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MODELING AND STRUCTURAL ANALYSIS OF BUCKET ELEVATOR BY USING ANSYS SOFTWARE

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Abstract: *Bucket Elevators are powered equipment for conveying bulk materials in a vertical or steep inclined path, consisting of an endless belt, or chain to which metallic buckets are fixed. With the flexible belt/chain, the buckets move unidirectional within a casing and collect bulk materials at bottom end of the equipment and deliver it at the top end. This paper deals with the design and analysis of different parts of elevator for conveying different types of materials. The modeling of bucket elevator is done and analyzed where stresses and deflections are obtained. This study shows that the negative influences of support of the shaft reflected through the increase in the stress concentration and occurrence of the initial crack are the main causes of the shaft fracture which is occurred at the keyway of the shaft and zone of contact between shaft and gearbox. The radial motion of the rotor is being translated to the output shaft. Rotational forces are to carry out based on the calculated loads at all transformations. Gravity analysis is carried out for checking the acceleration inside the components. For the determination of structural forces on the elements, models are to be made in CAD software by Catia software and analysis is done by Ansys software. The quality mesh is prepared in for converged solution and the solver set as analysis package with high optimizing results.*

I- INTRODUCTION

A bucket elevator, also called a grain leg, is a mechanism for hauling flowable bulk materials (most often grain or fertilizer) vertically.

It consists of:

1. Buckets to contain the material;
2. A belt to carry the buckets and transmit the pull;
3. Means to drive the belt;
4. Accessories for loading the buckets or picking up the material, for receiving the discharged material, for maintaining the belt tension and for enclosing and protecting the elevator.
5. A bucket elevator can elevate a variety of bulk materials from light to heavy and from fine to large lumps.
6. A centrifugal discharge elevator may be vertical or inclined. Vertical elevators depend entirely on the action of centrifugal force to get the material into the discharge chute and must be run at speeds relatively high. Inclined elevators with buckets spaced apart or set close together may have the discharge chute set partly under the head pulley. Since they don't depend entirely on the centrifugal force to put the material into the chute, the speed may be relatively lower.
7. Nearly all centrifugal discharge elevators have spaced buckets with rounded bottoms. They pick up their load from a boot, a pit, or a pile of material at the foot pulley.

8. The buckets can be also triangular in cross section and set close to on the belt with little or no clearance between them. This is a continuous bucket elevator. Its main use is to carry difficult materials at slow speed.
9. Early bucket elevators used a flat chain with small, steel buckets attached every few inches. While some elevators still are manufactured with a chain and steel buckets, most current bucket elevator construction uses a rubber belt with plastic buckets. Pulleys several feet in diameter are used at the top and bottom. The top pulley is driven by an electric motor.
10. The bucket elevator is the enabling technology that permitted the construction of grain elevators. A diverter at the top of the elevator allows the grain to be sent to the chosen bin.
11. A similar device with flat steps is occasionally used as an elevator for humans, e.g., for employees in parking garages. (This sort of elevator is generally considered too dangerous to allow use by the public.)

II - BUCKET ELEVATOR DESIGN

Bucket elevators are popular in a wide range of materials and industries. Regardless of their commonplace, there isn't a one-size-fits-all configuration for this equipment. In order to manage the specific material challenges it will face, as well as complement an overall processing system, it is important that each bucket elevator design is tailored to its specific application. The following questions walk through the basic design information that is utilized to design quality bucket elevators.

"What is the material?" is one of the most essential questions asked when discussing bucket elevator design. While many materials can be conveyed using a bucket elevator, there are limitations. Once a material is defined, the next step is to pinpoint the material's characteristics. Material characteristics play a major role in the design of a bucket elevator. While the versatility of bucket elevators makes this piece of equipment capable of handling a number of different characteristics (e.g., light, heavy, fragile, or abrasive), it is important that only free flowing materials are used. A material's density, size, and moisture level are also relevant when designing a bucket elevator to handle the job effectively. Examples of materials conveyed via bucket elevator include aggregates, fertilizers, potash, and pulp.

