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Design and Optimization of Muffler Guard Using Modal Analysis

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ABSTRACT

Mufflers are important part of engine system and commonly used in exhaust system to minimize sound transmissions caused by exhaust gases. Design of mufflers is a complex function that affects noise characteristics, emission and fuel efficiency of engine. Therefore muffler design becomes more and more important for noise reduction.

The noise control is depends upon types of louvered holes appeared on muffler. This project mainly focused on reducing the noise from muffler by developing new type of louvered holes with proper material.

This project deals with design of Louvered muffler guards using Unigraphics software and modal analysis of mufflers done to find natural frequencies and deformations induced in muffler these analyses are done in Ansys simulation tool with different material properties are studied in this project.

INTRODUCTION

1.1 MUFFLER GUARD

Mufflers are installed within the exhaust system of most internal combustion engines, although the muffler is not designed to serve any primary exhaust function. The suppressor is built as an acoustic soundproofing gadget intended to lessen the commotion of the sound weight made by the motor by method for acoustic calming. Most of the sound weight delivered by the motor is radiated out of the vehicle utilizing a similar channeling utilized by the quiet fumes gases consumed by a progression of entries and chambers fixed with meandering fiberglass protection or potentially resounding chambers agreeably tuned to cause dangerous obstruction wherein inverse sound waves offset each other. An unavoidable symptom of suppressor utilize is an expansion of back weight which diminishes motor productivity. This is on the grounds that the motor fumes must have a similar complex leave pathway worked inside the suppressor as the sound weight that the suppressor is intended to relieve. Some vehicle proprietors evacuate or introduce a reseller's exchange suppressor when motor tuning with a specific end goal to build control yield or diminish fuel utilization on account of financial or ecological concerns, recreational interests, for example, motorsport and hypermiling and additionally for individual stylish acoustical inclinations.

1.2Trade-off between power increase and noise reduction:

At the point when the stream of fumes gases from the motor to the environment is impeded to any degree, back weight emerges and the motor's productivity, and thusly control, is decreased. Execution arranged suppressors and fumes frameworks consequently endeavor to limit back weight by utilizing various innovations and techniques to lessen the sound. For the larger part of such frameworks, be that as it may, the general govern of "more power, more commotion applies. A few such fumes frameworks that use different outlines and development strategies

Two different modeling techniques are considered:

(1) First, the procedure described in previous works, 3D ducts/3D monolith, in which the finite element method leads to the calculation of the three dimensional acoustic field inside the complete catalytic converter.
(2) On the other hand, the proposed technique in thesis, 3D ducts/1D monolith, in which the
(3) Monolith is replaced by a plane wave transfer matrix, that is, only one-dimensional acoustic behavior is allowed within the capillary ducts. The results provided by both approaches are compared with experimental measurements, showing that the latter technique exhibits a better arrangement

1.3 THE AUTOMOTIVE EXHAUST SYSTEM:

Keeping your fumes framework in great working condition is imperative for fuel mileage, the earth and your security. We will talk about how the fumes framework functions, how it typically fizzles, and the most ideal approach to repair it. Your auto's fumes framework diverts the gases made when the fuel and air are scorched in the ignition chamber. These gases are hurtful to people and our condition. Visit checks of your fumes framework are an absolute necessity to accommodate you and your family's security. Ensure there are no gaps in the fumes framework or in the traveler compartment where deplete vapor could enter. We should start by posting the parts of the fumes framework and their capacities.

Exhaust manifold:

The ventilation system joins to the barrel head and takes every chamber fumes and consolidates it into one pipe. The complex can be made of steel, aluminum, tempered steel, or all the more generally cast press.

Muffler:

The suppressor serves to calm the fumes down to adequate levels. Keep in mind that the ignition procedure is a progression of blasts that make distribute of commotion. Most suppressors utilize bewilders to bob the fumes around disseminating the vitality and calming the clamor. A few suppressors likewise utilize fiberglass pressing which retains the sound vitality as the gases course through.

Common Problems:

Well the most exceedingly awful adversary of your fumes framework is consumption or all the more ordinarily known as rust. Rust is caused by dampness responding with the iron in the steel and framing iron oxide

Your oxygen sensor could be going south on you. Over the long haul the oxygen sensor starts to destroy and turns out to be less precise. This occasionally brings about a rich fuel blend where your motor consumes more fuel than is required.

On uncommon events the exhaust system will wind up stopped up and should be supplanted. Indications incorporate loss of intensity, warm originating from the floor of your auto, gleaming red converter or a sulfur smell.

Working of Automotive Exhaust Systems:

Honestly, an individual auto's outflows are moderately low, contrasted with different wellsprings of contamination. Be that as it may, when a huge number of individuals are each sitting in an auto, pressing a roadway to limit, the total impacts are huge. As you're sitting in a congested driving conditions, looking at the smoke leaving the tailpipe before you and ascending to join the brown haze in the sky, ponder what that smoke is. It won't not look like much, but rather that smoke has made some amazing progress since it was pushed through the auto's motor only minutes previously.

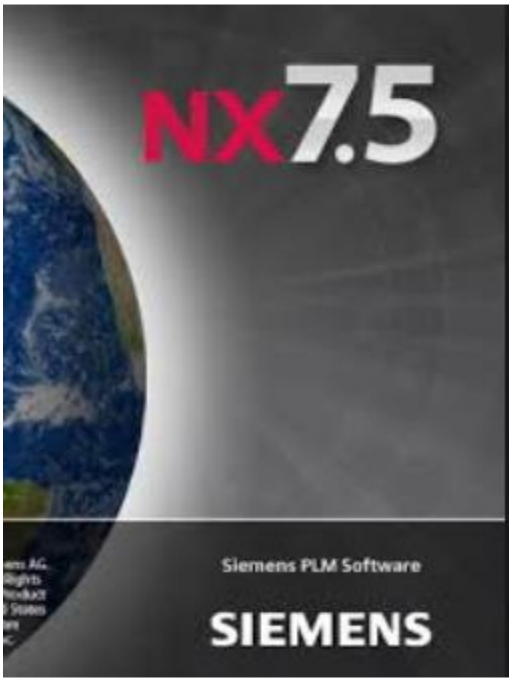
1.4 WORKING OF MUFFLERS

In the event that you've at any point heard an auto motor running without a suppressor, you realize what an enormous distinction a suppressor can make to the clamor level. Inside a suppressor, you'll discover a misleadingly straightforward arrangement of tubes with a few gaps in them. These tubes and chambers are quite finely tuned as a melodic instrument. They are intended to mirror the sound waves delivered by the motor such that they mostly offset themselves.

1.5 INTRODUCTION TO UNI-GRAPHICS

Overview of Solid Modeling

The UNIGRAPHICS NX Modeling application gives a strong demonstrating framework to empower quick calculated outline. Specialists can join their necessities and outline confinements by characterizing numerical connections between various parts of the plan.



Configuration architects can rapidly perform theoretical and point by point plans utilizing the Modeling highlight and requirement based strong modeler. They can make and alter mind boggling, reasonable, strong models intuitively, and with far less exertion than more conventional wire edge and strong based frameworks. Highlight Based strong demonstrating and altering capacities enable fashioners to change and refresh strong bodies by specifically altering the measurements of a strong component as well as by utilizing other geometric altering and development systems.

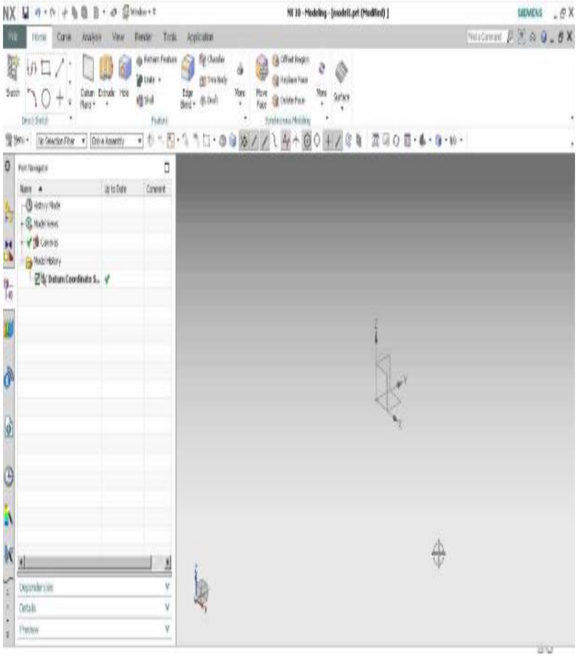


Fig: shows the interface of the nx (uni graphics)

Advantages of Solid Modeling

Strong Modeling raises the level of articulation with the goal that plans can be characterized as far as building highlights, as opposed to bring down level CAD geometry. Highlights are parametrically characterized for measurement driven altering in view of size and position.

