum A360	Mild Steel IS 2062	EN-31 100Cr6
Density	7.85 g/cm ³	2.63g/cm ³	7.81 g/cm ³
Shear modulus	27GPa	79.3GPa	80GPa
Poisson Ratio	0.33	0.26	0.3
Specific heat	0.9 J/gm K	0.434 J/gm K	
Thermal conductivity	205 w/mk	113 w/mk	46w/m k

7.1 Static Structural Analysis

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

Material properties can be linear or nonlinear, isotropic or orthotropic, and constant or temperature-dependent. Must define stiffness in some form (for example, Young's modulus, hyperplastic coefficients, and so on). For inertial loads must define the data required for mass calculations, such as density. Select the aluminum/MS material from the engineering data and click ok.

Import the geometry> close the drawing then automatically geometry will get green tick > double click on setup, > automatically mechanical will open, > right click on material and select the material as Aluminum > right click on mesh then update mesh > right click on static structural > give input as > and apply fixed face > apply force on other face > right click on solution >and apply total deformation >equivalent elastic strain >equivalent von-misses stress > select solve > after some time will get the solution.

Fig.7.1 Al Total deformation

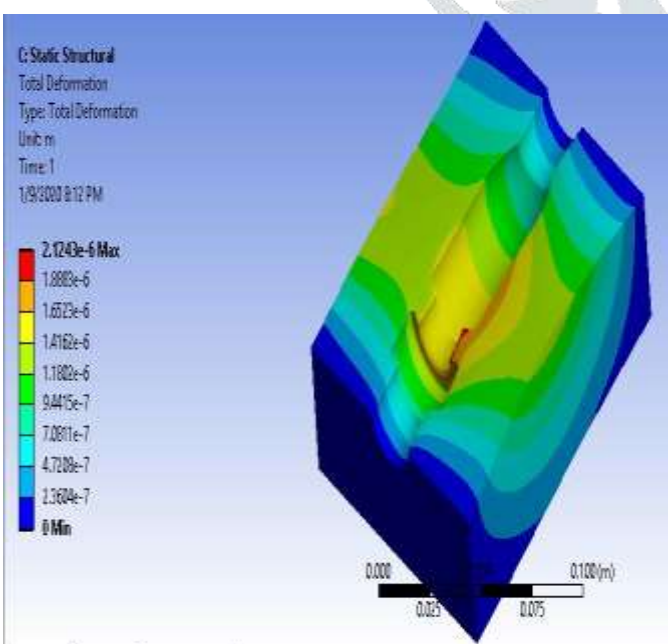


Fig.7.2 Al Equivalent strain

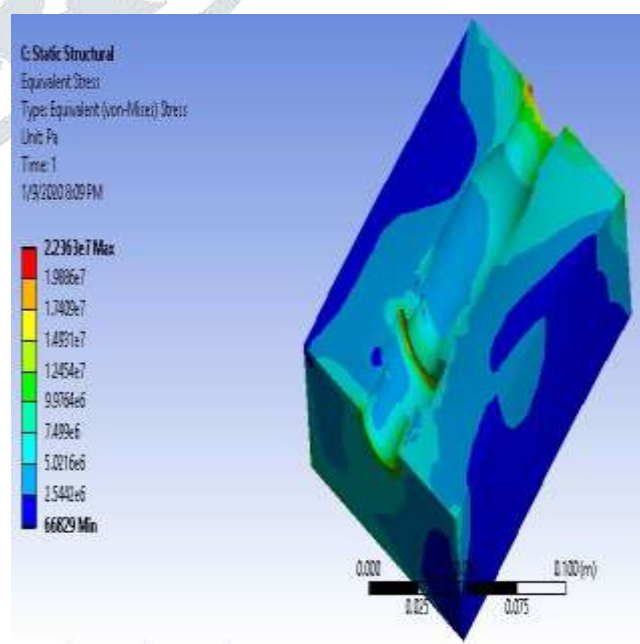


Fig.7.3 Al Equivalent Stress

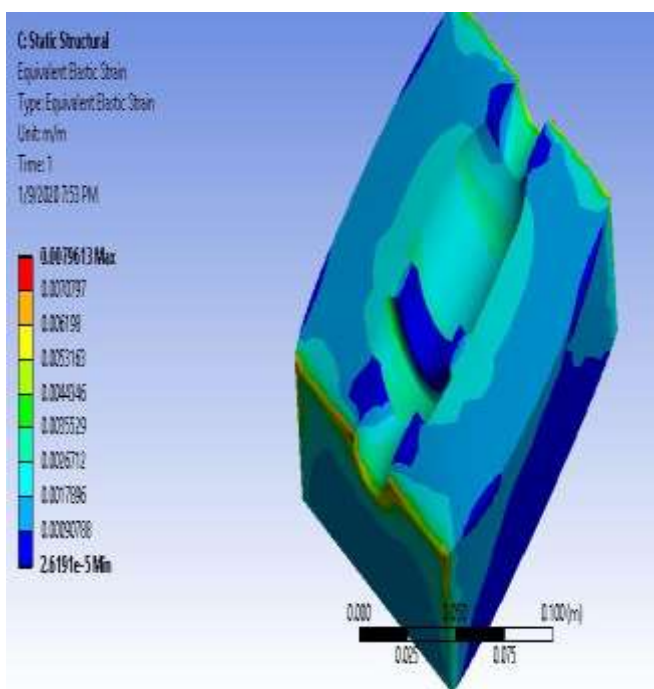
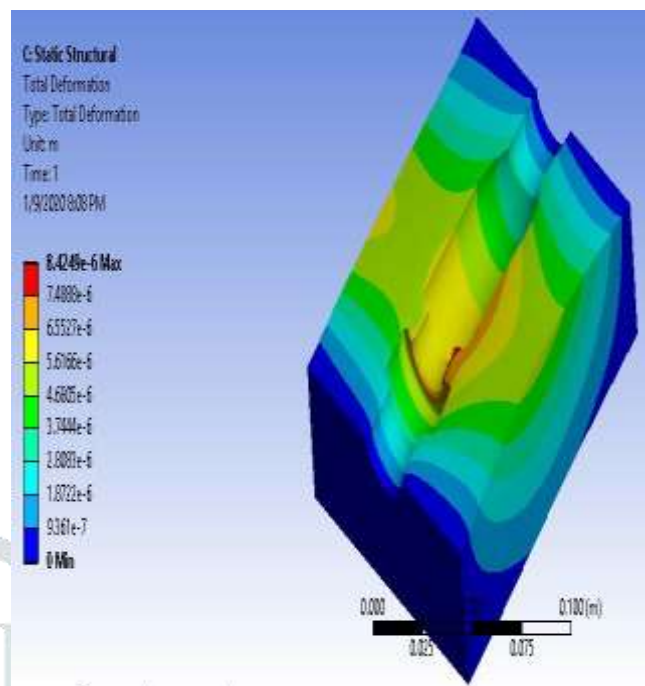


Fig.7.4 MS Total deformation



Doing analysis for another material just import the geometry> close the drawing then automatically geometry will get green tick > double click on setup, > automatically mechanical will open, > right click on material and select the material as Mild steel > right click on mesh then update mesh > right click on static structural > give input as > and apply fixed face > apply force on other face > right click on solution > and apply total deformation > equivalent elastic strain > equivalent von-misses stress > select solve > after some time will get the solution.

