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DESIGN AND ANALYSIS OF SIDE DOOR INTRUSION BEAM FOR AUTOMOTIVE SAFETY

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ABSTRACT *:*- Vehicle side impact is the condition of the 2 vehicles, during which the vehicles touch one another at 90° or at another angle. Space between the traveler and door is extremely less and there's no space for energy absorption throughout the facet collision of the car so, the side impact beam plays a vital role in protecting the occupants. This study is predicated on the choice of the correct cross-sectional facet intrusion beam for an SUV. the side entrance Intrusion Beam is one among the most energy engrossing parts in case of feature sway. This examination paper centers around near investigation of three cross-sectional profiles for side passageway interruption radiates. A nearby FEA and trial study has been performed to examine the static and dynamic conduct of different cross area profiles and materials of the side passage interruption shaft inside the occasion of aspect sway. Similar study of side entrance intrusion beams has been created to search out the force reaction and energy absorption capability of the beam to guard the resident from the facet collision by victimisation FEA software system. Final side entrance intrusion beam are checking on UTM for resistance force is valid on 3 point bending experimental test.

Keywords—Door Intrusion Beam ,side impact, ANSYS, composite, UTM.

I. INTRODUCTION

The Road safety is one amongst the key international considerations relating to the protection of human lives. Every year, 1.2 million individuals die in road connected accidents, and 20-50 million suffer from non-fatal injuries. When a frontal crash, facet impact is the leading reason for road fatalities. coming up with safety systems for preventing the accident, or controlling the damages it inflicts on the passengers once it happens, could be an international analysis subject during which the work developed in the thesis is inserted. The facet intrusion beam could be a protecting part put in within the vehicle door, designed to boost passengers safety within the

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event of a facet collision. This structure's role is to soak up the utmost quantity of impact energy through the associated elasto-plastic deformation method. Thin-walled beams are frequently applied due to their high energy absorption capability. Metals are unremarkably selected for the beam style, since they blend a high strength in with conjointly high pliability, each significant to energy ingestion. The current work centers around discovering the effect of the cross-sectional unadulterated arithmetic and material of a dainty walled bar in its bowing exhibition. Street mishaps are one among the critical reasons for death in india. In the present vehicle improvement area, auto wellbeing is the major issue. Accidents that are inflicting Injuries that may be controlled considerably if enough attention is given to accident and injury rejection ways. Due to this issue, Vehicle makers are currently victimising varied passive safety devices and have for his or her vehicles, as well as energy gripping steering columns, airbags, exterior door beams etc.

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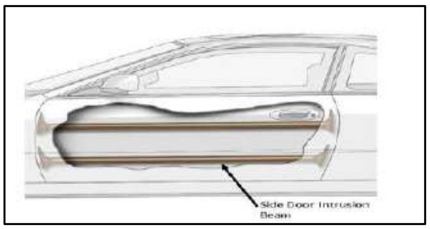

1.1 SIDE IMPACT BEAM

The Side impact door beams are a essential feature of modern cars designed to protect the driver and passengers. The side impact protection beam has to absorb the energy in the door area and shouldn't pass the effect responses to the tenants. Entryway misshapening must be restricted to give a side airbag adequate room between the vehicle's entryway and the seat. The most well-known answers for side effect radiates are expelled aluminum areas , round steel cylinders, and press-solidified or ultra-high strength steel sections. With the increasing size and height of vehicles on the road, including SUVs and vans, side impact beams have become a more popular safety feature for cars of all sizes. The beams provide extra protection during instances when smaller cars may be struck by a larger SUV

II. LITERATURE REVIEW

Kiran C. More , Girish M. Patil, et.al[1], This examination paper centers around relative investigation of three cross-sectional profiles, three checks and three materials for side entryway interruption bar. A nitty gritty mathematical and exploratory investigation has been performed to break down the static and dynamic conduct of various cross segment profiles, checks and materials of side entryway interruption shaft in case of side effect. Near investigation of side entryway interruption radiates has been made to discover the power response and energy

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retention limit of the shaft to shield the tenant from the side crash by utilizing FEA programming.

Yogesh K. Nichit, et.al[2], In this examination paper FEA models have been created with various cross-segment to do three point bowing test. Cycles are taken utilizing LS-DYNA. Further developed boundaries are resolved based on greatest twisting burden limit. The Bending power needed for various areas are assessed and thought about. Ideal plan of 'side interruption shaft' which is best performing for interruption is resolved. Exploration is begun to change the current side effect shaft with the better turn of events and utilizing an alternate cross-areas with same material just as various material then again to diminish the all out weight of the vehicle without limiting the wellbeing of the traveler. T.L. Teng , K.C. Chang, T.H. Nguyen. et.al[3], In this examination paper, full scale side effect test limited component model were introduced. The test mathematical models depend on FMVSS-214. The accident reenactment used the LS-DYNA limited component code. The limit of effect energy ingestion of side entryway is talked about. Examinations on the exhibition of the pillars in side accidents incorporate relocation and interruption estimation of entryway and injury investigation of faker.

John Townsend, Michael Kaczmar, Mohamed El-Sayed et.al[4], This paper presents an exclusive side effect defensive entryway framework inside the space between the external skin of a vehicle entryway and the inhabitant, which will be pretty much as proficient as those generally standard in front facing sway. The principle objective for presenting the side effect primary framework is to expand energy ingestion and limit injury to the occupant.To address a few car wellbeing issues, Joalto Design Inc. has fostered a fundamentally secluded entryway innovation with a few credits. The Joalto XSIB showed a decrease in the Thoracic Trauma Index (TTI). This was diminished by 32% in test 248 and 19.8% in test 249. This expanded the abstract "star" appraisals from a 3 star to a 5 star.

Raghvendra Krishana, Shivangi Yadav, Rajeev Kumar et.al[5],This Research depends on the determination of appropriate cross-part of side interruption shaft for SUV and afterward examination of the aftereffects of post effect test between the real side pillar utilized in vehicle and the bar with chosen cross-area. For determination of side shaft cross-segment three-point twisting test was led on rectangular and roundabout empty cross part of same material and from there on FEA examination was directed and results were thought about for the co-connection of logical information with actual test. Bar with rectangular cross area showed more twisting power taking limit than roundabout.

III. PROBLEM STATEMENT

Side impact of vehicles is the second leading cause of fatalities and serious injuries in the traffic accidents after frontal collisions. The project deals with the evaluation of effectiveness of side door intrusion beam in SUV.

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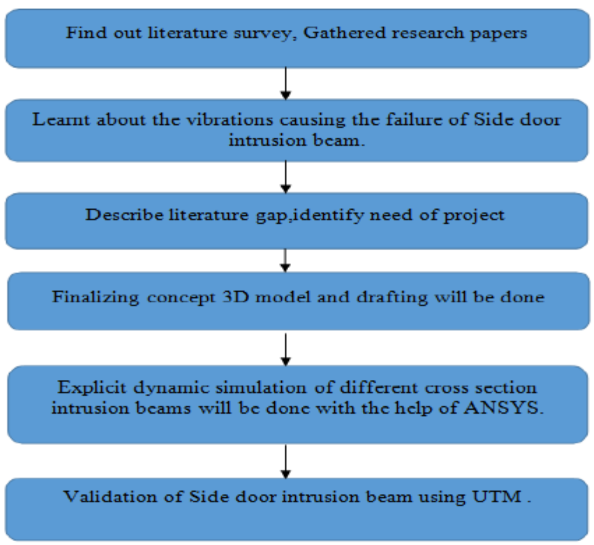
3.1 OBJECTIVES

Modelling offside door intrusion beam of an SUV in CATIA V5R20 software.

This work centers around relative investigation of three cross-sectional profiles and three materials for side entryway interruption shaft. A nitty gritty FEA and trial study has been performed to investigate the static and dynamic conduct of various cross area profiles and materials of side entryway interruption pillar in case of side effect. Final side door intrusion beam will be testing on UTM for resistance force is validated on three point bending experimental test.

IV. METHODOLOGY



4.1 ANALYSIS OF LEAF SPRING SHACKLE

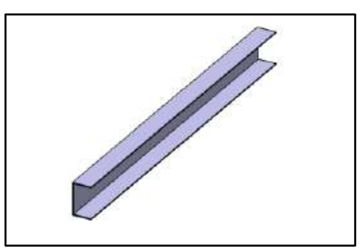


Fig. 01 c-channel

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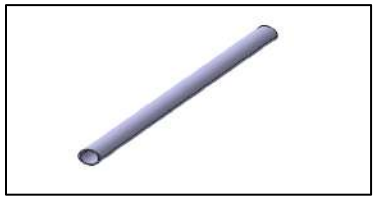

Fig. 02 Round channel

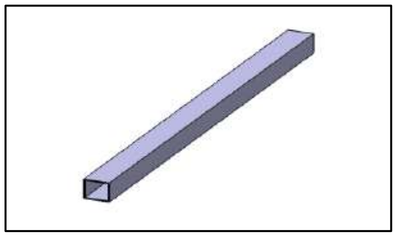

Fig. 03 Square cross-section

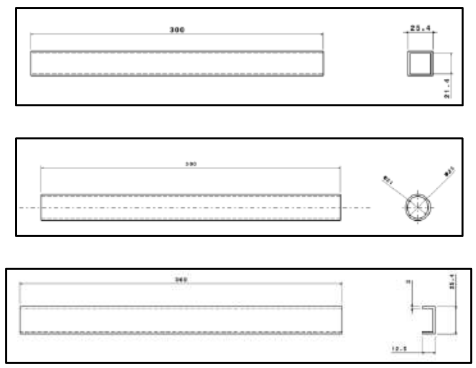

Fig.04 Drafting of different cross-section

4.2 EXPLICIT DYNAMIC ANALYSIS OF SIDE DOOR INTRUSION BEAMS

A. FINITE ELEMENT METHOD

The finite element method (FEM) is the most widely used method for solving problems of engineering and mathematical models. Typical problem areas of interest include the traditional fields of structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. The FEM is a specific mathematical technique for tackling incomplete differential conditions in a few space factors (i.e., some limit esteem issues). To tackle an issue, the FEM partitions a huge framework into more modest, less complex parts that are called limited components. This is accomplished by a specific space discretization in the space measurements, which is carried out by the development of a mesh of the object: the numerical domain for the solution, which has a finite number of points. The finite element method

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formulation of a boundary value problem finally results in a system of algebraic equations. The method approximates the unknown function over the domain. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem. The FEM then uses variation methods from the calculus of variations to approximate a solution by minimizing an associated error function.