Features

- Powerful built-in engineering-oriented form features-slots, holes, pads, bosses, pockets-capture design intent and increase productivity
- Patterns of feature instances-rectangular and circular arrays-with displacement of individual features; all features in the pattern are associated with the master feature

Blending and Chamfering

- zero radius
- Ability to chamfer any edge

- Cliff-edge blends for designs that cannot accommodate complete blend radius but still require blend

Advanced Modeling Operations

- Profiles can be swept, extruded or revolved to form solids
- Extremely powerful hollow body command turns solids into thin-walled designs in seconds; inner wall topology will differ from the outer wall, if necessary
- Fixed and variable radius blends may overlap surrounding faces and extend to a Tapering for modeling manufactured near-net shape parts
- User-defined features for common design elements (Unigraphics NX/User-Defined Features is required to define them in advance

General Operation

Start with a Sketch Utilize the Sketcher to freehand a portray, and measurement a "framework" of Curves. You would then be able to clear the draw utilizing Extruded Body or Revolved Body to make a strong or sheet body. You can later refine the outline to correctly speak to the question of enthusiasm by altering the measurements and by making connections between geometric items. Altering a measurement of the outline adjusts the geometry of the draw, as well as the body made from the portray.

- **Creating and Editing Features**

Highlight Modeling gives you a chance to make highlights, for example, openings, spaces and sections on a model. You would then be able to specifically alter the measurements of the component and find the element by measurements. For instance, a Hole is characterized by its measurement and length. You can straightforwardly alter these parameters by entering new qualities. You can make strong collections of any coveted plan that can later be characterized as a frame includes utilizing User Defined Features. This gives you a chance to make your own particular custom library of shape highlights.

- **Associativity**

Cooperatively is a term that is utilized to show geometric connections between singular parts of a model. These connections are built up as the originator utilizes different capacities for display creation. In an affiliated model, limitations and connections are caught naturally as the model is produced. For instance, in an acquainted model, a through opening is related with the appearances that the gap enters. In the event that the model is later changed so either of those faces moves, the gap refreshes consequently because of its relationship with the countenances. See Introduction to Feature Modeling for extra points of interest.

- **Positioning a Feature**

Inside Modeling, you can position an element in respect to the geometry on your model utilizing Positioning Methods, where you position measurements. The element is then connected with that geometry and will keep up those affiliations at whatever point you alter the model. You can likewise alter the situation of the element by changing the estimations of the situating measurements.

- **Reference Features**

You can make reference highlights, for example, Datum Planes, Datum Axes and Datum CSYS, which you can use as reference geometry when required, or as development gadgets for different highlights. Any component made utilizing a reference highlight is related to that reference include and holds that relationship amid alters to the model. You can utilize a datum plane as a source of perspective plane in building outlines, making highlights, and situating highlights. You can utilize a datum hub to make datum planes, to put things concentrically, or to make spiral examples.

- **Expressions**

The Expressions apparatus gives you a chance to fuse your prerequisites and plan limitations by characterizing numerical connections between various parts of the outline. For instance, you can characterize the tallness of a supervisor as three times its distance across, so when the breadth changes, the stature changes too.

- **Boolean Operations**

Displaying gives the accompanying Boolean Operations: Unite, Subtract, and Intersect. Join consolidates bodies, for instance, joining two rectangular squares to frame a T-molded strong body. Subtract expels one body from another, for instance, expelling a barrel from a square to shape a gap. Meet makes a strong body from material shared by two strong bodies. These activities can likewise be utilized with free frame highlights called sheets.

- **Undo**

You can restore a plan to a past express any number of times utilizing the Undo work. You don't need to take a lot of time ensuring every activity is completely right, in light of the fact that a slip-up can be effortlessly fixed. This flexibility to effortlessly change the model gives you a chance to stop stressing over missing the point, and liberates you to investigate more conceivable outcomes to take care of business.

- **Additional Capabilities**

Different UNIGRAPHICS NX applications can work straightforwardly on strong articles made inside Modeling with no interpretation of the strong body. For instance, you can perform drafting, designing investigation, and NC machining capacities by getting to the suitable application. Utilizing Modeling, you can plan an entire, unambiguous, three dimensional model to depict a question. You can extricate an extensive variety of physical properties from the strong bodies, including mass properties. Shading and concealed line abilities enable you to picture complex gatherings. You can distinguish obstructions consequently, wiping out the need to endeavor to do as such physically. Concealed edge perspectives can later be created and put on illustrations. Completely cooperative dimensioned illustrations can be made from strong models utilizing the proper choices of the Drafting application. In the event that the strong model is altered later, the illustration and measurements are refreshed consequently.

- **Parent/Child Relationships**

On the off chance that a component relies upon another question for its reality, it is a tyke or ward of that protest. The question, thusly, is a parent of its youngster include. For instance, if a HOLLOW (1) is made in a BLOCK (0), the square is the parent and the empty is its child.A parent can have in excess of one youngster, and a kid can have in excess of one parent. A component that is a kid can likewise be a parent of different highlights. To see the majority of the parent-youngster connections between the highlights in your work part, open the Part Navigator.

Creating A Solid Model

Displaying furnishes the plan build with instinctive and happy with demonstrating systems, for example, drawing, include based displaying, and measurement driven altering. A magnificent method to start a plan idea is with a draw. When you utilize an outline, an unpleasant thought of the part ends up spoke to and compelled, in view of the fit and capacity necessities of your plan. Along these lines, your plan aim is caught. This guarantees when the plan is passed down to the following level of building, the essential necessities are not lost when the outline is altered.

The technique you use to make and alter your model to frame the coveted protest relies upon the shape and many-sided quality of the question. You will probably utilize a few unique strategies amid a work session. The following a few figures outline one case of the plan procedure, beginning with a portray and closure with a completed model. To begin with, you can make a draw "diagram" of bends. At that point you can clear or pivot these bends to make a perplexing bit of your plan.

Introduction to Drafting

The Drafting application is intended to enable you to make and keep up an assortment of illustrations produced using models created from inside the Modeling application. Illustrations made in the Drafting application are completely affiliated to the model. Any progressions made to the model are consequently reflected in the illustration. This associativity enables you to roll out the same number of model improvements as you wish. Other than the ground-breaking associativity usefulness, Drafting contains numerous other helpful highlights including the accompanying:

- An intuitive, easy to use, graphical user interface. This allows you to create drawings quickly and easily.
- A drawing board paradigm in which you work "on a drawing." This approach is similar to the way a drafter would work on a drawing board. This method greatly increases productivity.
- Support of new assembly architecture and concurrent engineering. This allows the drafter to make drawings at the same time as the designer works on the model.
- The capability to create fully associative cross-sectional views with automatic hidden line rendering and crosshatching.
- Automatic orthographic view alignment. This allows you to quickly place views on a drawing, without having to consider their alignment.
- Automatic hidden line rendering of drawing views.
- The ability to edit most drafting objects (e.g., dimensions, symbols, etc.) from the graphics window. This allows you to create drafting objects and make changes to them immediately.
- On-screen feedback during the drafting process to reduce rework and editing.
- User controls for drawing updates, which enhance user productivity.

Finally, you can add form features, such as chamfers, holes, slots, or even user defined features to complete the object.

- **Updating Models**

A model can be refreshed either consequently or physically. Programmed refreshes are performed just on those highlights influenced by a proper change (an alter activity or the production of specific kinds of highlights). In the event that you wish, you can defer the programmed refresh for alter activities by utilizing the Delayed Update alternative. You can physically trigger a refresh of the whole model. You may, for instance, need to utilize a net invalid refresh to check whether a current model will effectively refresh in another adaptation of UNIGRAPHICS NX before you put a great deal of extra work into adjusting the model. (A net invalid refresh component powers an entire refresh of a model, without evolving it.)

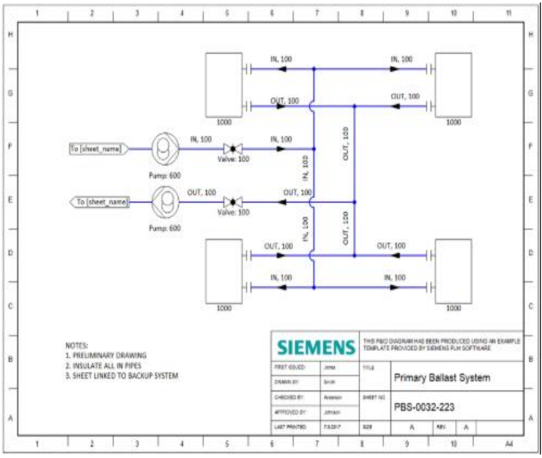


Fig: shows the drafting sheet in NX (UNI graphics)

LITERATURE SURVEY

SAIKIRAN D.MANGEELAL: Published on **MODEL AND STATIC ANALYSIS OFMUFFLER GUARD.** This is centered around the advancement and execution of successful strategies for acoustic outline and displaying of the fumes line of inside ignition motors, and particularly for two important segments, from the point of view of clamor control, for example, suppressors and exhaust systems. Along these lines, a writing audit of the one-dimensional models and their approach has been performed additionally a survey of the current writing with respect to the portrayal of punctured components, spongy materials and stone monuments has been done.