Customizing bucket elevators across a wide range of industries, and can often tell a customer instantly if their material is suitable for use in such equipment. In addition, questionable material can be tested in the international testing and tolling facility. A pilot plant can be set up on a single bucket elevator or multiple pieces of equipment in order to help customers make informed decisions and ensure process optimization.

Bucket elevators are not recommended for moving wet, sticky, or sludge-like materials. These material characteristics create build-up and discharge issues.

"What is the capacity rate?" is another crucial component to bucket elevator design. The capacity rate defines the quantity of material that the equipment will convey. A number of linked factors determine if the maximum capacity utilization of a bucket elevator can be achieved. However, selecting and designing the right configuration helps to attain the best possible capacity rate output.

Dimensional information is essential to any bucket elevator design. The primary dimension that must be defined is the desired height to lift the material. This information, combined with the intended material and capacity rate, contribute to how the overall bucket elevator equipment is sized. The needs and parameters of the facility are also important factors to the overall sizing of the equipment.

After collecting the basic design information, a bucket elevator configuration is selected for use as the basis of the equipment design. It utilizes information collected from the questions above to determine the best-suited bucket elevator for a customer. The design is then skillfully engineered and manufactured to manage each material's unique challenges while complementing a customer's existing processing facility. Additional customizations may also be incorporated in order to create the best solution for a customer's specific application.

If you are looking for a machine that can move bulk materials vertically, it is a pretty good chance you need a bucket conveyor. These machines will grant you a more efficient process flow, but you have to understand the design functions. Critical information to know is how your material will be affected with this machinery, and the three choices you have in choosing the correct bucket elevator.

Bucket elevators move bulk material vertically much like the conveyor belt. Buckets are attached to a rotating belt and fill with the material at the bottom of the elevator then move it to a designated point. When the bucket reaches this point, it discharges the contents, returns to the start point, and begins the process again. Buckets prevent spillage with their upright position design. There are three types of bucket elevators to choose from.

III - OPERATING PRINCIPLE

Material handling equipment is a connecting link of any industrial production. Enterprise's production capacity depends directly on conveyor transport design. The Samara Strommashina plant designs and manufactures material handling equipment of various types, in particular, belt bucket conveyors, one of the most popular industrial elevator types.

In bucket conveyors bulk materials are transported in buckets fixed on a traction unit – travelling rubber-treated belt or chains.

Bucket conveyors are divided into conveyors handling the material in vertical or close to vertical inclined direction, and conveyors handling the material on space or ring path.

The use of such elevators as an inter-floor handling system allows implementing compact handling circuits occupying small areas.

Elevators are used in construction, glass-ceramic, metallurgical, chemical, mining and other industries.

Only bucket elevators used at concrete batch plant to handle mainly powdered materials (cement, lime, gypsum) and in some cases coarse and fine fillers are applied in construction industry. Their capacity is 400 m3/h, lifting height is 40 m.

Bucket elevators are classified based on the following attributes:

a) in terms of traction unit – into belt and chain types;

 ISSN: 2320-1363

b) in terms of bucket speed — into high-speed elevators with centrifugal discharge and low-speed elevators with gravity discharge;

c) in terms of bucket arrangement — into elevators with diverged buckets and elevators with converged (lamellar) buckets.

In bucket elevators with a belt traction unit the belt envelopes over drive and tension drums, and in models with a chain traction unit the belt envelopes sprockets. The chain traction unit is applicable at any applied loads and depending on them it is designed with one or two parallel closed flights.

Bucket speed of low-speed elevators is 0.3—1 m/sec, bucket speed of high-speed conveyors is 1.2—2 m/sec.

High-speed elevators are mainly used for handling powdered and fine materials, low-speed conveyors are used for coarse materials.
Bucket elevator consists of a drive and tension drums (sprockets), traction unit (chain or belt) and buckets. The upper part with driving gear is called "head", the lower part with tension take-up is called "boot".

Some part of the material being handled and poured into the charging boot is fed into buckets directly, and the other part of the material is fed onto the rounded boot bottom from where it is scooped by the buckets.

When passing through upper sprockets material is poured from the buckets and is conveyed through a discharging tray into bins or onto handling devices.