B. EXPLICIT DYNAMIC

"Implicit" and "Explicit" refer to two types of time integration methods used to perform dynamic simulations. Explicit time integration is more accurate and efficient for simulations involving – Shock wave propagation – Large deformations and strains – Non-linear material behavior – Complex contact – Fragmentation – Non-linear buckling. Typical applications are drop tests and impact and penetration. ANSYS Explicit Dynamics analysis software provides simulation technology to help simulate structural performance long before manufacture. ANSYS explicit dynamics analysis software solutions are capable of solving short-duration, large-strain, large-deformation, fracture, complete material failure, and structural problems with complex contact interactions.

We are going to perform three different iterations for each cross-section and find out which is better.

C. SQUARE CROSS-SECTION:

GEOMETRY:

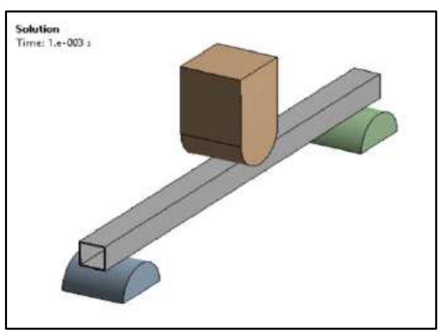

Fig. 05

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D. MATERIAL OF SETUP:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

Fig. 06

E. MATERIAL FOR COMPONENT:

Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

Fig. 07

F. MESHING:

ANSYS meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multi-physics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

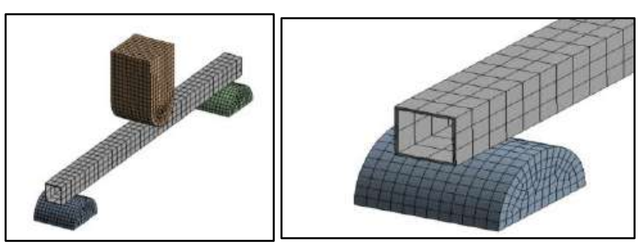

Fig. 08

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G. NODES AND ELEMENTS:

Statistics	
Nodes	5553
Elements	4266

BOUNDARY CONDITION:

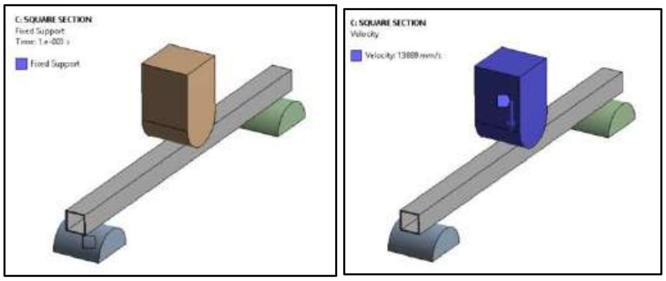

Fig.10

As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.So we have converted the unit in mm/sec. and the base is considered as a fixed support

FORCE REACTION PLOT:

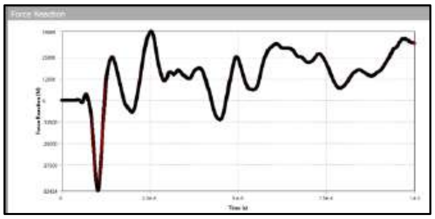

Fig. 11

DEFORMATION AND VON-MISES STRESS PLOT:

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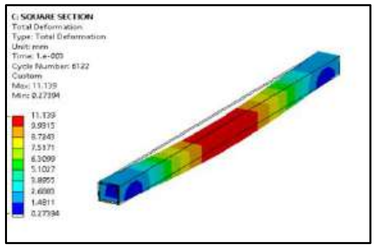

Fig.12 Total deformation plot

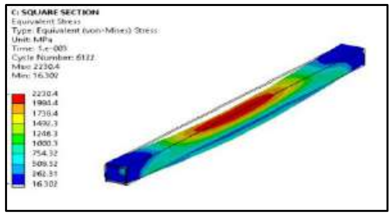

Fig.13 Von-mises stress plot

C-SECTION:

GEOMETRY:

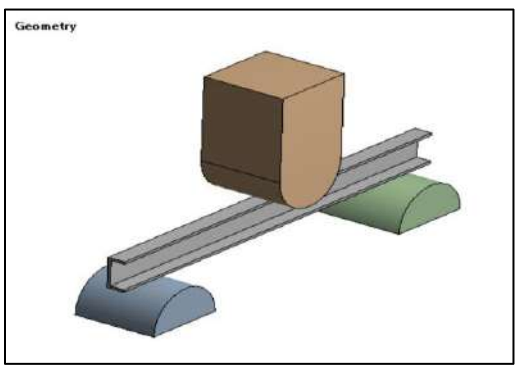

Fig.14

Material for setup:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

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Material for component:

Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

MESHING:

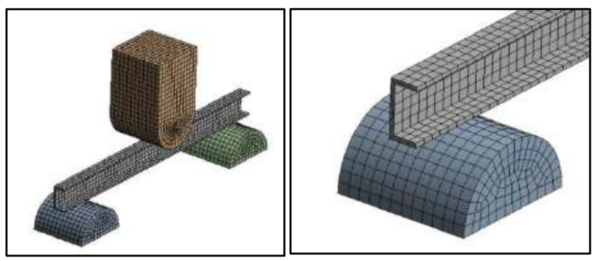

Fig. 17

NODES AND ELEMENTS:

Statistics	
Nodes	8407
Elements	6312

Fig.18

BOUNDARY CONDITION:

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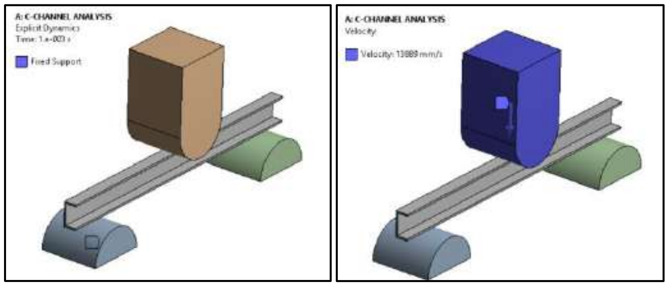

Fig. 19

As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.

So we have converted the unit in mm/sec. and the base is considered as a fixed support.

REACTION FORCE:

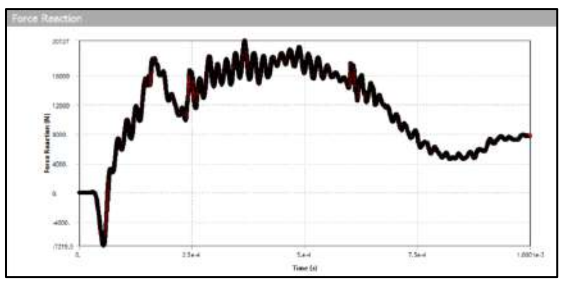

Fig. 20

TOTAL DEFORMATION AND VONMISES PLOT:

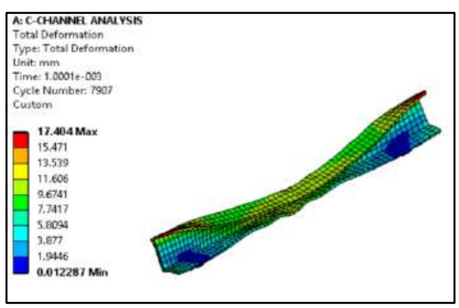

Fig.21 DEFORMATION PLOT

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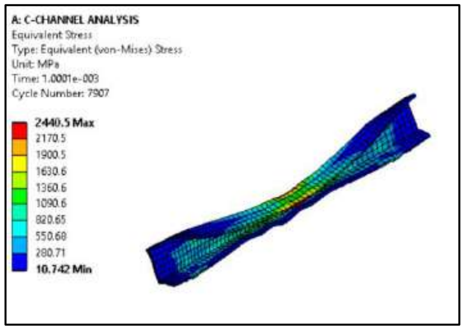

Fig.22 VON-MISES PLOT

CIRCULAR CROSS SECTION:

GEOMETRY:

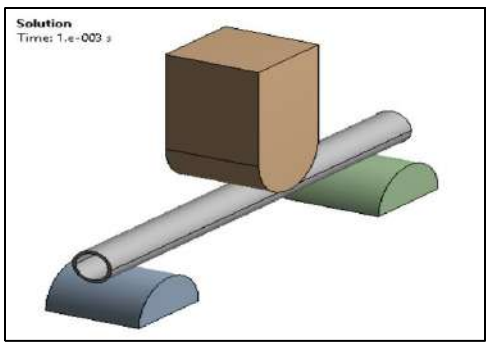

Fig. 23

MATERIAL FOR SETUP:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

MATERIAL FOR COMPONENT:

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Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

MESHING:

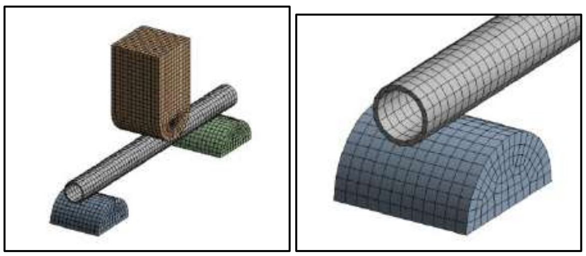

Fig. 25

As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.