Potente, Daniel: Potente and Daniel talk about the general rule of suppressor outline and clarifies the principle points of interest of different styles of suppressors. When planning suppressor for any application there are a few useful necessities that ought to be considered, which incorporate both acoustic and non-acoustical outline issues [2]

M.Rahman, T. Sharmin, A F M E. Hassan, and M. Al Nur: Clarifies outline and development of the suppressor so as to diminish the commotion. They mostly centered around the fumes clamor lessening that is decreasing the commotion contamination. They produced and plan suppressor for stationary oil motor. The execution trademark, that is clamor diminishment ability of suppressor, has been tried and contrasted and that of the regular suppressor. They discovered outcome has been discovered attractive. [3]

RAHUL D. NAZIRKAR, S.R.MESHRAM, AMOL D. NAMDAS, SURAJ U. NAVAGIRE, SUMIT S. DEVARSHI: Concentrated on transmission misfortune (TL) and characteristic recurrence (NF) of suppressor. In this they outlined the suppressor of single extension chamber and twofold development chamber. They modaled the strong modular of exhaustmuffler by utilizing CATIAV-5 and the modular investigation is done by ANSYS to consider the vibration and normal recurrence of suppressor. In order to separate between the working recurrence from common recurrence and abstain from resounding. Furthermore, they found that twofold extension chamber gives better outcomes when contrasted with single development chamber.[4]

A.K.M. Mohumuddin, MohdRashidinIderes and ShukariMohadHashim: Presents trial investigation of clamor and back weight for silencer outline attributes. The principle target of this investigation was to discover the connection between the back weight and the clamor level. He infers that the connection between the clamor and the back weight is contrarily corresponding. [5]

Mr. Jigar H. Chaudhri, Prof. Bharat S. Patel, Prof. Satis A. Shah: Clarifies distinctive sorts of suppressors and outline of fumes framework having a place motor has been contemplated. The question of this examination is choosing suppressor outline which one decreases a lot of clamor level and back weight of motor. In planning, there is diverse parameter which needs to take in to the thought. These parameters influence the suppressor proficiency. What's more, they at long last found that mix kind of suppressor is more productive than responsive and absorptive suppressors. [6]

Jigar H. Chaudhari
talks on the different kinds of suppressors and plan of fumes framework having a place motor has been examined. The protest of this investigation is picking suppressor plan which one decreases a lot of clamor level and back weight of motor. In planning, there are different parameters which needs to take in to the thought. These parameters influence the suppressor productivity. Absorptive suppressor configuration utilizes just assimilation of the sound wave to decrease the clamor level without irritating the fumes gas weight. [7]

Rahul D. Nazirkar clarified a car fumes framework the clamor level, transmission misfortune and back weight are the most vital parameters for the driver and motor execution. With a specific end goal to upgrade the plan productivity of suppressor, resounding of the fumes suppressor ought to be stayed away from by its regular recurrence. The outline of suppressor turns out to be increasingly essential for commotion diminishment. The strong displaying of fumes suppressor is made by CATIA-V5 and modular investigation is completed by ANSYS to consider the vibration and common recurrence of suppressor, to separate between working frequencies from normal recurrence and abstain from reverberating. [8]

PROBLEM IDENTITYAND METHODOLOGY

Design of mufflers is a complex function that affects noise characteristics, emission and fuel efficiency of engine. Therefore muffler design becomes more and more important for noise reduction.

The noise control is depends upon types of louvered holes appeared on muffler. This project mainly focused on reducing the noise from muffler by developing new type of louvered holes with proper material.

METHODOLOGY

- Design of muffler guard with circular louver holes using NX-CAD.
- Performing modal analysis of muffler with Aluminium using Ansys to estimate that free vibration characters.
- Performing modal analysis of muffler with Titanium using Ansys to estimate that free vibration characters.
- Design of muffler guard with square louver holes using NX-CAD.
- Performing modal analysis of muffler with Aluminium using Ansys to estimate that free vibration characters.
- Performing modal analysis of muffler with Titanium using Ansys to estimate that free vibration characters.
- From Analysis results best muffler guard is proposed.

DESGIN OF MUFFLER GUARD WITH CIRCULAR LOUVERED HOLES

4.1 DESIGN PROCEDURE

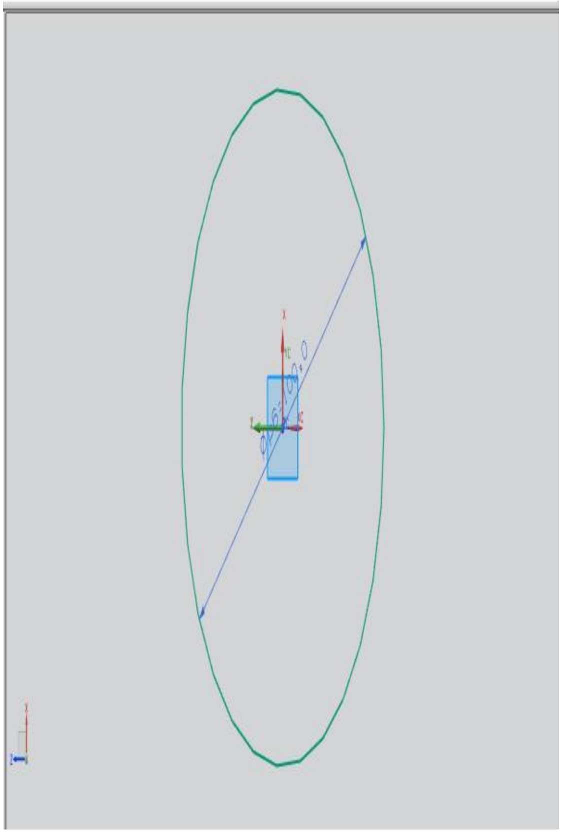


Fig.4.1 2d sketch of muffler

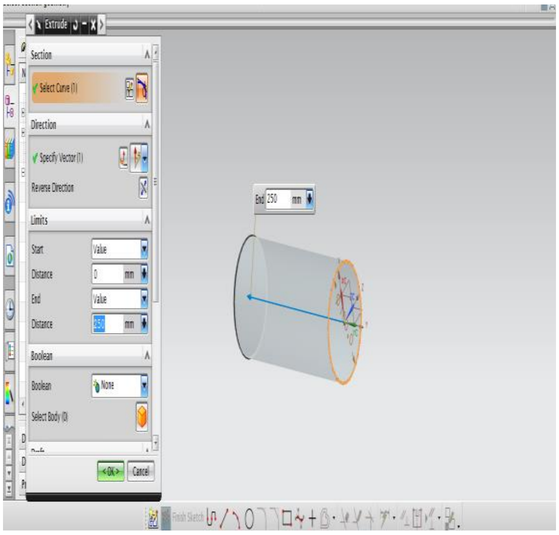


Fig:4.2 shows the 3d model of muffler body

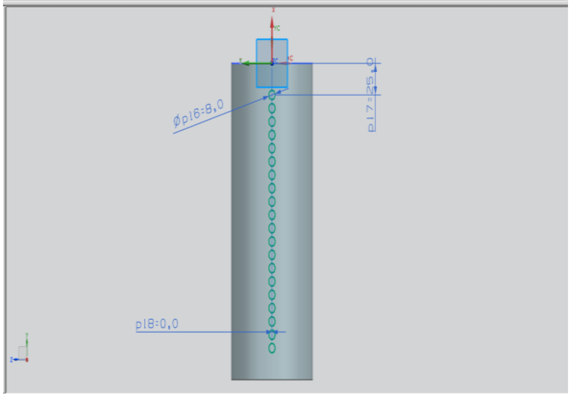


Fig: 4.3 shows the vertical holes on cylinder

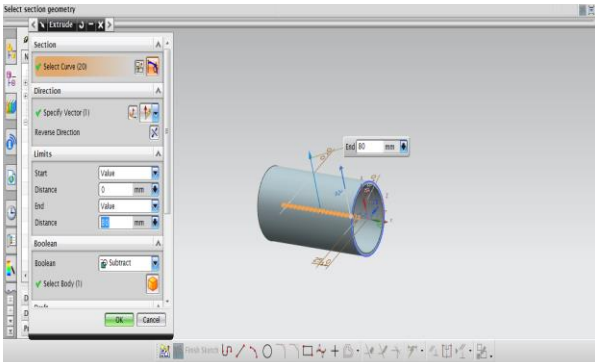


Fig:4.4 shows the extrusion of the muffler

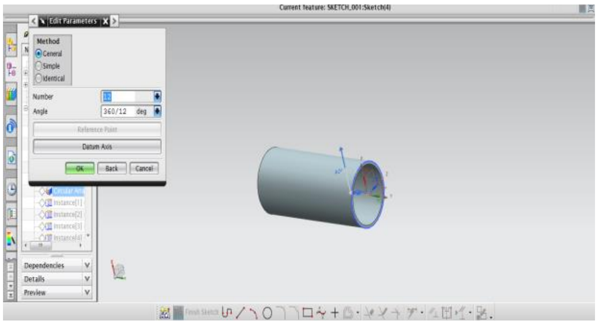


Fig:4.5 shows the Circular Pattern extrusion of the muffler

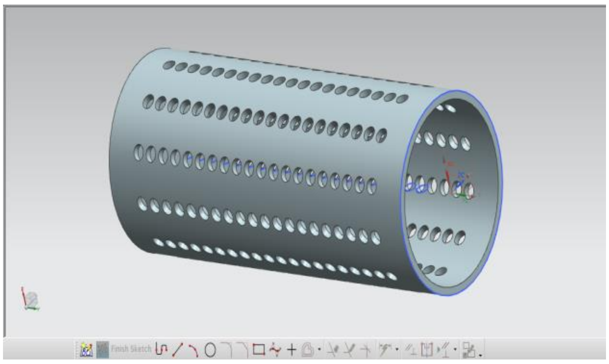


Fig: 4.6 shows the final model of louvered muffler

FINITE ELEMENT ANALYSIS OF MUFFLER GUARD WITH CIRCULAR LOUVERS

5.1 INTRODUCTION TO FEM THEORY

Finite Element Modeling (FEM) also, Finite Element Analysis (FEA) are two most prominent mechanical building applications offered by existing CAE frameworks. This is ascribed to the way that the FEM is maybe the most famous numerical strategy for tackling building issues. The strategy is sufficiently general to deal with any unpredictable state of geometry (issue space), any material properties, any limit conditions and any stacking conditions. The all inclusive statement of the FEM fits the investigation necessities of the present complex building frameworks and plans where shut shape arrangements are administering harmony conditions are not accessible. Furthermore it is a productive outline instrument by which creators can perform parametric plan examining different cases (distinctive shapes, material burdens and so forth.) investigating them and picking the ideal outline.