The main assemblies of elevators are buckets, traction units, drive head and boot.

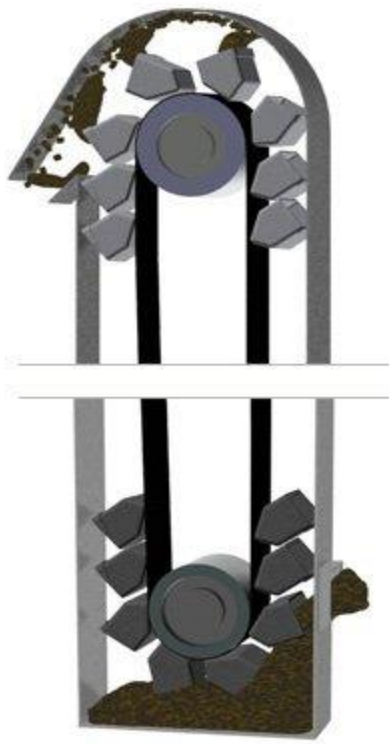
Buckets are selected depending on specified elevator capacity and handled material. The bucket dimensions shall be selected so that material lumps were fed into it unimpededly during charging and were discharged from it during discharging. The bucket shape depends on the bucket discharge type (centrifugal or gravity) and on the material mobility degree. The buckets are made welded or stamped from steel sheets; their front edges are reinforced with an apron made of strip steel, and sometimes they are guided with a hard alloy.

The standard establishes three bucket types for general-purpose stationary vertical bucket elevators: deep, shallow with cylindrical bottom and acute-angled with side guides. Deep buckets are used for dry free-flowing materials (sand, cement, fine coal). Shallow buckets with sharp cut-off of the upper edge are used for handling of moist and caking materials. Capacity of buckets with cylindrical bottom varies within 0.65–15.0 l at 135– 450 mm bucket width; distance between buckets (bucket spacing) is 300, 400, 500 and 600 mm. Acute-angled buckets with converged bucket arrangement are used for handling heavy lump cargoes. The width of such buckets is 160 to 900 mm, capacity is 1.5 to 130 l.

The Samara Strommashina plant offers services on design of belt bucket elevators and other material handling equipment. We are also ready to provide services on design of turnkey production lines – our plant manufactures equipment for cement, road-building, construction, petrochemical and other industries. Taking into consideration high quality of our equipment and reasonable price, it may safely be said that purchasing the Strommashina brand production equipment (for example, buying a belt bucket elevator) means making a step towards successful production!

Bucket Elevator Design: Centrifugal Vs. Continuous

When selecting a bucket elevator, the goal is to allow for the most efficient process flow possible. In order to do this, it is important to understand the design functions of each piece of equipment and how they affect the material that is being handled.



Centrifugal style elevators are available in either belt or chain drive. The elevator shown in figure 1 is setup with AC style buckets mounted on a belt drive system. Due to belt stretch and chain strength, both systems have some restrictions when they reach immense heights. FEECO can assist in fine-tuning the technical details to ensure efficiency for the specific requirements.

the engineering, designing, and manufacturing of bucket elevators. Where most elevator manufacturers rely on modular designs, we understand that each material has specific requirements. In many cases, a custom solution is the key to an innovative and efficient bucket elevator. Collaborating with our customers, as well as our in house experts (R&D, engineering, and design), we can create the best possible result to suit the customer's unique handling system needs.

IV - HORSEPOWER CALCULATION

There are many variables to consider when designing a Bucket Elevator. These include bucket size, bucket spacing, speed, and various components. This information can act as a guide for determining the Horse Power (HP) requirements of a Bucket Elevator.

When designing a Bucket Elevator there are more variables to be consider that can be listed here. It should be noted that a small mistake in calculating the required HP of a small, low capacity Bucket Elevator may not result in a unit failure, but a small mistake on a large, high capacity bucket elevator may result in a catastrophic failure.

This is why it is important to always work with an experienced Bucket Elevator Manufacturer who can help in the design and implementation of a successful project.