So we have converted the unit in mm/sec. and the base is considered as a fixed support.

BOUNDARY CONDITION:

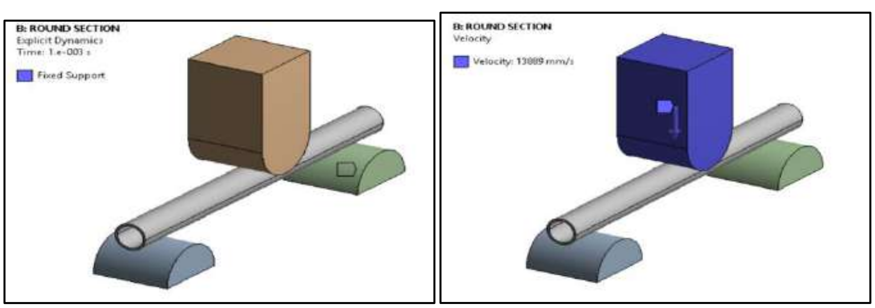

Fig. 26

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As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.

So we have converted the unit in mm/sec. and the base is considered as a fixed support.

REACTION FORCE PLOT:

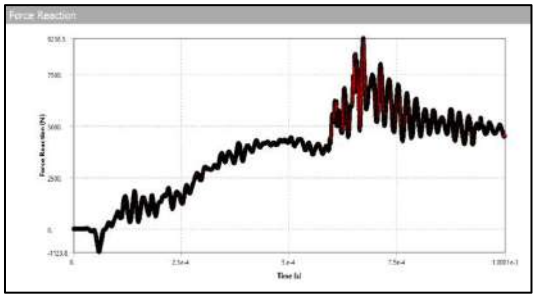

Fig.27

TOTAL DEFORMATION AND VONMISES PLOT:

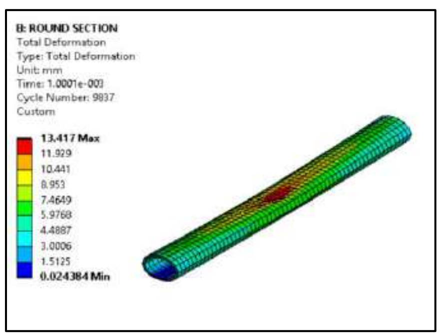

FIG.29 TOTAL DEFORMATION PLOT

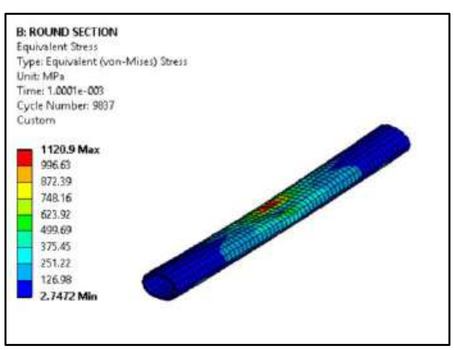

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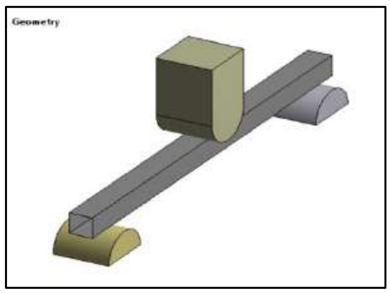
FIG.30 VON-MISES STRESS PLOT

from the above analysis it has been proved that the square cross section has the better reaction force than other to profiles so the square section is the best profile for side door intrusion beam.

to increase the reaction force of the square profile beam reinforcement of composite fiber is done. and the analysis is carried out and further validated through UTM testing.

4.3 ANALYSIS OF REINFORCED SQUARE SECTION PROFILE BEAM:

GEOMETRY:



MATERIAL FOR SETUP:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

MATERIAL FOR COMPONENT:

Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

FIG.33

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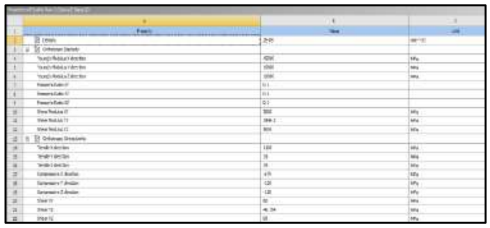
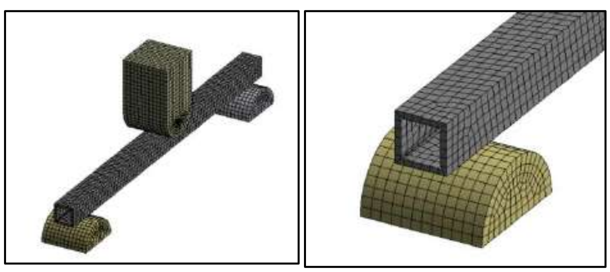
MATERIAL APPLIED ON PIPE:



MESHING:

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient multiphysics solutions. A mesh well suited for a specific analysis can be generated with a

single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.



NODES AND ELEMENTS:

Statistics	
Nodes	8667
Elements	7339

BOUNDARY CONDITION:

A boundary condition for the model is the setting of a known value for a displacement or an associated load. For a particular node you can set either the load or the displacement but not both..

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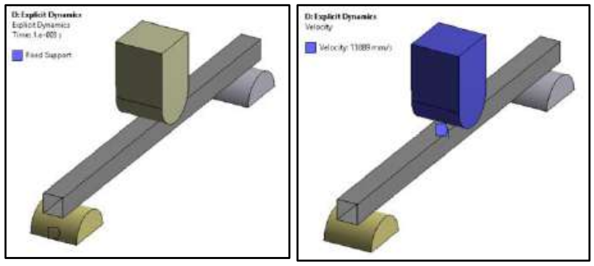
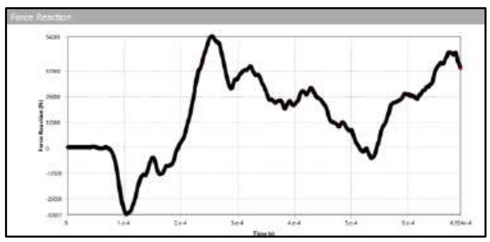
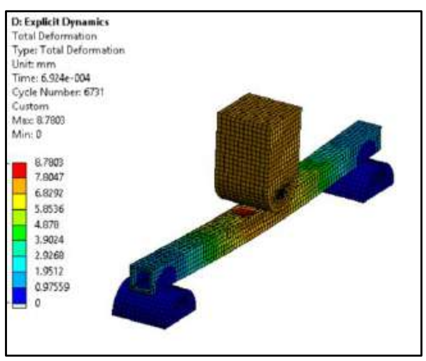


REACTION FORCE GRAPH:



TOTAL DEFORMATION PLOT:



EQUIVALENT STRESS PLOT:

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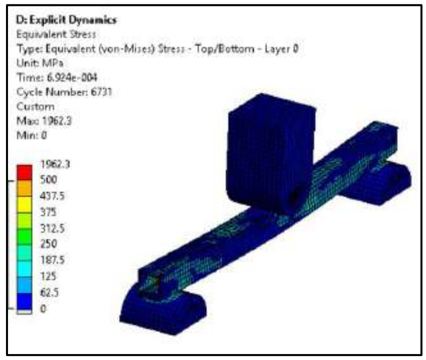

MANUFACTURING PROCESS

Fig. Tools for E-glass fiber reinforcement

V. EXPERIMENTAL VALIDATION:

A Universal Testing Machine (UTM) is used to test both the tensile and compressive strength of materials. Universal Testing Machines are named as such because they can perform many different varieties of tests on an equally diverse range of materials, components, and structures.

All inclusive Testing Machines can oblige numerous sorts of materials, going from hard examples, like metals and cement, to adaptable examples, like elastic and materials. This variety makes the Universal Testing Machine similarly relevant to for all intents and purposes any assembling industry.

The UTM is a versatile and valuable piece of testing equipment that can evaluate materials properties such as tensile strength, elasticity, compression, yield strength, elastic and plastic deformation, bend compression, and strain hardening. Different models of Universal Testing Machines have different load capacities, some as low as 5kN and others as high as 2,000kN.

5.1 SPECIFICATION OF UTM

1	Max Capacity	400KN
2	Measuring range	0-400KN
3	Least Count	0.04KN
4	Clearance for Tensile Test	50-700 mm
5	Clearance for Compression Test	0- 700 mm
6	Clearance Between column	500 mm
7	Ram stroke	200 mm
8	Power supply	3 Phase , 440Volts , 50 cycle. A.C
9	Overall dimension of machine (L*W*H)	2100*800*2060
10	Weight	2300Kg

- Component is placed in the position according to the analytical boundary condition.
- On UTM machine the deflection of beam is given as input as per the deflection the reaction force is plotted on the graph.
- The constraint for deflection of beam is set as 5 mm and the reaction forces are plotted.