5.2 FINITE ELEMENT METHOD

The FEM is numerical examination system for getting inexact answers for wide assortment of designing issues. The strategy began in the avionic business as a device to examine worries in confused airframe structures. It became out of what was known as the grid examination technique utilized as a part of air ship plan. The technique has picked up fame among the two analysts and professionals and after such a significant number of advancements codes are created for wide assortment of issues.

5.3 APPLICATION OF FEM

For the most part, FEM is the technique for decision in a wide range of investigation in basic mechanics (i.e. illuminating for disfigurement and worries in strong bodies or progression of structures) while computational liquid flow (CFD) tends to utilize FDM or different strategies (e.g., limited volume strategy). CFD issues ordinarily require discretization of the issue into countless/network focuses (millions and that's just the beginning), hence cost of the arrangement favors more straightforward, bring down request estimate inside every phone. This is particularly valid for 'outer stream' issues, similar to wind stream around the auto or plane, or climate reenactment in an expansive zone.

5.4 FEM TERMINOLOGY

Established expository mechanics is that concocted by Euler and Lagrange and created by Hamilton and Jacobi as a precise detailing of Newtonian mechanics. Its objects of consideration are models of mechanical frameworks extending from particles made out of adequately vast of atoms, through planes, to the Solar System. The spatial setup of any such framework is depicted by its degrees of opportunity. These are additionally called summed up arranges. The terms state factors and essential factors are additionally utilized, especially in scientifically situated medications. In the event that the quantity of degrees of flexibility of the model is limited, the model is called discrete and persistent something else.

Since FEM is a Descritization strategy, the quantity of degrees of opportunity of a FEM demonstrate is essentially limited. The opportunities are gathered in a section vector called u. This vector is for the most part called the DOF vector or state vector. The term nodal relocation vector for u is held to mechanical applications. In expository mechanics, every level of opportunity has a comparing "conjugate" or "double" term, which speaks to a summed up compel. In non-mechanical applications, there is a comparative arrangement of conjugate amounts, which for need of a superior term are likewise called powers or driving terms. These powers are gathered in a segment vector called f. The internal item fT u has the importance of outer vitality or work. Similarly as in the bracket issue, the connection amongst u and f is thought to be of straight and homogeneous. The last supposition implies that if u vanishes so does f. The connection is then communicated by the ace solidness conditions:

$$\mathbf{K\ u = f}$$

K is universally called the stiffness matrix even in non-structural applications because no consensus has emerged on different names.

5.5 GENERAL PROCEDURE OF THE FINITE ELEMENT METHOD

The arrangement of a continuum issue by the limited component strategy ordinarily takes after an organized well ordered process. The accompanying advances appear by and large how the limited component technique functions. These means will turn out to be more justifiable when the FEA is shrouded in more detail later.

- Discretize the given continuum. The pith of the limited component strategy is to separate a continuum, that is, issue area, into semi disjoint non-covering components. This is accomplished by supplanting the continuum by an arrangement of key focuses, called hubs, which when associated appropriately create the components. The accumulation of hubs and components frames the limited component work. An assortment of component shapes and sorts are accessible. The expert or planner can blend component composes to take care of one issue. The quantity of hubs and components that can be utilized as a part of an issue involves designing judgment. When in doubt, the bigger the quantity of hubs and components, the more exact the limited component arrangement, yet in addition the more costly the arrangement is; more memory space is expected to store the limited component model, and more PC time is expected to acquire the arrangement. Figure18-1 demonstrates a case of discretizing a cantilever pillar made of steel and supporting an amassed stack at its free end. Figure 18-1c indicates two writes (four-hub and six-hub) of a quadrilateral (component shape) component.

2. Select the arrangement estimate. The variety of the obscure (called field variable) in the issue is approximated inside every component by a polynomial. The field variable might be a scalar (e.g., temperature) or a vector (e.g., level and vertical removals). Polynomials are typically used to inexact the arrangement over a component area since they are anything but difficult to coordinate and separate. The level of the polynomial relies upon the quantity of hubs per component, the quantity of questions (segments of field variable) at every hub, and certain progression necessities along component limits.

3. Create component grids and conditions. The limited component plan exhibited in the following segment includes change of the representing conditions from the continuum area. Once the hubs and material properties of a given component are characterized, its relating grids (solidness lattice, mass network, and so on.) and conditions can be determined. Four techniques are accessible to determine component networks and conditions: the immediate strategy, the variation strategy, the weighted lingering technique, and the vitality strategy. In this part, we cover the second (appropriate for strong mechanics issues) and the third (reasonable for warm liquids issues) strategies.

4. Amass the component conditions. The individual component grids are included by summing the balance conditions of the components to acquire the worldwide lattices and arrangement of arithmetical conditions. Before illuminating this framework, it must be altered by applying the limit conditions. On the off chance that limit conditions are not connected, wrong outcomes are acquired, or a particular arrangement of conditions may come about.

5. Understand for the questions at the hubs. The worldwide of logarithmic conditions is unraveled by means of Gauss end techniques to give the estimations of the field factors at the hubs of the limited component work. Estimations of field factors and their subordinates at the hubs frame the entire limited component arrangement of the first continuum issue before Descritization. Qualities at different focuses inside the continuum other than the hubs are conceivable to acquire, in spite of the fact that it isn't usually done.

6. Translate the outcomes. The last advance is to examine the arrangement and results got from the past advance to settle on plan choices. The right understanding of these outcomes requires a sound foundation in both designing and FEA. This is the reason regarding FEA and FEM codes as a black box is generally not prescribed and, truth be told, is viewed as perilous.

With regards to the above well ordered system, unmistakably there are different basic choices that experts of the limited component investigation need to make, e.g., the sort of examination, the quantity of hubs, the degrees of opportunity (parts of the field variable) at every hub, the component shape and sort, the material kind, lastly the translation of the outcomes. Settling on these choices turns out to be more clear after we talk about the above strides in more detail while covering FEA.

5.7 MODAL ANALYSIS OF LOUVERED MUFFLER GUARD

Natural Frequency:

Natural frequency is the frequency at which a system naturally vibrates once it has been set into motion. In other words, natural frequency is the number of times a system will oscillate (move back and forth) between its original position and its displaced position, if there is no outside interference.

The natural frequency is calculated from the formula given below. The natural frequencies depend on stiffness of the geometry and mass of the material.

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Fundamental Natural Frequency

The fundamental frequency, often referred to simply as the fundamental, is defined as the lowest frequency of a periodic waveform. In terms of a superposition of sinusoids (e.g. Fourier series), the fundamental frequency is the lowest frequency sinusoidal in the sum.

Resonance:

In physics, resonance is the tendency of a system to oscillate with greater amplitude at some frequencies than at others. Frequencies at which the response amplitude is a relative maximum are known as the system's resonant frequencies, or resonance frequencies. At these frequencies, even small periodic driving forces can produce large amplitude oscillations, because the system stores vibration energy.

Resonance occurs when a system is able to store and easily transfer energy between two or more different storage modes (such as kinetic energy and potential energy in the case of a pendulum). However, there are some losses from cycle to cycle, called damping. When damping is small, the resonant frequency is approximately equal to the natural frequency of the system, which is a frequency of unforced vibrations. Some systems have multiple, distinct, resonant frequencies.

Resonance phenomena occur with all types of vibrations or waves: there is mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) and resonance of quantum wave functions. Resonant systems can be used to generate vibrations of a specific frequency (e.g. musical instruments), or pick out specific frequencies from a complex vibration containing many frequencies (e.g. filters).

Mode Shapes:

For every natural frequency there is a corresponding vibration mode shape. Most mode shapes can generally be described as being an axial mode, torsional mode, bending mode, or general modes. Like stress analysis models, probably the most challenging part of getting accurate finite element natural frequencies and mode shapes is to get the type and locations of the restraints correct. A crude mesh will give accurate frequency values, but not accurate stress values.

Modal Analysis:

Modal analysis is used to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed. It can also serve as a starting point for another, more detailed, dynamic analysis, such as a transient dynamic analysis, a harmonic response analysis, or a spectrum analysis.