Fig.7.5 MS Equivalent strain

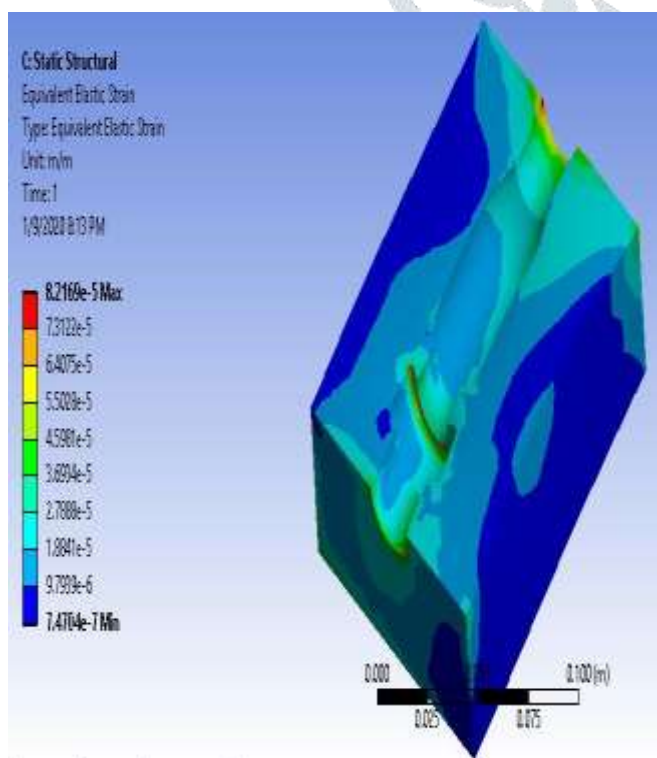


Fig.7.6 MS Equivalent Stress

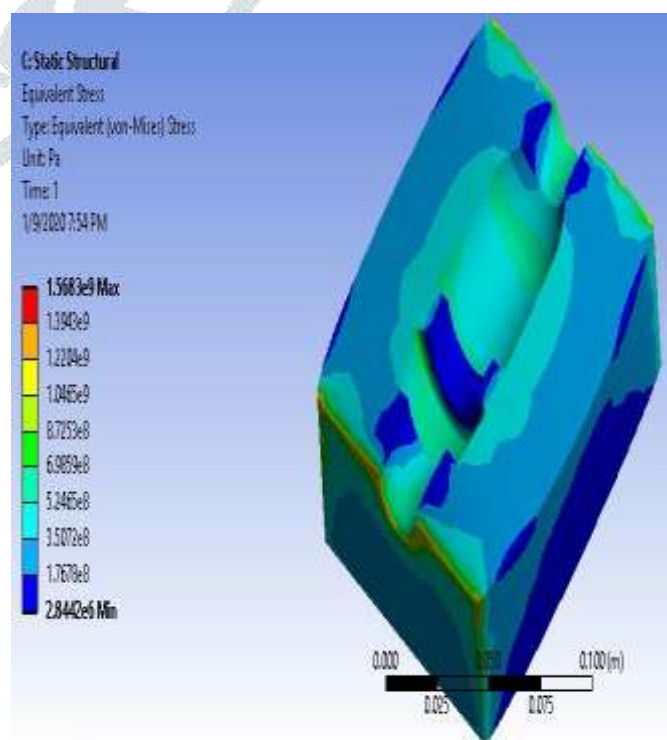