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Fig Experimental testing photo

Fig. Experimental result

5.2 EXPERIMENTAL FEA

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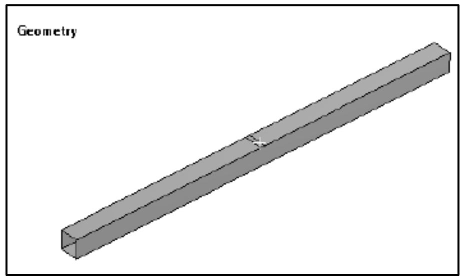
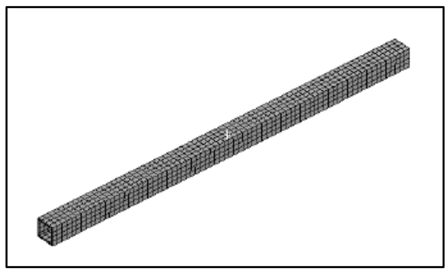


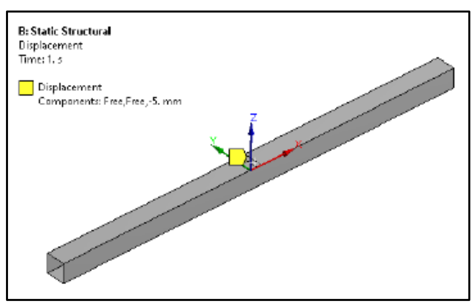
Fig. Geometry



Statistics	
Nodes	1216
Elements	1200

Fig. Meshing

BOUNDARY CONDITION



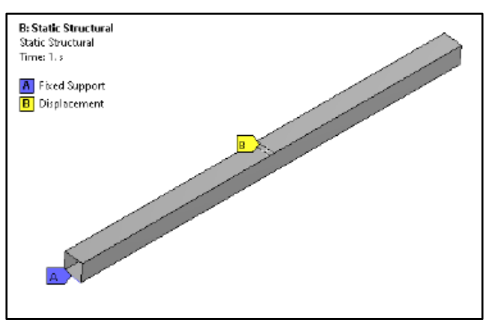


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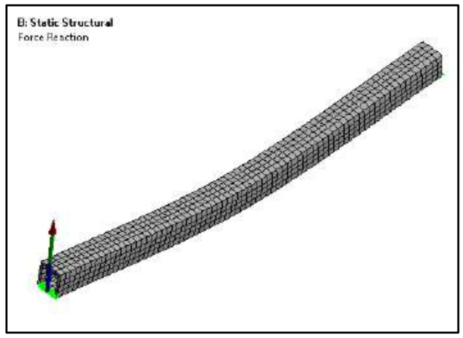
Fig. Boundary condition



Maximum Value Over Time	
X Axis	-1.3943e-009 N
Y Axis	-3.5027e-010 N
Z Axis	7909.7 N
Total	7909.7 N

VI. CONCLUSION

Explicit analysis is performed on the different profiles of the intrusion beam, from FEA results the square cross area is seen to have the advantage as contrasted and other two profiles. As the response power of the various profiles are noticed, the response power of the square cross segment is better. As the response power is better, it will respond to the powers applied on the shaft more viably than different profiles. To increase the force reaction of square cross section reinforcement of E-glass fibre is done on the beam by hand lay-up method. This reinforced beam is validated on a UTM machine.

PROFILE	REACTION FORCE	TOTAL DEFORMATION	EQUIVALENT STRESS
C-SECTION	20727	17.404 mm	2440.5 MPa
ROUND SECTION	9236.5	13.417 mm	1962.3 MPa

SQ. SECTION	39869 N	11.139 mm	2230.4 MPa

SR NO	TESTING FOR 5 mm DISPLACEMENT	REACTION FORCE(N)
1	FEA TESTING	7909 N
2	EXPERIMENTAL TESTING	7585 N

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Design, Develop and Validate Nitrile Hose in Mandrel less Construction

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Abstract: This A hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes (the word pipe usually refers to a rigid tube, whereas a hose is usually a flexible one), or more generally tubing. The shape of a hose is usually cylindrical (having a circular cross section). Hose design is based on a combination of application and performance. Common factors are size, pressure rating, weight, length, straight hose or coil hose, and chemical compatibility. Applications mostly use nylon, polyurethane, polyethylene, PVC, or synthetic or natural rubbers, based on the environment and pressure rating needed. In recent years, hoses can also be manufactured from special grades of polyethylene (LDPE and especially LLDPE). Other hose materials include PTFE (Teflon), stainless steel, and other metals. Dredge rubber hoses have a long story, which features high strength and flexibility. A flexible dredging hose widely used in dredgers for silt/gravels conveyance. It is abrasion and wear-resistant to ensure long service life. Types of flexible dredge hose: floating rubber hose, discharge hose, suction hose, armoured hose and ceramic hose.

Keywords**: **Discharge hose, fluid, flexible, suction hose, armoured hose, and ceramic hose

I. INTRODUCTION

A hose is flexible, reinforced tube designed to transfer high pressure fluids from one location to a different. The hose construction typically has inner plastic or rubber tube compatible with the fluid being transferred, metal or fibre reinforcement to stand with pressure and outer plastic or rubber cover protects the reinforcement from external environment.

Nitril Series Easy Couple hose is a multipurpose vinyl nitrile hose that is good for several uses. It is designed for purpose of using with Barb-Tite, push-to-connect reusable hose fittings which make it very easy to work with onsite locations. This hose is good choice for transfer of oil and fuel and the black version is MSHA (2G-13C) approved.

A. Hydraulic hose construction basics

The Modern hydraulic hose generally consists of at least three parts: an inner tube that carries the fluid, a reinforcement layer, and a protective outer layer. The inner tube should have some flexibility and needs to be compatible with the type of fluid it will carry along. Usually used compounds include synthetic rubber, thermoplastics, and PTFE, sometimes is called as Teflon. The reinforcement layer contains of one or more sheaths of braided wire, spiral-wound wire, or textile yarn. The outer layer is frequently weather-, oil-, or abrasion-resistant, depending upon the type of environment the hose is especially designed for. A not surprisingly, hydraulic hoses typically have a finite life. Correct sizing and use of the accurate type of hose will certainly extend the life of a hose assembly, nonetheless there are many different factors that affect a hose's lifespan. The SAE identifies some of the worst offenses as – flexing / twisting the hose to less than the specified minimum bend radius twisting, pulling, the kinking, crushing, or abrading the hose operating the hydraulic system above the maximum or below the minimum temperature. A Exposing a hose to rapid or transient rises (surges) in a pressure above the maximum operating pressure, and intermixing hose, fittings, or assembly equipment not suggested as compatible by the manufacturer or not following the manufacturer's directions for fabricating hose assemblies.

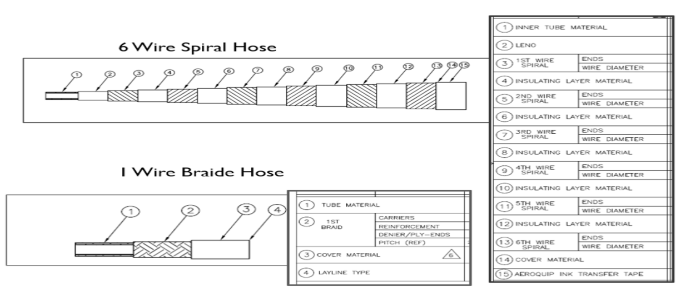

Figure 1: Spiral & Braided Hose construction.

B. Selecting the Correct Hose

Here are the seven suggested steps the system designer should follow during the hose and coupling selection process. To help identify the proper hose for an application, we can use the acronym STAMPED – that is Size, Temperature, Application, Materials, Pressure, Ends, and Delivery. Here are more details for consideration in each area:

Size - To select the correct hose size for replacement, it is imperative to measure the inside and outside hose diameters accurately using a precision-engineered calliper, as well as also the length of the hose. Hose OD is primarily important when hose-support clamps are used or even when the hoses are routed through bulkheads. Check the separate hose specification tables for ODs in suppliers' catalogues. When replacement a hose assembly, always cut the new hose of the same length as the one being removed from system. The moving components of the equipment might pinch or even sever too long a hose. If the replacement hose is too short, pressure might cause the hose to contract and to be stretched, leading to reduced service life of hose. Changes in the hose length when pressurized range between +2% to 4% while hydraulic mechanisms are also in process. Permit for possible shortening of the hose during operation by making the hose lengths slightly longer than the actual distance between the two connections or systems.

Temperature – Mostly all hoses are rated with a maximum working temperature ranging from 200° to 300° F based upon the fluid temperature. Revelation to continuous high temperatures can lead to hoses losing their flexibility. Failure to use hydraulic oil with the correct viscosity to hold up under high temperatures may accelerate this problem.

Please always follow the hose manufacturer's recommendations. Surpassing these temperature recommendations can reduce hose life by as much as 80%. Depending upon materials used, acceptable temperatures shall range from -65° F (Hytrel and winterized rubber compounds) to 400° F (PTFE). Outer temperatures become a factor when hoses are exposed to a turbo manifold or some other heat source. When hoses are typically exposed to high external and internal temperatures concurrently, there will be a considerable reduction in hose service life. Insulating sleeves may help protect hose from hot equipment parts and other high temperature sources that are potentially hazardous. In these situations, an additional barrier is typically required to shield hydraulic fluid from a potential source of ignition.

Application - May the designated hose meet bend radius requirements? This refers to the minimum bend radius (usually in inches) that is a hydraulic hose must meet. Exceeding this bend radius (using a radius smaller than recommended) is mostly to injure the hose reinforcement and reduce hose life. Routes high-pressure hydraulic lines are parallel to machine contours whenever possible. This practice may help save money by reducing line lengths and also minimizing the number of hard-angle, flow-restricting bends. These routing also can protect lines from external damage and promote easier servicing.

Materials - It is required to consult a compatibility chart to check that the tube compound is compatible with the fluid used in the system. Raised temperature, fluid contamination, and concentration will affect the chemical compatibility of the tube and fluid as well. Most of the hydraulic hoses are very compatible with petroleum-based oils. Note that new readily biodegradable or green fluids may present a issue for some hoses.

Pressure capabilities –Hose working pressure must always be selected so that it is greater than or equal to the maximum system pressure, including pressure spikes. Pressure spikes must greater than the published working pressure will greatly shorten hose life.

Hose ends - The coupling-to-hose mechanical interface should be compatible with the hose chosen. The suitable mating thread end must be chosen so that connection of the mating components will result in leak-free sealing.

C. Objective & Project Plan

The objective of this project is to design & validate nitrile (-06 size) on Air Mandrel as opposed Nylon Mandrel currently being used.