A. Determining Horse Power

To be able to accurately determine the power requirements of a Bucket Elevator, it must first be understood the internal forces acting on the unit. Although there are many components in the Bucket Elevator, only the upward movement of the conveyed product needs to be considered.

This is because the weight of the Belt/Chain and Cups are identically balanced on both sides of the head shaft. Only the internal friction caused by the movement of these components needs to be considered when calculating the HP requirements.

There are many variations of Horse Power (HP) calculations found in historical and individual

ISSN: 2320-1363

manufacturer's literature. The formulas below are used to determine the power requirements of a Bucket Elevator throughout the industry.

V - DESIGN METHODLOGY OF BUCKET ELEVATOR

CATIA (laptop Aided 3-dimensional Interactive utility) is a multi-platform CAD/CAM/CAE business software suite evolved through the French company Dassault systems. Written within the C++ programming language, CATIA is the cornerstone of the Dassault structures product lifecycle management software program suite. CATIA competes inside the excessive-give up CAD/CAM/CAE market with Cero factors/seasoned and NX (Unigraphics).

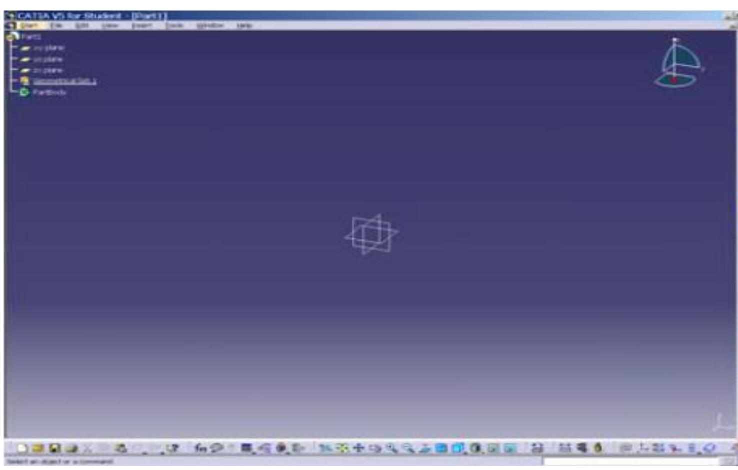


Fig: 5.1: page of CatiaV5

Modeling of Bucket Elevator in Catia V5

This Elevator is designed the use of CATIA V5 software program. This software program utilized in vehicle, aerospace, client goods, heavy engineering and so forth. it's far very powerful software program for designing complex three-D models, programs of CATIA version five like element layout, assembly design.