Fig.7.7 EN-31 Total deformation

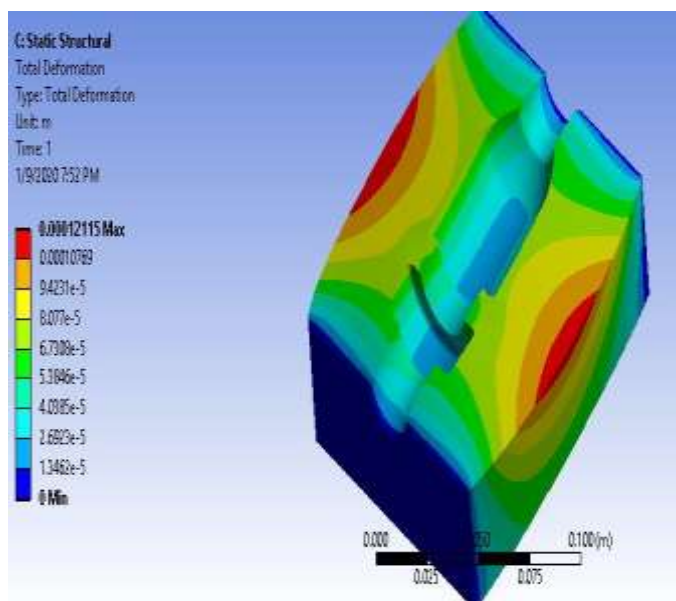
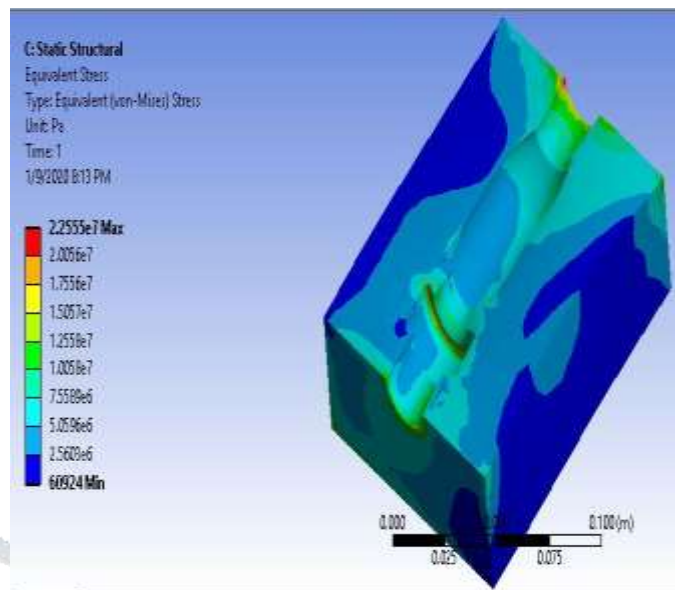
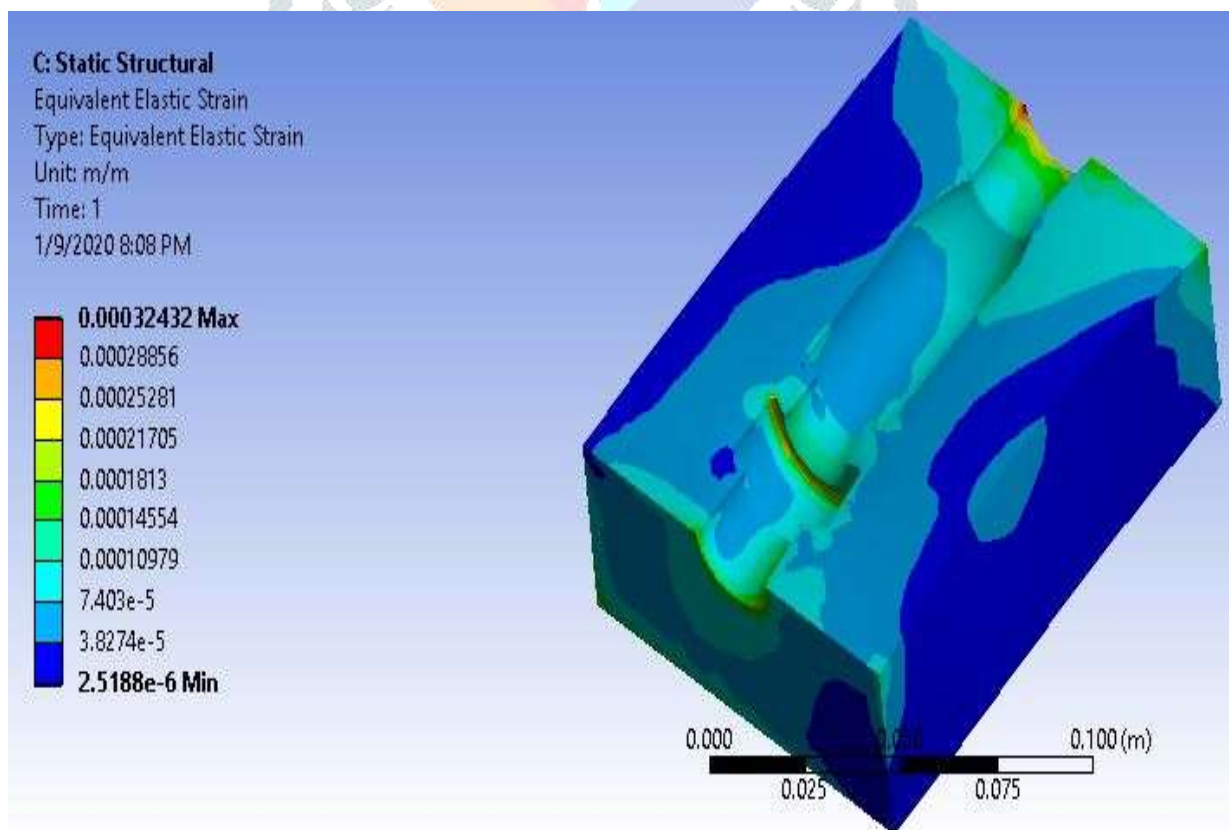