1) Measure Milestones:
2) To Identify & Validate the Inner Tube Compound
3) To Finalize Hose Dimensions
4) To Identify risks and mitigation plan
5) To Build the Hose
6) To Perform the Test and validate the results with Nylon Mandrel.
7) To Initiate the PCR (Process Change Request) & PPAP process.
8) To Send the customer Notification

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TABLE I
Project Plan

Phase	Design, Develop & Validate nitrile hose in Mandrel less construction
Phase 1	Project Kick of
	Project Charter (Project Scope)
	Project plan (Volume, Cost out)
Phase 2	Identify & Validate Inner Tube material for Air Mandrel
	Evaluate various hose tube materials for Air mandrel
	Select & validate the suitable inner tube material.
Phase 3	Design & develop the hose
	Tolerance stack-up analysis for ID & OD
	Define & finalize ID & OD Dimensions.
Phase 4	Experimental Hose builds
	Release advance print
	Raise PO for Proto Build
	Develop Proto Build at forest city
Phase 5	Validation of hose by performing product testing.
	Identify test and execute as per test plans
	Purchase Order Hose, Fitting's for Testing
	Get Hose, Fitting's for testing
	Complete Hose Assembly testing
	Complete Compound related testing
	Compare test results against the analytical predictions.
	Capability study
Phase 6	PPAP Approval & Notifications
	Initiate PPAP
	Initiate Customer change Notification
	Release production drawing
	Issue PCR
	Complete PPAP for CL
	Send Customer Notification & Production release
	Lessons learned captured thorough discussion with all project team

II. PROJECT SCOPE IDENTIFICATION

Nitrile Series Easy Couple hose is a versatile vinyl nitrile hose that is good for many uses. It's designed for use with Barb-Tite (Aeroquip Socket less, – Push On) push-to-connect reusable hose fittings which make it very easy to work with on site. This is general purpose hose & widely used in air & Diesel fuel applications. Looking at its wide range of application & annual usage volume, one of the requirements is came from marketing about cost reduction of this hose. Existing hose is made up with mandrel construction. Below is the information about construction, performance, application, usage & potential saving of existing 06 size Hose.

Part Number	Hose I.D.			Hose O.D.			Working Pressure		Min. Burst Pressure		Min. Bend Radius		Hose Weight		Avail. Lengths
	mm	in	fraction	mm	in	fraction	bar	psi	bar	psi	mm	in	Kg/m	lbs/100ft	feet
H20104BK H20104BK-250R H20104BK-500R	6,4	0.25	1/4	12,7	0.50	1/2	20,7	300	82,7	1,200	76,2	3.00	3,6	8	50 250 500
H20106BK H20106BK-250R H20106BK-500R	9,5	0.38	3/8	16,7	0.65	21/32	20,7	300	82,7	1,200	76,2	3.00	5,9	13	50 250 500
H20108BK H20108BK-250R H20108BK-500R	12,7	0.50	1/2	19,1	0.75	3/4	20,7	300	82,7	1,200	127,0	5.00	6,8	15	50 250 500
H20110BK H20110BK-250R	15,9	0.63	5/8	23,8	0.93	15/16	20,7	300	82,7	1,200	152,4	6.00	9,1	20	50 250
H20112BK H20112BK-250R	19,1	0.75	3/4	26,2	1.03	1-1/32	20,7	300	82,7	1,200	177,8	7.00	11,8	26	50 250

Inner Tube: Nitrile
Reinforcement: 1 Fiber Braid
Cover: Neoprene (Black), Vinyl Nitrile (Colored Hoses)
Temp. Range: -40°C to +100°C (-40°F to +212°F)

Typical Application: General purpose hose. Air and diesel fuel applications.
MSHA Approved (Black only)

Note: For colors change BK to: Gray (GY), Red (RD), Green (GN) & Yellow (YW), Blue (BU)

Hose Fitting Reference	Page
Field Attachable	
100 'B' Barb-Tite® Series	K-5-7

Figure 2: Existing Reference 20106 Nitrile Hose information.

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Initiated a program to introduce a 201 hose that is make on an air mandrel as opposed to the nylon platform currently being used. The primary CTQ identified by the team was tube material that maintains its' concentricity independent of mandrel type employed during processing. This identified property was determined to be related to the "green" or unvulcanised strength of the tube compound. A request was made to assist in the selection of a current FC production compound as a potential replacement formulation for the 201 incumbent 640-99.

III.IDENTIFY & VALIDATE INNER TUBE MATERIAL FOR AIR MANDREL

An important step in hose design is the identification of inner tube material. For identification of tube material, we have searched for existing hoses which are made up with mandrel less construction, & we got following options.

TABLE II
Material identification

Part Number	Size	Description	Tube Stock
EC03804	04	AIR BRAKE	F26053
EC03806	06	AIR BRAKE	F26053
EC03808	08	AIR BRAKE	F26053
H11605	05	Mandrel-Less Boston Performer II	F23210
H11606	06	Mandrel-Less Boston Performer II	F23210
H11606BU	06	Mandrel-Less Boston Performer II	F23210
H11608	08	Mandrel-Less Boston Performer II	F23210
H177604	04	Mandrel-less Boston Perfection	F23052
H177606	06	Mandrel-less Boston Perfection	F23052

We did detailed study of each hose tube compound, its properties, performance & application, with reference to this study we got below results about the properties, Green tensile strength of the rubber material is important parameter, The green strength of an elastomer is its resistance to deformation and fracture before vulcanization. As per our study & results in table, we found that F23052 tube compound is having 132.60 psi tensile strength which is less than existing 640-99 compound (133.48 psi). FC26053 compound is having 490.07 psi tensile strength which is very higher than existing 640-99 compound (133.48 psi) & costlier also. Looking at our requirements FC23210 is found more suitable option because it is having 171.00 psi tensile strength which is within our limits. After identification of FC23210 material, we have done material testing of this compound

TEST PROCEDURES AND RESULTS:
Test procedures and results shown on the following pages of this report.

MATERIAL LAB REQUEST			
REFERENCE:	ML3816		
PROCEDURES: CHECK ALL THAT APPLY AND PROVIDE APPROPRIATE PARAMETERS BELOW. ADD ADDITIONAL PROCEDURES AS NECESSARY			
	DESCRIPTION:	SPECIFICATION	PARAMETERS
☒	Cure Press	ASTM D 3182 F23210 and 640-99	Time: 30' Temperature: 320°F
☒	Durometer Hardness (Shore A)	ASTM D 2240-95	
☒	Large dumbells 20"/min	ASTM D 412-92	
☒	Air Age	ASTM D 573-88	Time: 70hrs Temperature: 100°C
☒	Effects of liquids	ASTM D 471-95 + VS	Time: 70hrs Temperature: 127°C Fluid: IRM903
☒	Effects of liquids	ASTM D 471-95 + VS	Time: 70hrs Temperature: 21°C Fluid: Diesel Fuel
☒	Effects of liquids	ASTM D 471-95 + VS	Time: 48hrs Temperature: 21°C Fluid: Fuel B

Figure 2: Original Properties

Compound	Tensile (psi)	% Elong	100% Mod (psi)	Shore A
640-99	1853.39	263.55	858.88	77
F23210	1454.31	343.47	604.70	76

Figure 3: Percent Change Air Aging Properties 70hrs @ 100°C
(Tensile change max 20%; Elong change max 50%)

Compound	Tensile (psi)	% Elong	Shore A
640-99	12.66	35.26	-15.58
F23210	18.79	28.91	-11.84

Figure 4: Percent Change IRM 903 Oil Aging Properties 70hrs @ 127°C (Max 100% VC)

Compound	Tensile (psi)	% Elong	Shore A	VC (%)
640-99	26.29	46.06	16.88	21.23
F23210	39.07	34.86	27.63	38.25

Figure 5: Diesel Fuel Aging Properties 70hrs @ 21°C (Max 60% VC)

Compound	Tensile (psi)	% Elong	Shore A	VC (%)
640-99	10.12	9.99	16.88	15.57
F23210	30.46	20.49	27.63	32.13

Figure 6: Fuel B Aging Properties 48hrs @ 21°C (Max 40% VC)

Compound	Tensile (psi)	% Elong	Shore A	VC (%)
640-99	27.13	24.41	24.68	31.58
F23210	44.04	33.14	42.11	38.19

Figure 3: Material Properties

Testing was performed according to the ASTM standards described in the "Test Procedures and Results" section above. The only deviation is the unvulcanised rubber tensile strength assessment.

The results in figure describe the "green", unvulcanised rubber tensile strength measurement which has been incriminated as a primary factor affecting hose tube dimensional stability. The results suggest that the current production compound used at the Forest City plant that has the strongest "green" strength is F26210 (171.00 psi) which has a 21.94% higher tensile strength then the 201 incumbent 640-99 tube. Other non-standard recipes that can be implemented into Forest City are 31440 and 640-33 (26.50% and 31.15% higher tensile strength respectively) based on the generated data. The project team took this data and found success in constructing -6 and -8 builds with some minor "tweaking" to obtain the desired dimensions.

The second section of this test request was generated to ensure that changes to 201 continue to meet the ES4189 specification. The requirements include air, IRM903, diesel and fuel B exposure testing. The results in figure 2 detail the original properties of the F23210 and 640-99 compounds. A comparison of the two formulations characterizes the F23210 as having a 21% lower tensile strength, 23% higher percent elongation and a 30% lower modulus as opposed to the incumbent 640-99.

Figure shows the results generated after air aging at 100°C for 70 hours. The data suggest that F23210 has slightly higher change in tensile strength (6%) and 7% less change in percent elongation versus 640-99. Both compounds pass the ES4189 specification of 20% maximum tensile change and 50% maximum elongation change.

The results from IRM 903 oil exposure are detailed in figure 4 where F23210 passed the ES4189 standard of allowing a maximum of 100% volume swell after 70 hours at 127°C with a 38.25% result. Similar to the above-mentioned air aging results, F23210 lost more tensile strength (11%) and had higher percent elongation retention (12%) when compared to 640-99.