Aluminum A360:

Density -2.65 g/cm3
Ultimate Tensile strength -300MPa
Yield tensile strength -180MPa
Modulus of elasticity -71GPa
Poisson ratio - 0.33

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Specific heat -963J/kg-K
Thermal conductivity -113W/m-K

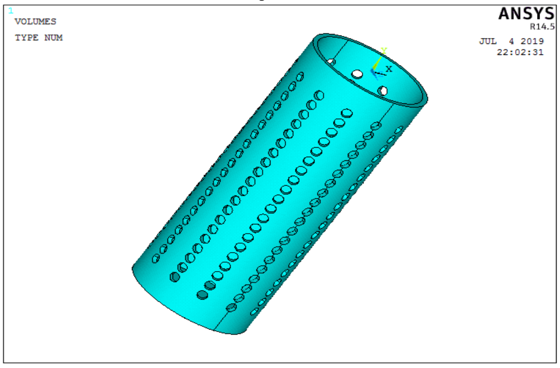


Fig.5.1 Imported model in Ansys

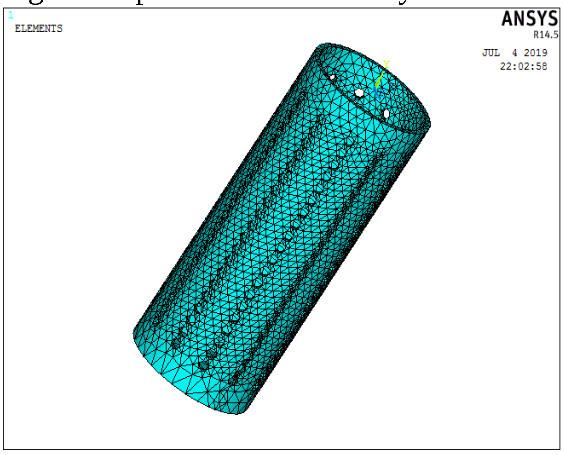


Fig.5.2 Created mesh on muffler

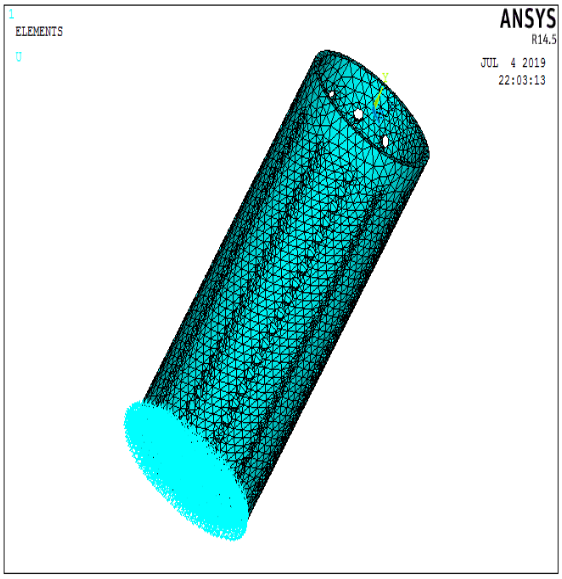
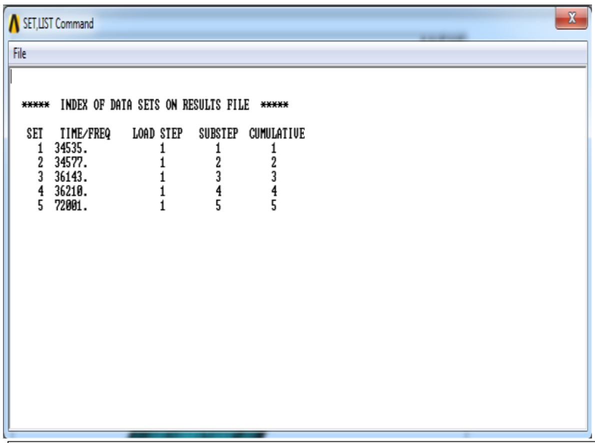


Fig.5.3 Applied fixed constraints on muffler

Frequency results



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5	72001.	1	5	5

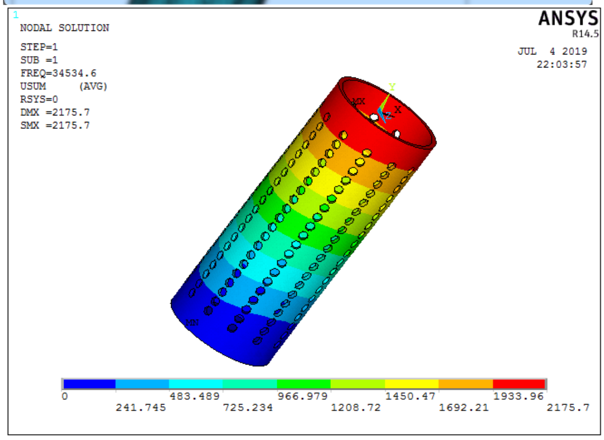

Fig.5.4 Mode shape-1 results

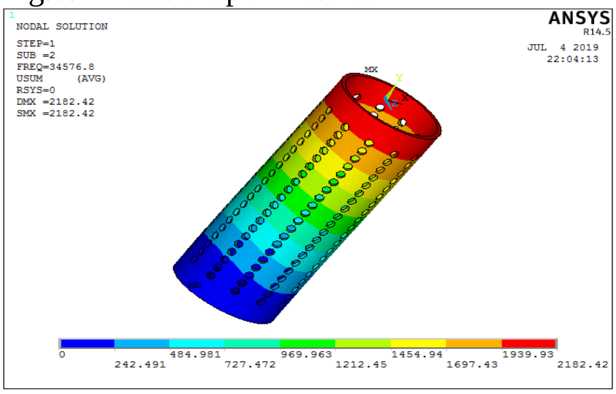

Fig.5.5 Mode shape-2 results

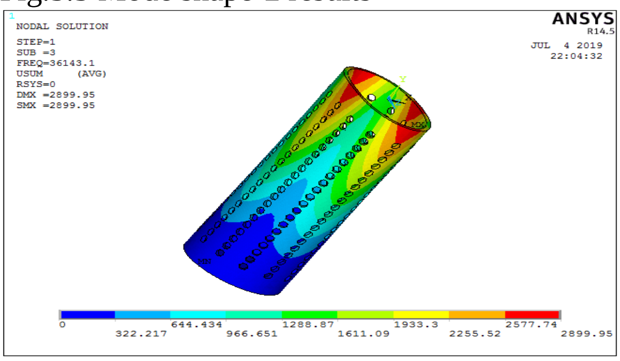

Fig.5.6 Mode shape-3 results

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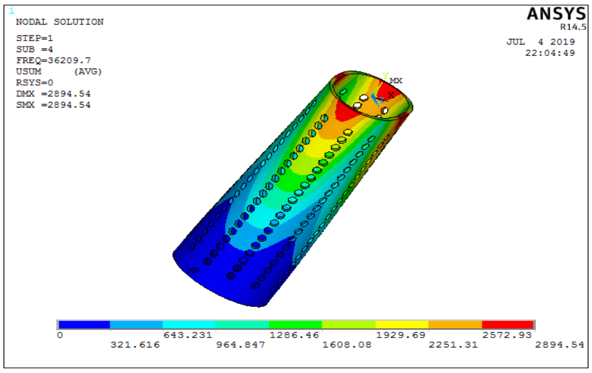


Fig.5.7 Mode shape-4 results

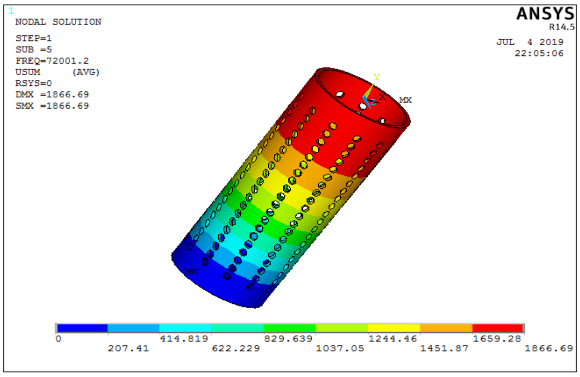


Fig.5.8 Mode shape-5 results

5.8 MODAL ANALYSIS OF LOUVERED MUFFLER GUARD ZAMAK:

Density -6.60 g/cm3
Ultimate Tensile strength -240MPa
Modulus of elasticity -96 GPa
Poisson ratio - 0.29
Specific heat -420J/kg-K
Thermal conductivity -113W/m-K