Fig.7.8 EN-31 Equivalent strain



Doing analysis for another material just import the geometry> close the drawing then automatically geometry will get green tick > double click on setup, > automatically mechanical will open, > right click on material and select the material as EN-31 > right click on mesh then update mesh > right click on static structural > give input as > and apply fixed face > apply force on other face > right click on solution >and apply total deformation >equivalent elastic strain >equivalent von-misses stress > select solve > after some time will get the solution.

Fig.7.9 EN-31 Equivalent stress



8. RESULTS & GRAPHS

Table 8.1 Comparison of analytical results of Al and MS and EN-31

Type	Properties	Al A360		EN-31		MS IS2062 BR	
Static structural		Min	Max	Min	Max	Min	Max
	Total deformation	0	0.00073695	0	2.1243	0	0.002509
	Equivalent elastic strain	6.27E-03	0.0019697	7.4704	8.2169	2.13E-06	0.000671
	Equivalent stress	73788	1.41E+08	6092	2.2555E+07	73788	1.41E+08

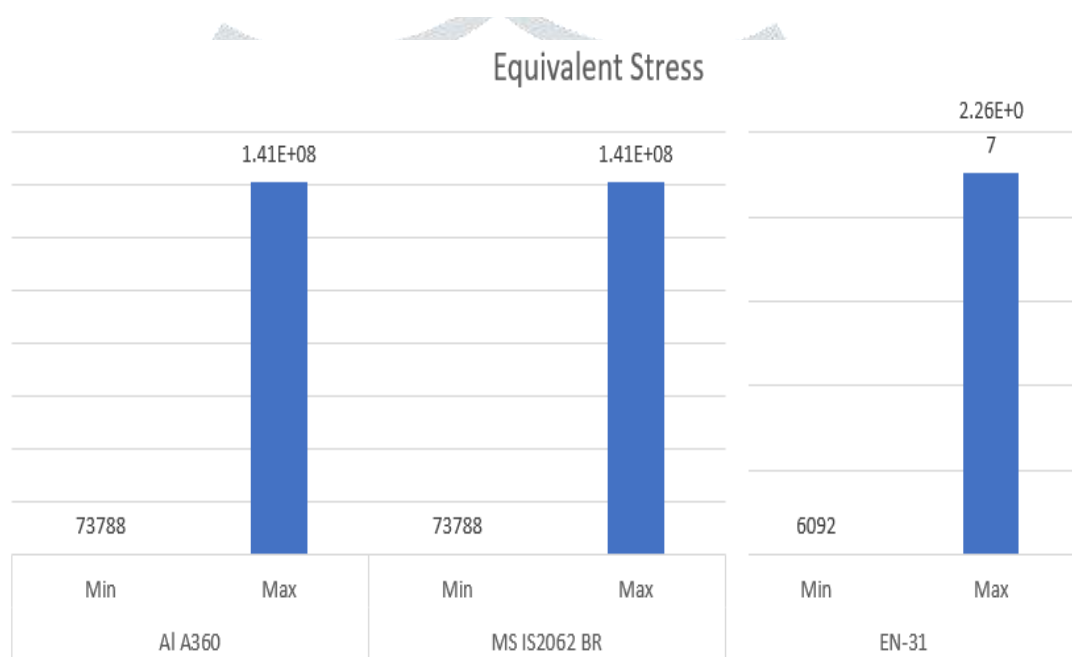
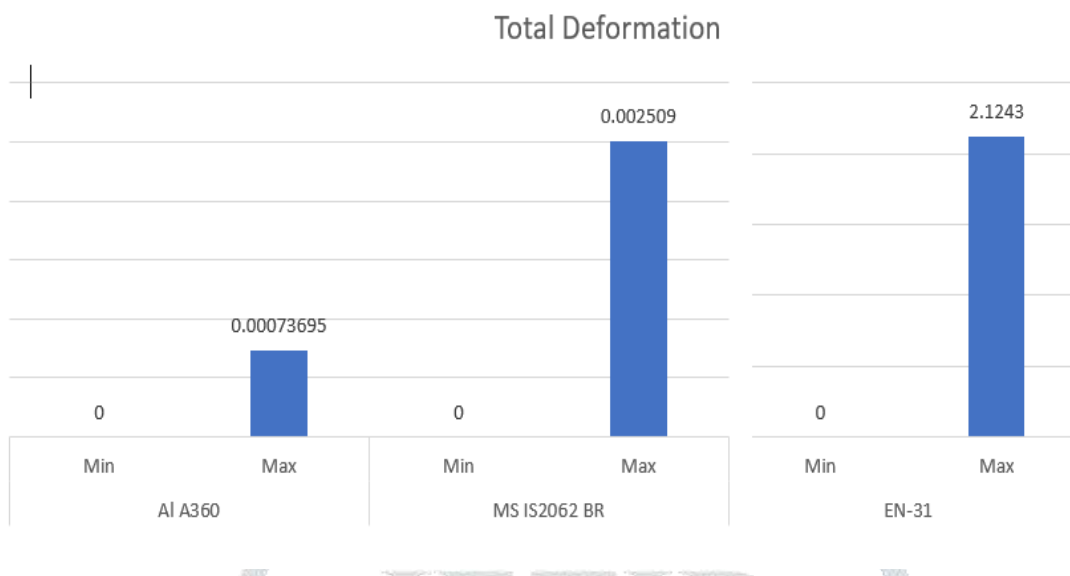
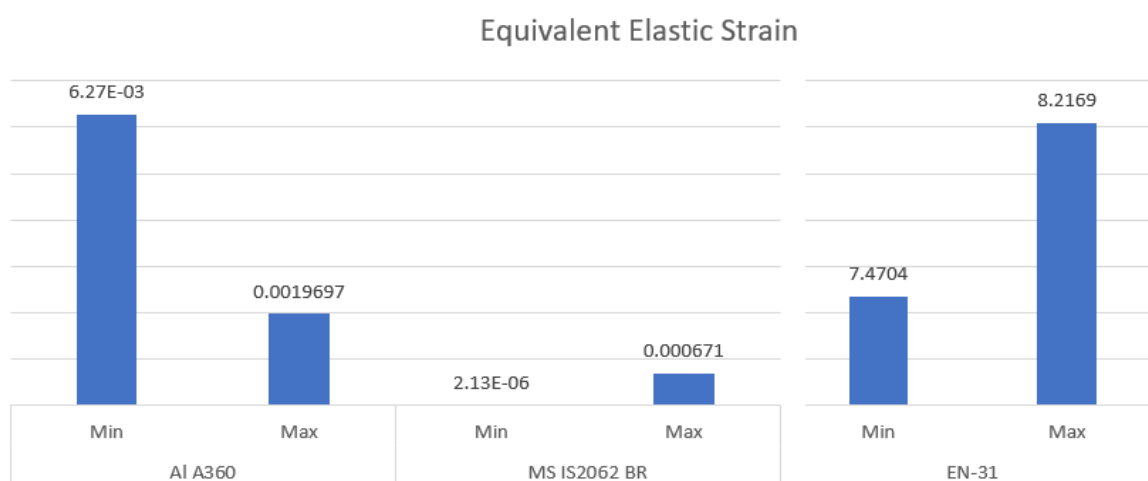


Fig.8.2 Total Deformation on Three Materials

Fig 8.3 Equivalent Elastic Strain on Three Materials**Fig 8.4 Equivalent Stress on Three Materials**

9. CONCLUSION:

Blow moulding die is designed by using CREO software and analyzed the three different materials one is aluminum, and another one is mild steel and next one is EN-31. By using ANSYS software the analysis was performed on the three different materials from the results and graphs the yielding point of EN-31 is high compared to other materials and it refers to high ductility by seeing their equivalent strain values. So that we can say that EN-31 is the best material.

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