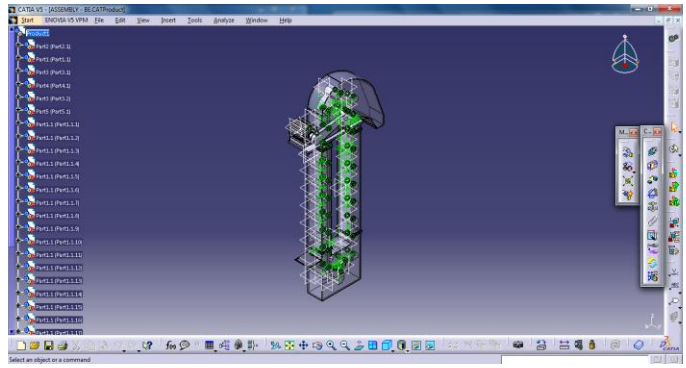


Fig: 5.2: version layout in CATIA-V5

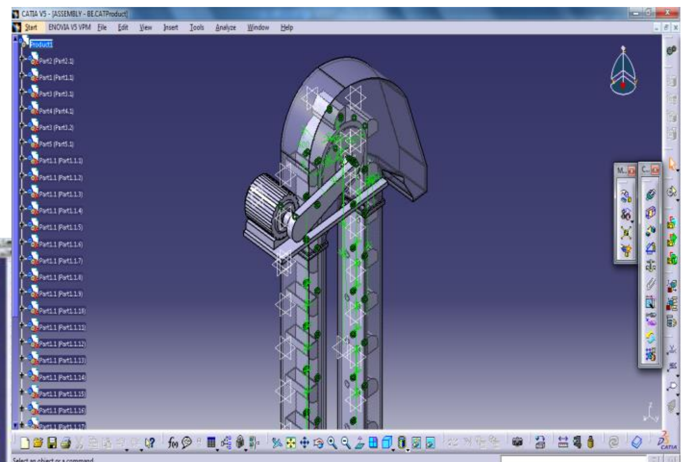


Fig: 5.3: version arrangement mechanism in CATIA-V5

VI- ANALYSIS OF BUCKET ELEVATOR

6.1 manners for FE evaluation the usage of ANSYS:

The assessment is executed the use of ANSYS. For compete meeting is not required, motor and attached gadget is to executed via the usage of using moments at the rotation vicinity alongside which axis we want to say. Solving region is bottom legs of meeting.

6.2 Preprocessor

On this degree the subsequent steps had been carried out:

• Import file in ANSYS window

File Menu > Import> STEP > click on exact sufficient for the popped up communiqué container > click on Browse" and pick out the

IJMTARC – VOLUME – IX – ISSUE – 34, APR - JUN, 2021

ISSN: 2320-1363

record stored from CATIAV5R20 > click on good enough to import the report

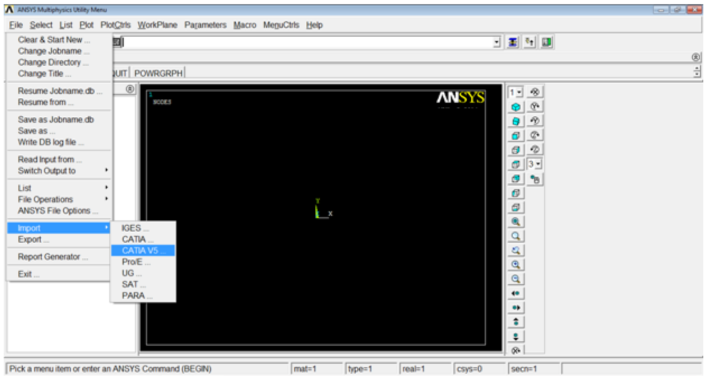


Fig.6.1: Import panel in Ansys.

6.2.2 Finite detail technique:

Minimization of useful in relation to every unknown ends in the system of equations from which the unknown coefficients may be decided. One from the primary regulations in the Ritz approach is that abilties used need to fulfill to the boundary conditions of the hassle.

VII - DISCUSSION ON ANALYSIS END RESULT

7.1 results of Displacement analysis:

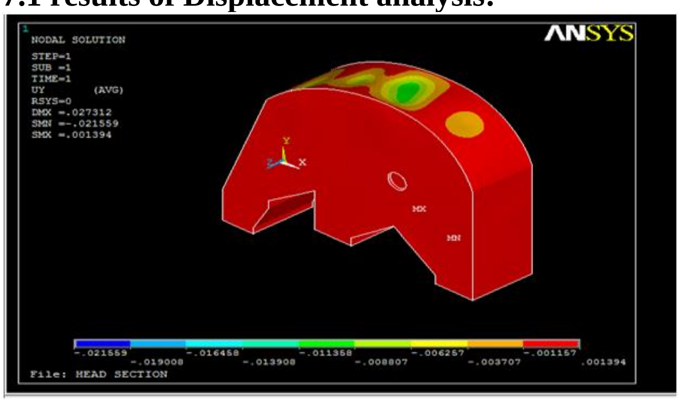


Fig.7.1 Head Section Displacement

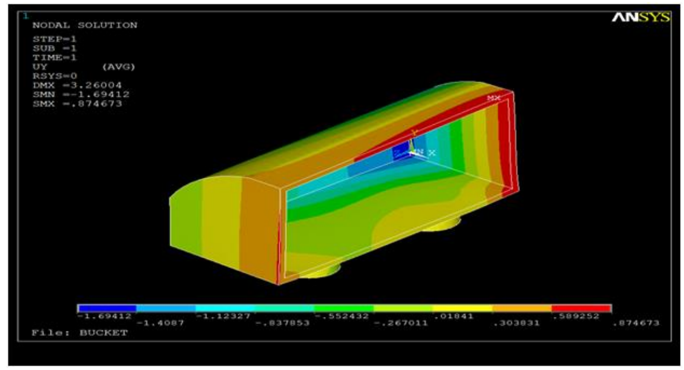


Fig.7.2: Bucket Displacement

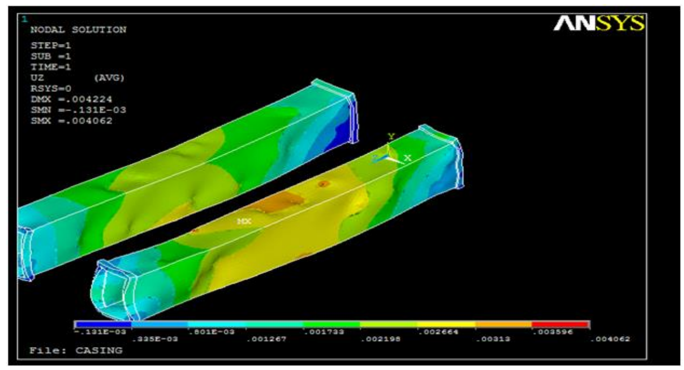


Fig.7.3: Casing Displacement

7.2 results of stress analysis:

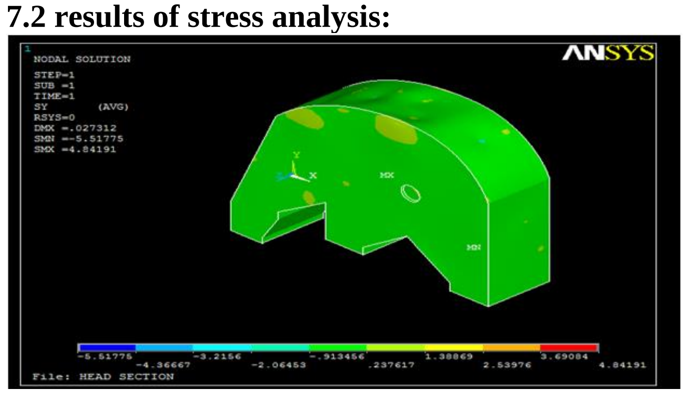


Fig.7.4: Head Section Stress

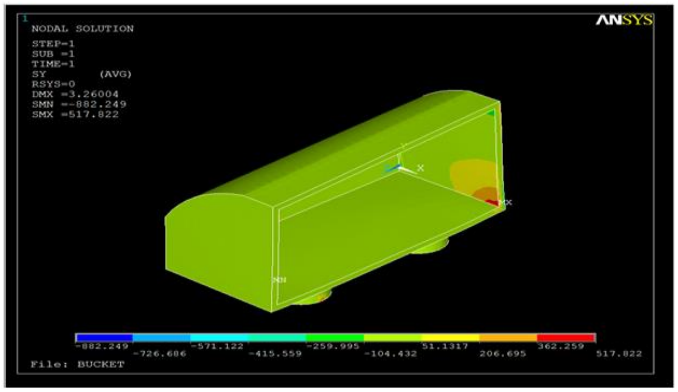


Fig.7.5: Bucket Stress

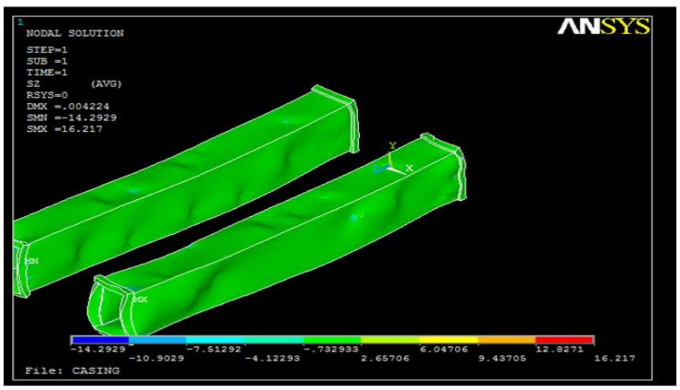


Fig.7.6: Casing Stress

7.3 outcomes of Strain analysis:

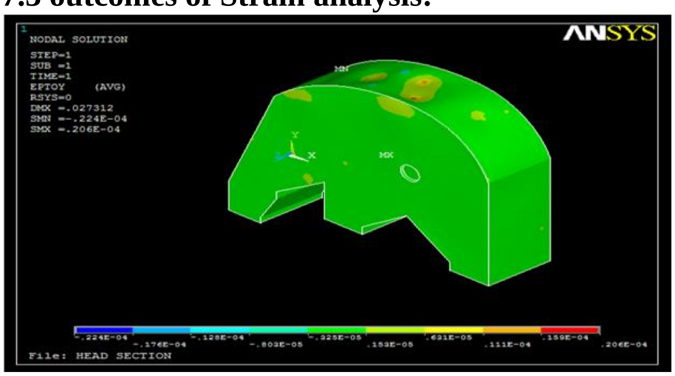


Fig.7.7: Head Section Strain

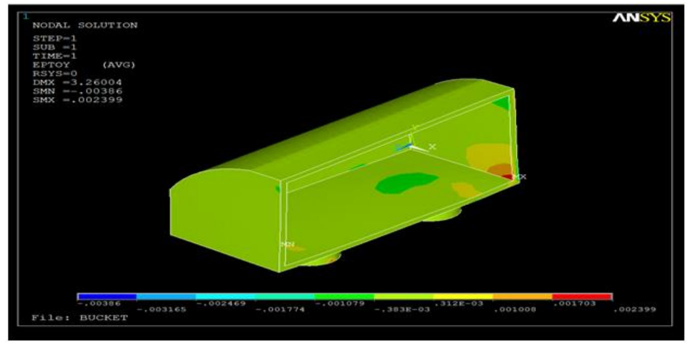


Fig.7.8: Bucket Strain

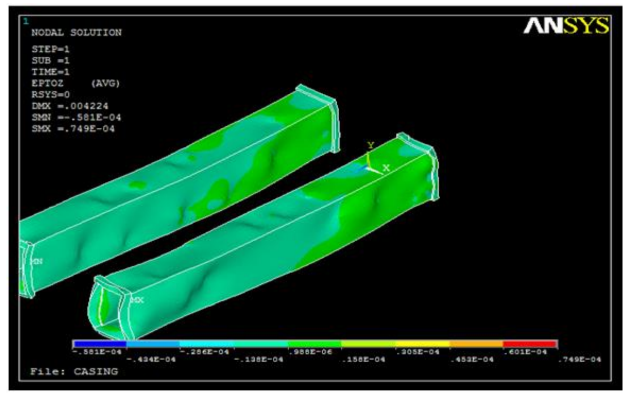


Fig.7.9: Casing Strain

VIII - CONCLUSION

The project "Bucket Elevator" has been correctly designed and examined. it has been evolved via integrating features of all of the hardware additives used. Secondly, the usage of quite superior carried out. The fashion toward industries hand held will increase all of these challenges. Maintaining all the above parameters in view we've got designed a low value integrated machine for tracking the specific varieties of parameters between systems.

As shown above figures, the displacement of the layout is meshed and solved the usage of Ansys and displacement is very less. This is showing us that actually every issue in meeting is having minor displacement. Stress is at the fixing place (minimum pressure which is acceptable), Stress cost very less. The cost which may be very less as compared to yield fee; that is under the yield factor. The most pressure is coming, this answer

IJMTARC – VOLUME – IX – ISSUE – 34, APR - JUN, 2021 ISSN: 2320-1363

solving with the assist of Ansys software in order that the most strain is much less .so we are able to finish our layout parameters are about correct.

The improvement process can be incremental however the overall concept requires a paradigm shift in the manner we consider mechanization for self reliant machines that is based extra on desires and novel methods of assembly them rather than modifying present strategies. Subsequently we finish that business Automation machine is an emerging discipline and there's a big scope for research and development.

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