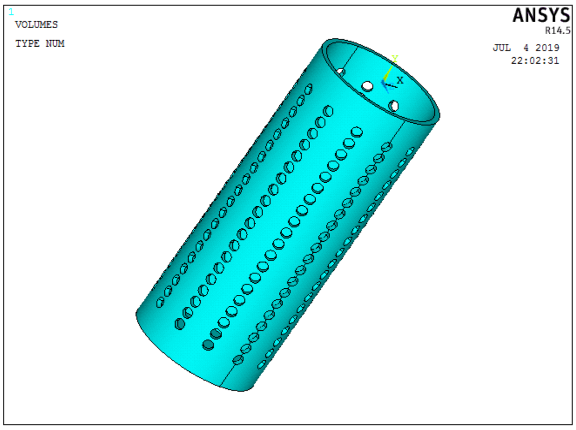


Fig.5.9 Imported model in Ansys

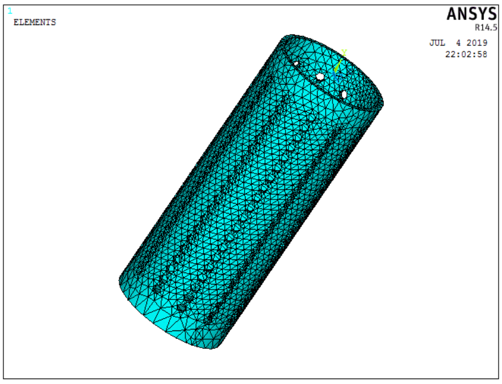


Fig.5.10 Created mesh on muffler

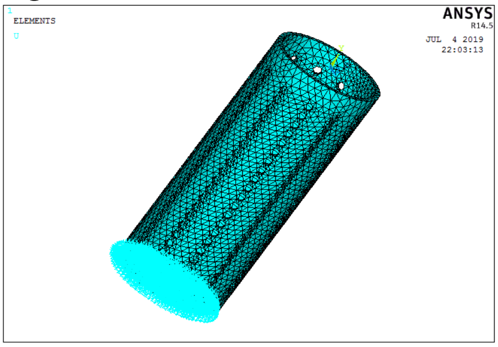
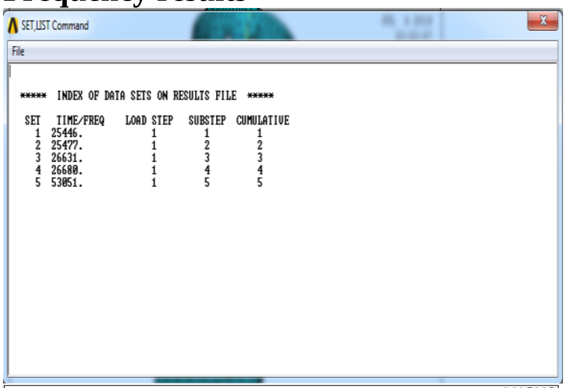


Fig.5.11 Applied fixed constraints on muffler

Frequency results


SET,LIST Command
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5	53051.	1	5	5

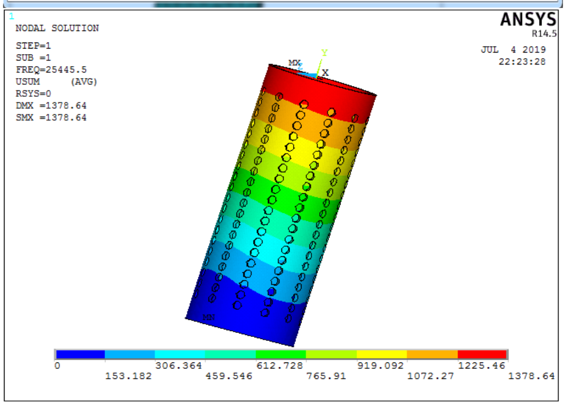

Fig.5.12 Mode shape-1 results

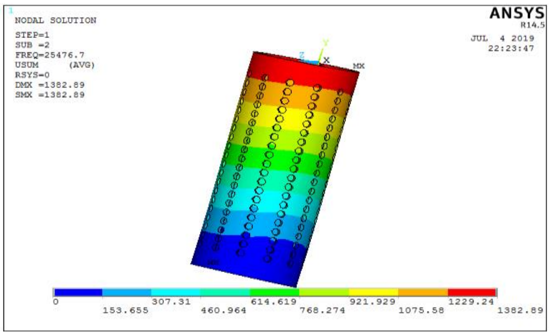

Fig.5.13 Mode shape-2 results

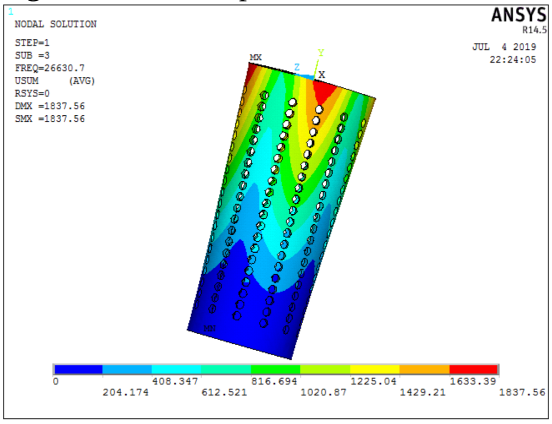

Fig.5.14 Mode shape-3 results

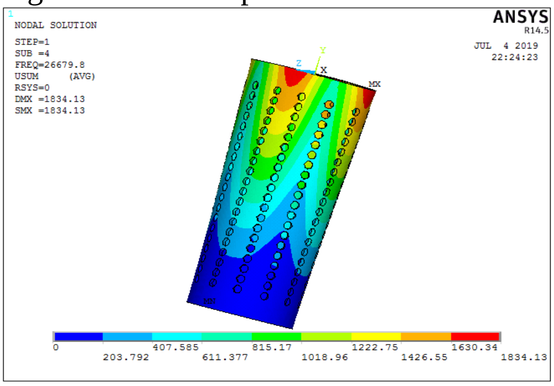

Fig.5.15 Mode shape-4 results

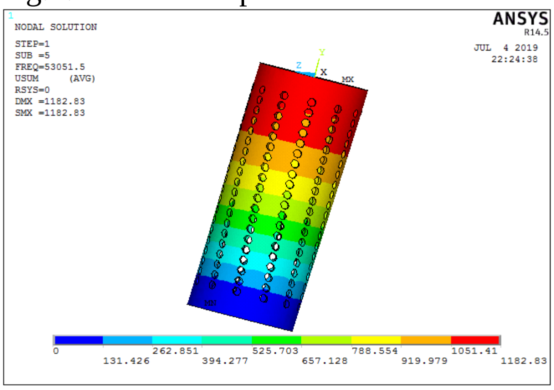

Fig.5.16 Mode shape-5 results

DESGIN OF MUFFLER GUARD WITH RECTANGULAR LOUVERED HOLES

6.1 DESIGN PROCEDURE

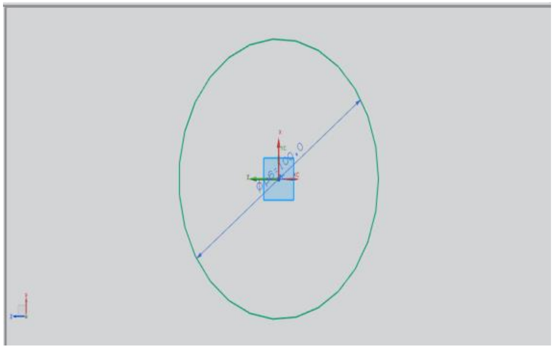

Fig.6.1 2d sketch of muffler

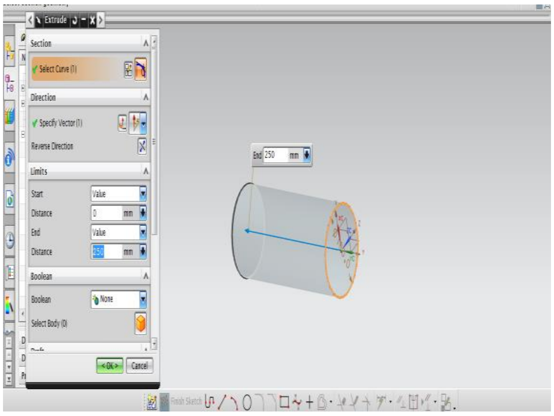

Fig:6.2 shows the 3d model of muffler body

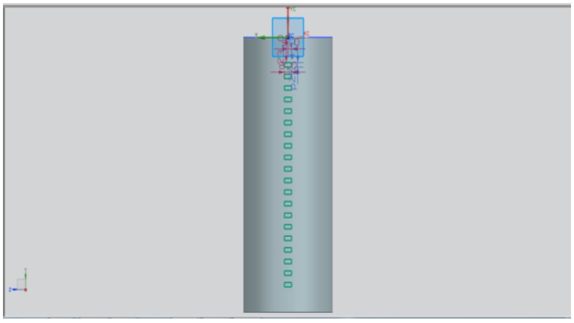

Fig: 6.3 shows the vertical holes on cylinder

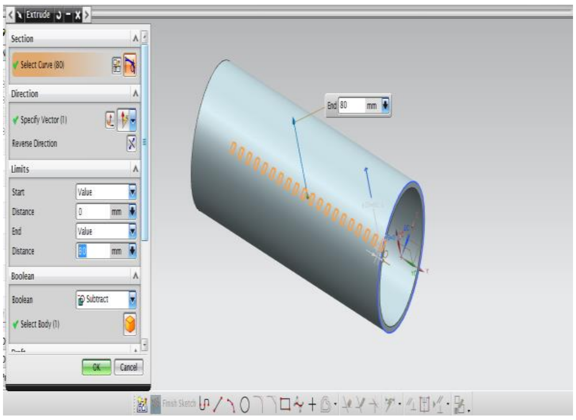

Fig:6.4 shows the extrusion of the muffler

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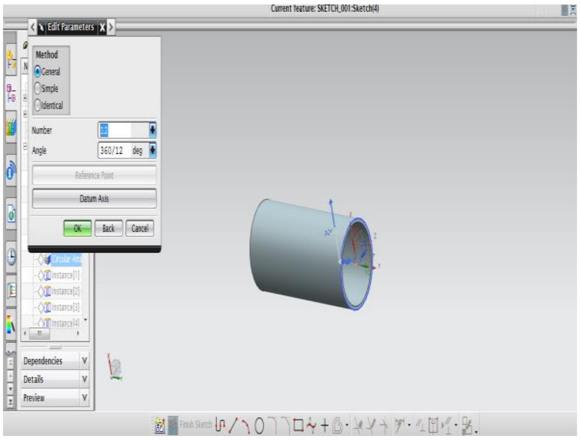