While diesel fuel (figure 5) proved to have up to a 20% higher negative effect (tensile strength) on F23210 versus 640-99, it still easily passed the ES4189 limit of 60% volume swell with a 32.13% measured value.

The final fluid exposure was a 48 hour at 21°C material soak in ASTM reference fuel B which is a blend of 70% isooctane and 30% toluene. The data in figure 6 imply that F23210 is adversely affected by fuel B up to 18% (shore A) more than the incumbent elastomeric formulation. Additionally, F23210 narrowly passed the ES4189 volume swell requirement of 40%.

In conclusion, while the F23210 recipe does vary from the incumbent 201 recipe (640-99), it does pass the ES4189 fluid compatibility requirements. Additionally, F23210 has proven successful in the -6 and -8 201 builds from July 2014 from a processing and concentricity aspect. These results together suggest that F23210 is a good candidate for the 201 mandrel less hose project.

Compound	Tensile (psi)
F23052	132.60
640-44	145.42
*640-99	133.48
F23210	171.00
**F26053	490.07
3799-4	119.72
3799-1	137.82
3799-3	129.95
3799-2	123.12
31440	181.64
640-33	193.87

Figure 4: Green Tensile Strength

IV. LITERATURE STUDY

As per the Hose Handbook 2003, the three basic methods of making hose are: (1) non-mandrel, (2) flexible mandrel, and (3) rigid mandrel. In methods (2) and (3), the mandrels are typically used for support and as dimensional control devices for the hose tube during the processing. Then after the hose building and, if required, the vulcanization is complete, the mandrels are removed, inspected and recycled. Non-mandrel Type -The non-mandrel method of manufacture is usually used for lower working pressure (less than 500 psi), smaller diameter (2" and under), textile reinforced products may not require stringent dimensional tolerances. Normally hose products in this category would include garden, washing machine inlet, and multipurpose air and water styles etc. Fundamentally, the non-mandrel technique involves extruding the tube, applying the reinforcing, and extruding the cover in an unsupported mode (It's without a mandrel).

Most often low-pressure air is used inside the tube for a minimal support, keeping the tube from flattening during the reinforcing process. In some cases, particularly 1" to 2" ID, the tube might be extruded with air injection along with an internal lubricant to avoid adherence to itself. The non-mandrel tube extrusion process may be done continuously, if appropriate handling equipment is accessible, thus providing outstanding length patterns for the finished products. In a recent year with developments in die design and cooling, dimensional control of non-mandrel rubber tube is approaching that of flexible mandrel style. Most smooth bore thermoplastic hoses usually are extruded non-mandrel. The higher rigidity of most thermoplastics removes the need for mandrel support. In addition, with the advanced cooling and dimensional sizing equipment, thermoplastic tube dimensions may be maintained quite accurately.

Flexible Mandrel Type - When a moderate tube processing support is needed and more accurate dimensional tolerances are a required, flexible mandrels may be utilized. These mandrels are either rubber or thermoplastic extrusions, sometimes may with a wire core to minimize distortion. This style process can be used for mid-range working pressures (up to 5000 psi) with ID's of 1/8" to 1-1/2". Of the three flexible mandrel types, solid rubber offers negligible support, while rubber with the wire core and thermoplastic versions provide decent dimensional control. In all these cases, the flexible mandrel is usually removed from the hose with either the hydrostatic pressure or mechanical push/pull after processing. The mandrel is later then inspected for dimensional and the cosmetic imperfections, re-joined into the continuous length, and recycled into a hose making process. Though the flexible mandrel is continuous, limitations of expulsion from the finished hose hardly allow hose lengths above 1000 ft. Either textile or wire reinforcements can be used. Examples of this style product are the power steering, hydraulic, a wire braided and air conditioning hoses.

Rigid Mandrel Type - In larger a hose sizes, where flexible mandrels become quite cumbersome to handle and working pressures are high, or stringent dimensional control is mostly required, the rigid mandrel process is the most preferred technique. This method is used for any rubber hose greater than 2" ID and for 1/8" to 2" ID constructions that have higher working pressures, particularly wire spiral reinforced products. The rigid mandrels are usually aluminium or steel. For a specialty application where cleanliness is a necessity, stainless steel mandrels can be used

V. DESIGN & DEVELOPMENT

After finalizing the tube compound, next step is to define ID & OD dimensions. We have performed Tolerance stack up analysis for this. We have taken existing mandrel hose OD & Cap ID dimensions to find out min & maximum gap requirement.
With reference to that we got below results.

A. *Hose OD & Hose cap ID*

Root Sum Square Tolerance Stack-up analysis was done to identify the gap requirement between hose OD & Hose cap ID.

- Root Sum Square Method

$$t_{RSS} = \sqrt{\sum_{i=1}^{n} t_i^2}$$

t_{RSS} = Total expected (Equal Bilateral) variation using MRSS method
n = Number of contributing dimension
t_i = Equal Bilateral tolerance for the individual contributing dimension

Figure 5: Root sum square method Equation

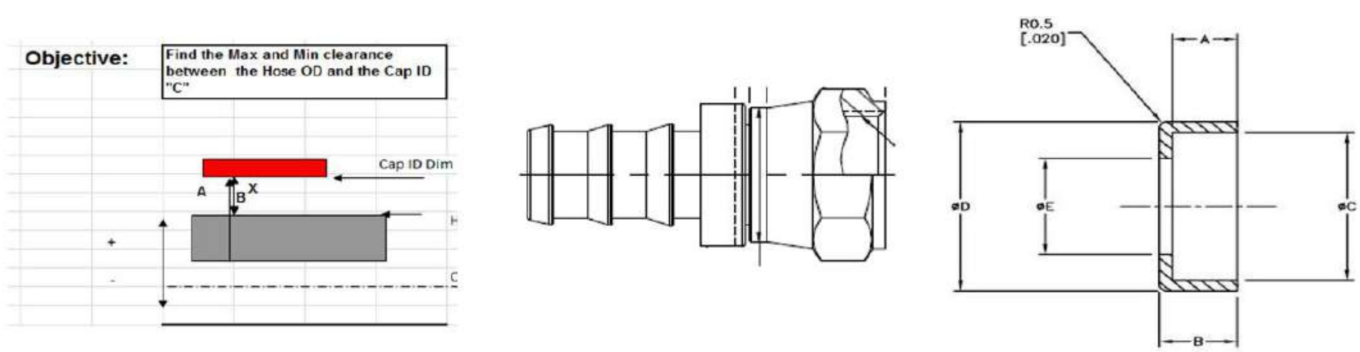

Figure 6: Hose OD & Cap ID Tolerance Stack up

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TABLE III
Tolerance stack up

Dimension Totals	9.75	8.3375	1.0325	
Nominal Dim.= (Pos - Neg. Dim)=		1.4125		
Result	Nominal	Tolerance	Maximum	Minimum
Worst Case Method	1.4125	1.0325	2.445	0.38
Statistical Stack (RSS)	1.4125	0.65858	2.07108	0.75392
Adjusted Statistical: 1.5*RSS	1.4125	0.98787	2.40037	0.42463

Concentricity of hose ID to OD = 1.02 / 2 = 0.51
Min 0.7539 mm clearance required for Cap and new Hose OD

B. Hose ID & Nipple OD

Root Sum Square Tolerance Stack-up Anaylasis was done to identify the gap requirement between hose ID & Nipple OD.
Some interference observed between Nipple OD & Hose ID which was acceptable considering exapansion of rubber tube material.

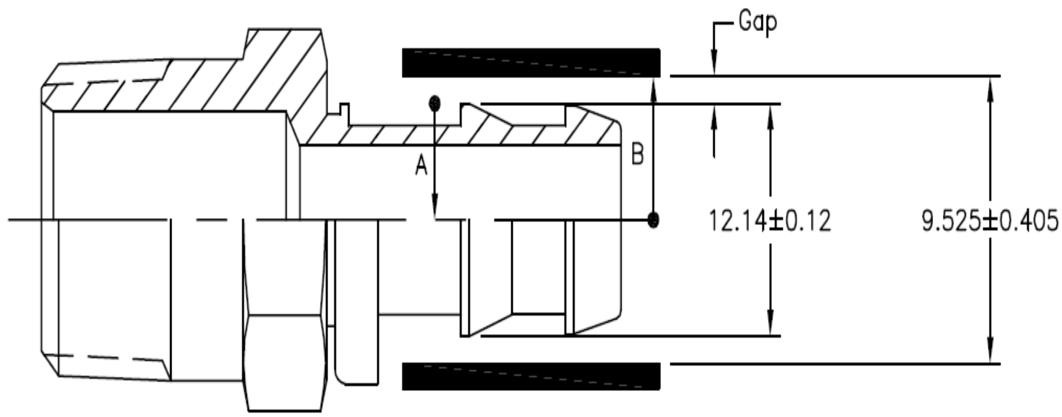

Figure 7: Tolerance stack-up Hose ID & Nipple OD

TABLE IV
Tolerance stack up hose id nipple Od

Dimension Totals	4.7625	6.07	0.8975	
Nominal Dim. = (Pos - Neg. Dim)=		-1.3075		
Result	Nominal	Tolerance	Maximum	Minimum
Worst Case Method	-1.3075	0.8975	-0.41	-2.205
Statistical Stack (RSS)	-1.3075	0.56598	-0.74152	-1.87348
Adjusted Statistical: 1.5*RSS	-1.3075	0.84897	-0.45853	-2.15647

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C. Hose ID & OD selection

With the help of Tolerance Stack-up Analysis, Hose handbook & Benchmarking approach, we came up with below ID & OD dimensions for new hose.

TABLE V
Dimension selection

Dash Size	-6	
201	Min	Max
I.D	9.12	9.93
O.D	15.88	17.47

VI. EXPERIMENTAL HOSE BUILD

After finalizing the dimensions, the mandrel less hose build process begins. Below figure shows the steps of sample preparation.