Fig:6.5 shows the Circular Pattern extrusion of the muffler

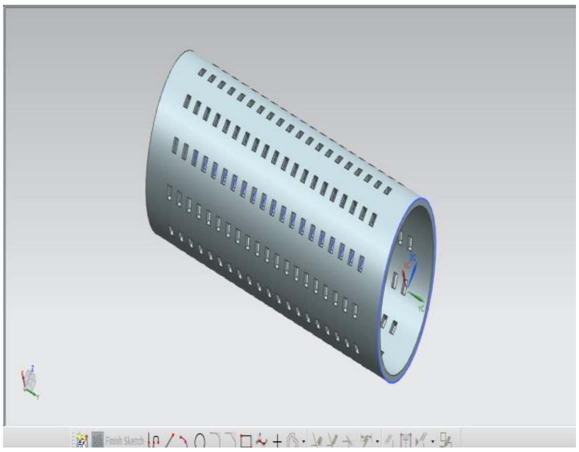


Fig: 6.6 shows the final model of louvered muffler

FINITE ELEMENT ANALYSIS OF MUFFLER GUARD WITH RECTANGULAR LOUVERS

7.1 MODAL ANALYSIS OF LOUVERED MUFFLER GUARD

Aluminum A360:

Density -2.65 g/cm3
Ultimate Tensile strength -300MPa
Yield tensile strength -180MPa
Modulus of elasticity -71GPa
Poisson ratio - 0.33
Specific heat -963J/kg-K
Thermal conductivity -113W/m-K

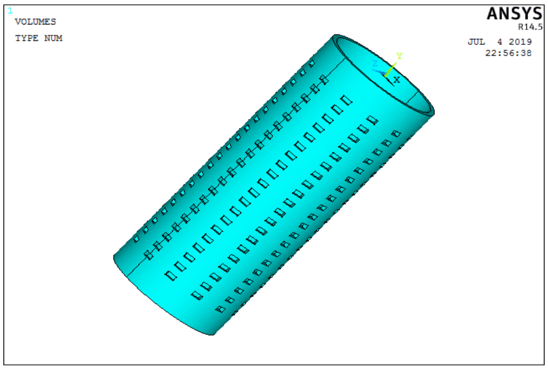


Fig.7.1 Imported model in Ansys

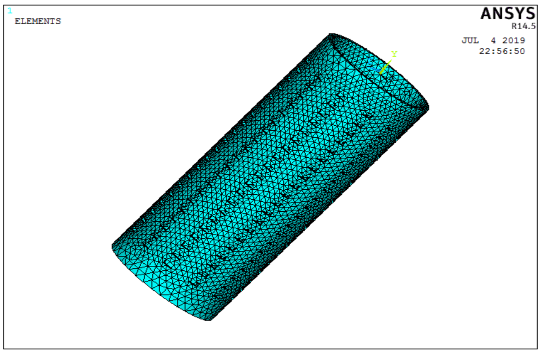


Fig.7.2 Created mesh on muffler

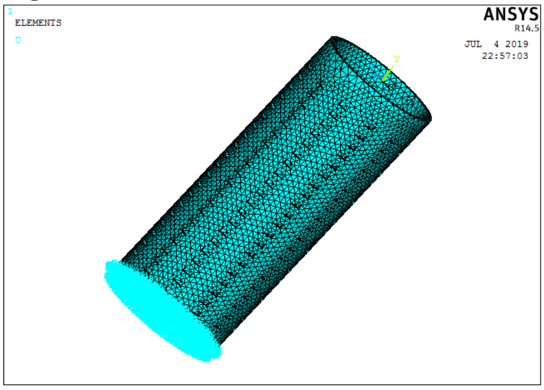
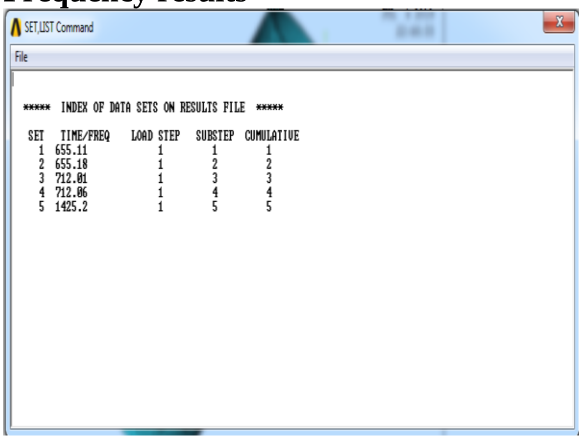


Fig.7.3 Applied fixed constraints on muffler

Frequency results



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File

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2	655.18	1	2	2
3	712.01	1	3	3
4	712.06	1	4	4
5	1425.2	1	5	5

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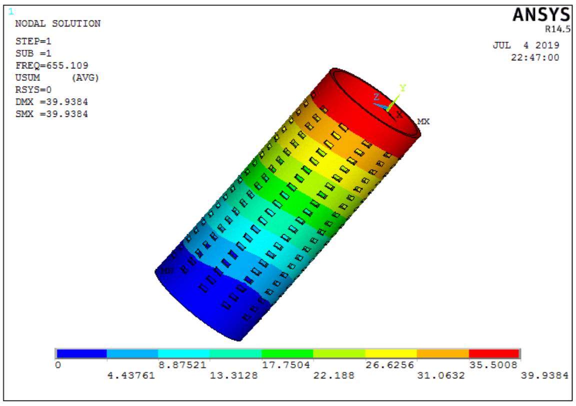

Fig.7.4 Mode shape-1 results

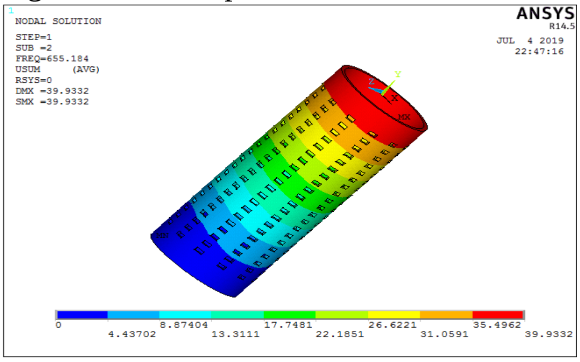

Fig.7.5 Mode shape-2 results

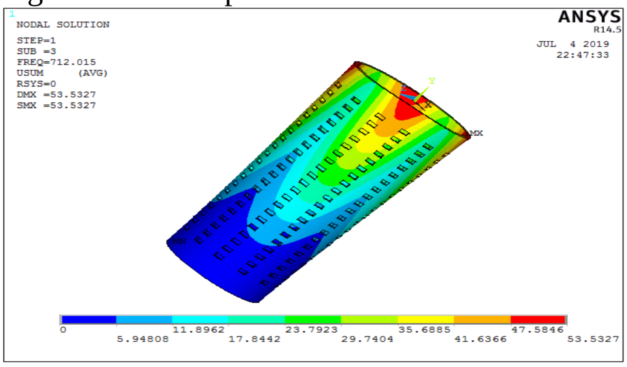

Fig.7.6 Mode shape-3 results

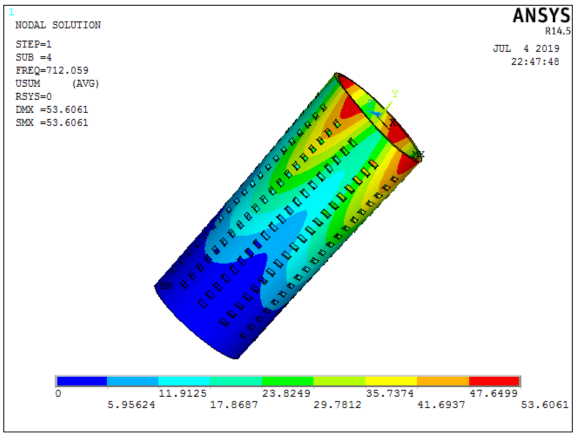

Fig.7.7 Mode shape-4 results

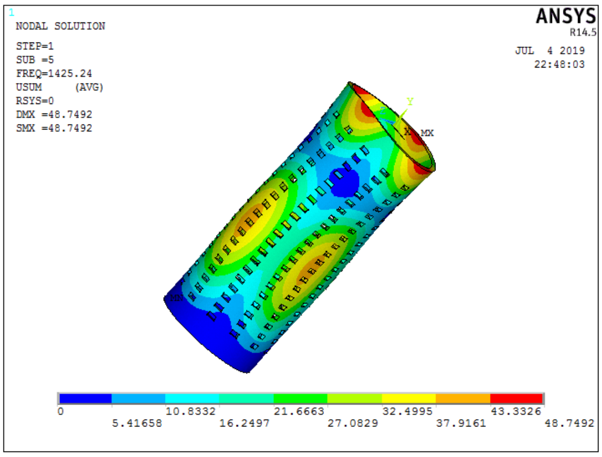

Fig.7.8 Mode shape-5 results

7.2 MODAL ANALYSIS OF LOUVERED MUFFLER GUARD ZAMAK:

Density -6.60 g/cm3
Ultimate Tensile strength -240MPa
Modulus of elasticity -96 GPa
Poisson ratio - 0.29
Specific heat -420J/kg-K
Thermal conductivity -113W/m-K

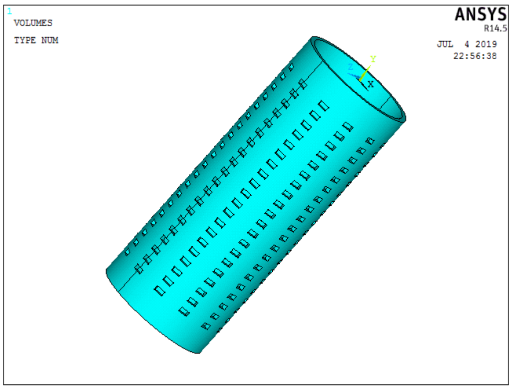

Fig.7.9 Imported model in Ansys

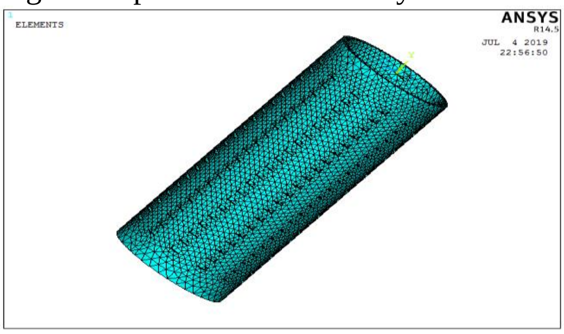

Fig.7.10 Created mesh on muffler

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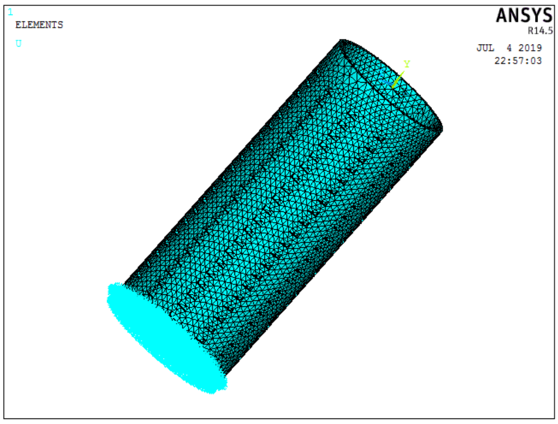
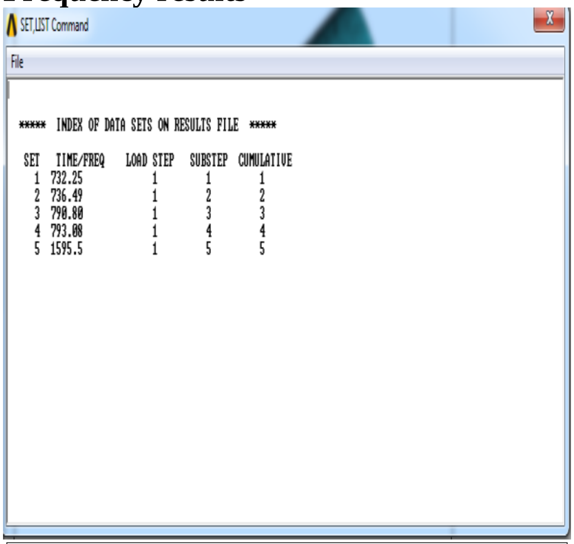


Fig.7.11 Applied fixed constraints on muffler

Frequency results



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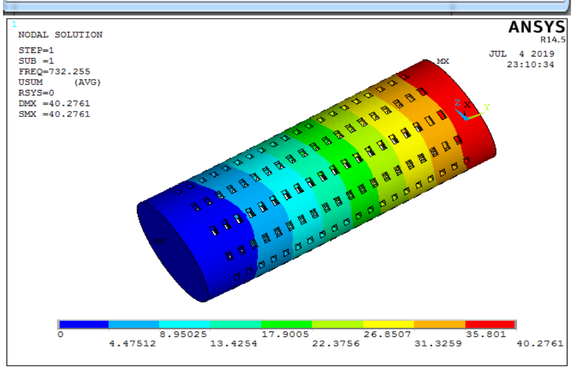

Fig.7.12 Mode shape-1 results

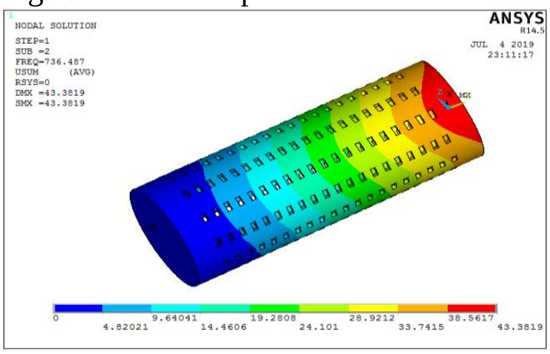

Fig.7.13 Mode shape-2 results

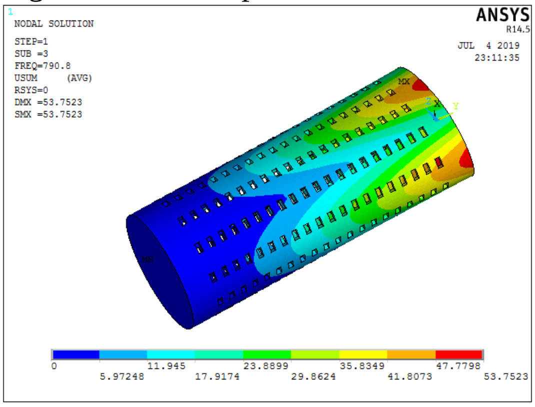

Fig.7.14 Mode shape-3 results

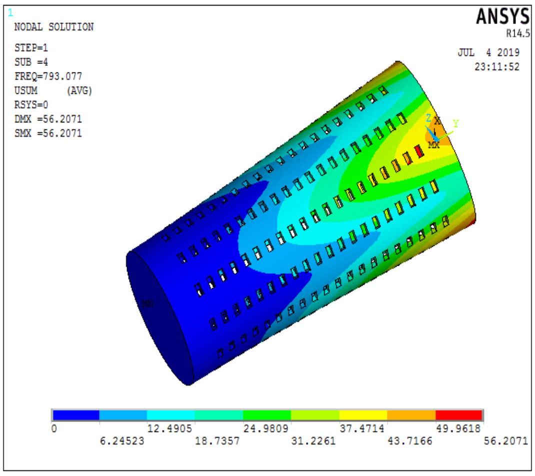

Fig.7.15 Mode shape-4 results

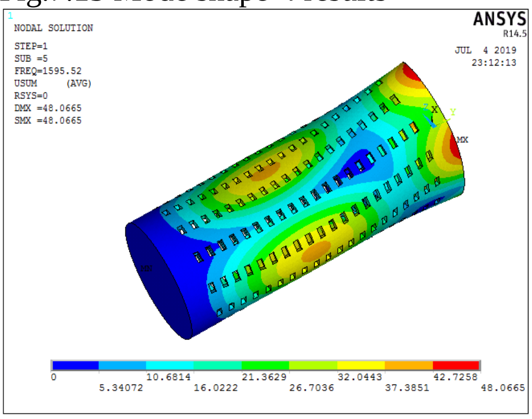

Fig.7.16 Mode shape-5 results

RESULTS AND CONCLUSION

In this paper louvered muffler was studied briefly with different materials like AluminiumA360 and ZAMAK. Design of louvered muffler is done using Unigraphics software with accurate dimensions. Modal analysis of louvered muffler guard done by using Ansys software.

Modal analysis carried out for different types of muffler guard with different materials. Results are given below.

MODAL ANALYSIS RESULTS

	Frequency range Muffler guard with circular holes(Hz)	Frequency range Muffler guard with rectangular holes (Hz)
ALUMINUM A-360	34535 - 72001	655.11 – 1425.5
ZAMAK	24446- 53051	732.25 – 1595.5

From analysis results concluded that louvered muffler guard with rectangular holes using Aluminium A360 material produced less frequency range (less noise) in operating conditions. So louvered muffler guard with rectangular holes using Aluminium A360 material is a perfect for louvered muffler.

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