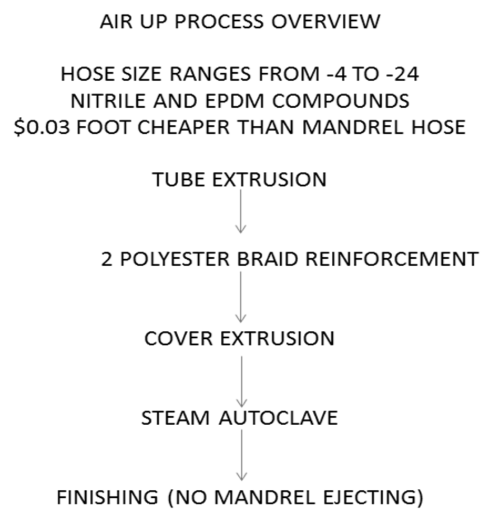

Figure 8: Hose build process

VII. DESIGN & DEVELOPMENT

Below test were finalized to perform in concept testing to establish the initial diameter range.

1) Assembly
2) Examination of Product
3) Proof Pressure
4) Elongation and Contraction
5) Leakage
6) Burst Pressure
7) Cold Flexibility Test
8) Ozone Resistance
9) Adhesion Test
10) Oil Resistance
11) Tensile Test
12) Dry Heat Resistance
13) Fuel Resistance Test
14) Diesel Fuel Resistance Test
15) High Temperature Burst

We decided to build 6 samples for testing to get more reliable result.

TABLE VI
PRODUCT TEST & VALIDATION

Test Type	Test Purpose	Failure Criteria
Examination of product	To determine the hose and end fittings are in conformance with applicable Eaton drawings with respect to material, size and workmanship	The samples shall conform to the requirements of applicable Eaton drawings with respect to material, size and workmanship.
Proof	This test is used to determine the integrity of the hose fitting interface.	There shall be no evidence of permanent deformation, damage or leakage from the hose assembly during or at the completion of this test.
Elongation & contraction	This test is used to determine whether the proper braid-angle has been used for the end application. Deformation is calculated in Pressurizes and de-pressurized condition on Specified length	Elongation or contraction in excess of the limits specified in the applicable engineering document referencing this test shall be cause for rejection.
Leakage	This test is used to determine the leak-proof integrity of the hose-fitting combination at 70% of the hose minimum burst pressure.	Any evidence of leakage from hose or fittings, hose burst, fitting blow-off or other malfunction shall constitute failure.
Burst	This test is used to determine the ultimate pressure potential of an assembly. Burst pressure and type of failure also indicate the quality of the assembly process	The hose shall not burst, the fittings shall not blow off or loosen, and there shall be no leakage from the hose or fittings or other evidence of malfunction below the specified burst pressures. The type of failure shall be recorded.
Cold Flexibility test	This test is used to establish the suitability of the hose, and tube-stock compound, in cold-weather applications.	Evidence of cover cracks or leakage during proof testing shall be cause for rejection.
Ozone Resistance	This test is used to determine the comparative ability of rubber compounds to withstand the effects of normal weathering, or exposure in an atmosphere containing controlled amounts of ozone	After 70 hours of exposure, the samples shall not show evidence of cracking or deterioration while viewed under 7x magnification and still in the stressed condition.
Adhesion Test	This test is used to determine the adhesion strength between different layers of hose.	An average adhesion value lower than the values specified in the applicable engineering documents shall be cause for rejection.
Oil Resistance	This test is used to determine the relative fluid resistance qualities of the tube and cover compounds.	Volume change shall not exceed the amount specified in the applicable engineering document.
Tensile test	This test is used to determine the integrity of hose fittings interface, when subjected to tensile force.	he hose assembly, complete with fittings, shall withstand a minimum pull of values specified in the applicable engineering documents without separation from the end fittings or rupture of the hose structure. Test assemblies shall not pull apart or pull out of the end fittings at less than the values specified in the applicable engineering documents.

VIII. OBSERVATION

Cold temp flexing test was done on one sample only and met the required criteria. All the hose samples made out of F23210 Inner tube compound met the High Temp. Burst, Ozone & Cold Temp Flexing test.

IX. CONCLUSION

201 hose made by F23210 Inner tube compound has passed the entire performance requirements as specified in ES 4189. Based on the test results for F23210 material testing (Refer R-0119A) and test results conducted, we recommend building 201 in Mandrel less construction with the suggested inner tube material.

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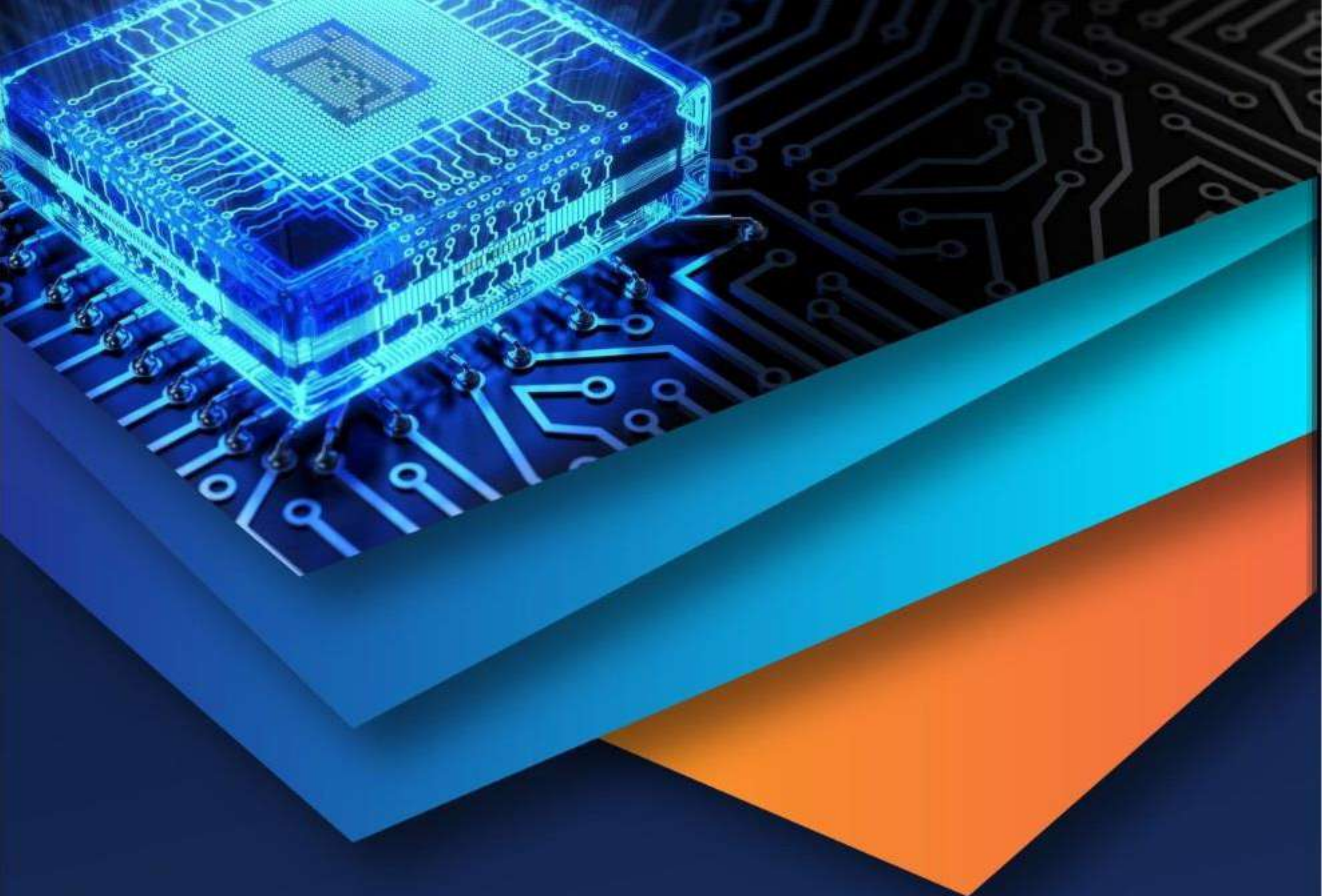

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Design of Shell Tube Heat Exchanger Using Vibration Analysis

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***Abstract:** The condenser with BXM configuration in manicoy and Agatti plant worked well without any accident, but the condenser with BXV configuration in karavati plant failed six times in a year. The vortex shedding, elastic instability and accoustic vibration of the tube bundle this parameter are analyzed. And further modes of vibration and fundamental are studied with parameters like tube pitch, span and cross flow velocity were made. Optimum tube pitch for allowable cross flow velocity, minimum amplitude of vibration short span lengths for vibration free heat exchanger are determined. Vibration analysis results find for BHM to BXM type heat exchange installed in Minicoy and Agatti Desalination Plants. Shell and Tube Heat exchangers are with TEMA configuration BHM in Minicoy and Agatti desalination plants and BXM in Kavaratti with fresh nominal water generation capacity is 100 m3/day.*
***Keywords:** Heat Exchanger, vibration, tube, span length, pipe, Temperature.*

I. INTRODUCTION

The plant for low-temperature thermal desalination (LTTD) works on the principle of flash distillation, in which warm seawater (at around 28 °C) evaporates in a chamber kept under vacuum (at around 27 mbar abs) and the resulting vapor is then in a condenser is liquefied. A shell and tube heat exchanger (STHE) in which 12°C cold deep sea water flows within the shell and tube was selected considering its various advantages such as low pressure drop, multiple tube pass arrangement, easy maintenance and robust mechanical construction. The heat exchanger contains 90/10 cupro-nickel tubes enclosed in a SS-304L shell in which steam flows. The pipes are exposed to high vibration bending stresses and corrosives that can lead to pipe failure (Jahangiri, 2011). Corrosion can be mitigated by proper shell and tube bundle material selection, while vibration can be mitigated by proper design against tube failure, so flow induced vibration is considered an integral part of thermal design. Fluid elastic instability, random excitation or turbulent buffeting, vortex shedding or periodic wake shedding, and acoustic resonance lead to tube vibrations in shell and tube heat exchangers (Pettigrew and Taylor, 2003a and b). Among these excitation mechanisms, the most severe vibration mechanism is fluid elastic instability, which may cause tube damage after few hours of operation and buffeting due to flow-turbulence causes very little vibration, which causes tube wall thinning, due to fretting, such causes of vibration must be avoided (Goyder, 2003 and Price, 2001). For closely spaced tube arrays with pitch ratio less than 2, the vortex shedding degenerates into broadband turbulent eddies resulting in turbulent buffeting (Blevins, 1990). Due to cross flow, turbulence increases in tube bundles as the fluid flows across the array geometry and, as such, the tubes are subjected to turbulent buffeting (Polak and Weaver, 1995). Shell and tube heat exchanger design can be optimized by changing the tube length which shows influence of shell acoustic frequency, tube natural frequency, bundle cross flow, critical velocity, and vortex shedding ratio (Gawande, et al.,2011). All the above studies are based on fundamental frequency only; there may be influence of higher modes on vibrations. A detailed analysis was carried out for flow induced vibrations due to fluid elastic instability, vortex shedding and acoustic resonance of the tube bundle along with the fundamental and higher modes of vibration by changing various parameters such as span, tube pitch and cross flow velocity.

II. PROBLEM STATEMENT

The heat exchanger is the most important concept in the thermal field and also vibration is always associated with it, so analyzing the vibration state of the heat exchanger is challenging. A mathematical model to minimize the annual costs incurred in operating a heat exchanger needs to be formulated and optimized. The thermal and physical properties of the two fluids at the inlet conditions are known. The heat exchanger is an integral part of its thermal design. A proper design is absolutely secure against tube failure due to flow induced vibration. Most sophisticated thermal design software packages perform vibration analysis as a routine part of thermal design. This is important because during thermal design the geometry of a heat exchanger is ultimately established and that same geometry along with flow, physical and property parameters will determine whether the given heat exchanger is safe from tube failure due to flow induced vibrations.

Flow induced vibration is a very complex subject and involves the interaction of several parameters, many of which are not very well known.

Although many cases of tube failure due to flow-induced vibration have been reported in recent years, an understanding of the factors responsible for these failures leaves much to be desired. The literature reveals several interesting studies on specific facets of the vibration problem; however, very little research has addressed the specific problems associated with shell and tube heat exchangers.

It is desirable that the heat exchanger be designed for given outlet temperatures of both the shell-side and tube-side fluids. The heat transfer area and pump power required to achieve the desired temperature conditions were calculated as a function of the design variables. The objective function is a function of the effective heat transfer area and the pumping power required to overcome the pressure drop.

III. LITURATURE REVIEW

A. Durgesh Bhatt, Priyanka M Javhar-2012

Durgesh Bhatt, Priyanka M Javhar conducted a Shell and Tube Heat Exchanger Performance Analysis It is observed that by changing the value of one variable the by keeping the rest variable as constant we can obtain the different results. Based on that result we can optimize the design of the shell and tube type heat EXCHANGER. HIGHER THE THERMAL CONDUCTIVITY OF the tube metallurgy higher the heat transfer rate will be achieved. Less is the baffle spacing , more is the shell side passes, higher the heat transfer but at the cost of the pressure drop.

B. Vindhya Vasiny Prasad Dubey, Raj Rajat Verma-2014

Dubey and Verma conducted a Performance Analysis of Shell & Tube Type Heat Exchanger under the Effect of Varied Operating Conditions and concluded that It may be said that the insulation is a good tool to increase the rate of heat transfer if used properly well below the level of critical thickness. Amongst the used materials the cotton wool and the tape have given the best values of effectiveness. Moreover the effectiveness of the heat exchanger also depends upon the value of turbulence provided. However it is also seen that there does not exists direct relation between the turbulence and effectiveness and effectiveness attains its peak at some intermediate value. The ambient conditions for which the heat exchanger was tested do not show any significant effect over the heat exchanger's performance.

C. Dawit Bogale-2014

Dawit Bogale conducted a experiment on shell and tube heat exchangers showing optimization and redesign of the machine is done for both mechanical and thermal designs and the simulation for the heat transfer between the two fluid is analyzed using the concept of CFD (Computational Fluid Dynamics) using Gambit and Fluent software's. The final result of the STHEx in HBSC which is the redesigned STHEX can achieve or efficiently work to achieve the required outlet temperature 340˚C the temp at which the beer is ready for customer for use.

IV. ADVANTAGES

1) The Design of Shell and Tube Heat Exchangers is very compact.
2) It capable to handling with High Pressure.
3) It less expensive too.
4) Can be used in systems with higher operating temperatures and pressures Pressure drop across a tube cooler is less Tubular coolers in refrigeration system can act as receiver also. Using sacrificial anodes protects the whole cooling system against corrosion Due to the pressure differential use coolers may be preferred for lubricating oil cooling

V. LIMITATION

1) It is very tough to readily analyze the shell side of the tubes for scaling or tube damage.
2) Less efficiency in Heat Exchanger Cleaning and maintenance is Problematic since a tube cooler requires enough clearance at one end to remove the tube nest.
3) It cannot be increased the capacity of tube cooler.
4) It requires more space for drop it at one place.

VI. FUTURE SCOPE

We could not scale up our project due to limitations and limitations of knowledge. Although the heat pipe heat exchanger is a successful project, some improvements are needed. Our focus was to make the project easy and not very expensive. So that it benefits society and can be easily bought. It can also be used in cars. Heat pipe heat exchangers in thermal conductivity are highly effective. Heat pipes do not require any other source of energy such as electricity, they simply work with a working fluid in the heat pipe and heat is absorbed in the evaporator section and then transferred to the condenser where the vaporized liquid then condenses and releases the heat to the refrigeration section. This idea or project can be of great appeal to society as it is eco-friendly.

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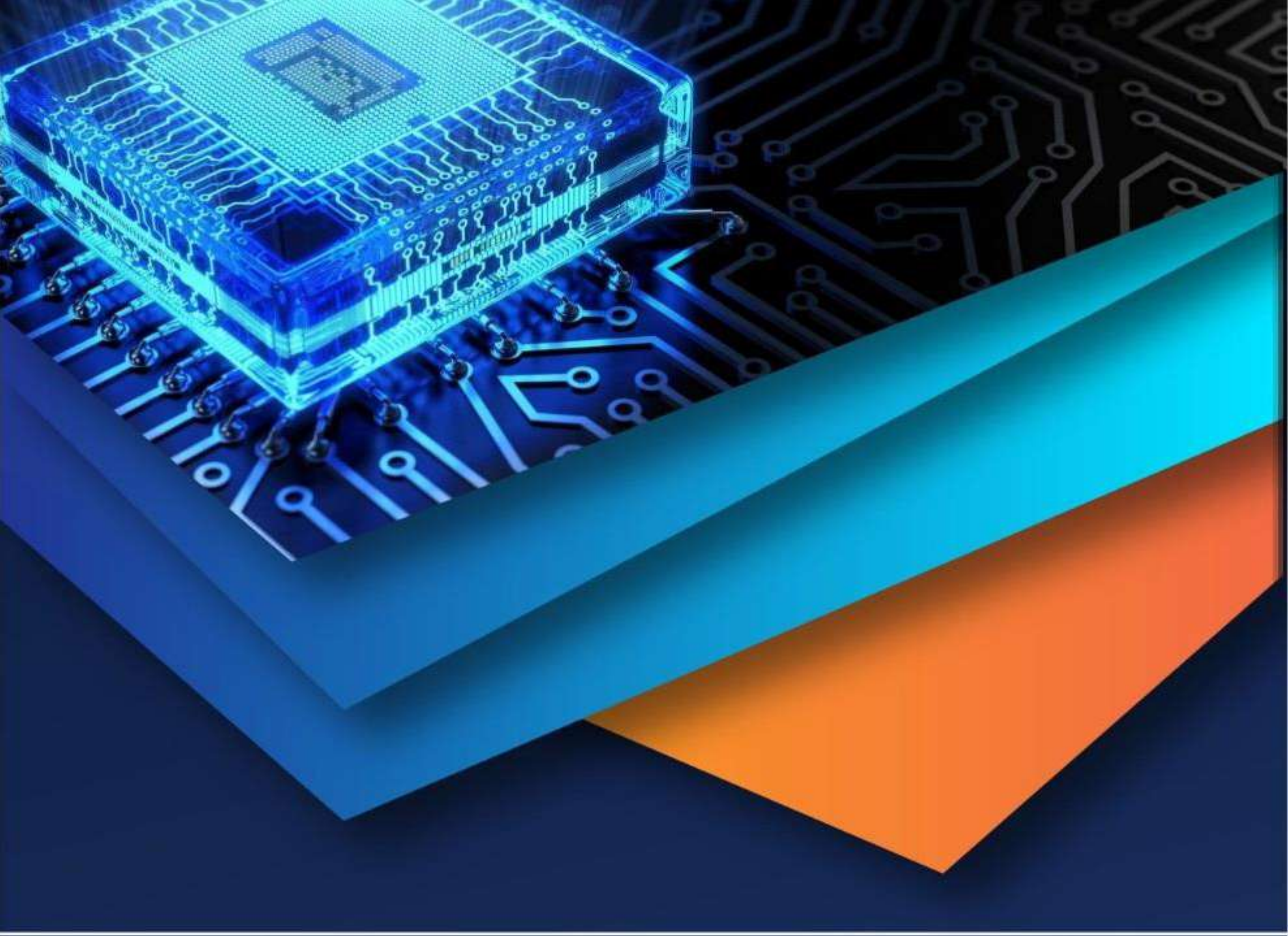

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