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DESIGN AND ANALYSIS OF MOTOR BIKE FRAME

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***Abstract*:**

The chassis frame is the back bone of the vehicle, It's principle function is to safely carry the maximum load for all designed operating conditions. Automotive chassis is the main carriage system of vehicle. The chassis serves as a skeleton upon which parts like gear box and engine are mounted. The two wheeler chassis consists of a frame, Suspension, Wheels and Brakes .The chassis what truly sets the overall style of the two wheeler. Commonly used material for two wheeler chassis is steel which is heavy in weight or more accurately in density. There are various alternative materials like aluminium alloy, Titanium, Carbon fiber, magnesium etc., which are lesser in weight and provide high strength and thus can be used for chassis. This paper deals with design of two wheelers chassis frame and it's weight optimization .Various loading conditions like static and dynamic loadings were carried out on the chassis and the structural stability of the chassis is analyzed by using alternative material while maintaining the strength. The 3D model of the chassis is created using solid works and it's structural behaviour is analysed using ANSYS work bench.

INTRODUCTION

A bicycle, often called a bike or cycle, is a human- powered, pedal-driven, single-track vehicle, having two wheels attached to a frame, one behind the other. The bicycle has undergone continual adaptation and improvement since its inception. These innovations have continued with the advent of modern materials and computer-aided design, allowing for a proliferation of specialized bicycle types. Bicycles can be categorized in many different ways: by function, by number of riders, by general construction, by gearing or by means of propulsion. The more common types include utility bicycles, mountain bicycles, racing bicycles, touring bicycles, hybrid bicycles, cruiser bicycles, and BMX bikes. Less common are tandems, low riders, tall bikes, fixed gear, folding models, amphibious bicycles and recumbent. Unicycles, tricycles and quadra cycles are not strictly bicycles, as they have respectively one, three and four wheels, but are often referred to informally as "bikes".

Engine As a stressed member: For rider comfort, a motorcycle's engine can be mounted on rubber bushings to isolate vibration from the rest of the machine. This strategy means the engine contributes little to frame stiffness, and absorbing rather than dissipating vibration can lead to stress damage to the frame, exhaust pipes, and other parts.

***Steel**:* The most traditional frame material, steel has been used by frame builders for over a century. Many types of steel tubing are available and the material is easy to bend and shape. Plus, there are myriad methods of assembly making steel very adaptable to cyclists' needs. It also offers excellent ride quality, durability, is easily repaired and affordable. If there's a knock on steel, it's that it tends to be heavy when low-quality tubing is used (found on bikes sold at department stores). And steel can rust if treated carelessly (protect that paintjob!).

Entry-level steel-frame bikes are usually less sophisticated than those typically favored by discerning cyclists and steel fanatics. But, the affordability of the lesser steel frames usually allows you to get a better level of components. And, it's possible to make a fine-riding steel frame on a budget by cutting back on some of the frills that add cost.

***Aluminium**:* Aluminium was first used in frame construction in 1895. But, it didn't come into wide use until the 1980's when large-diameter tubing was conceived and construction processes were perfected. Now, it's the most popular of frame materials. It's subject to the same variances in assembly and quality as steel.

The buzz about aluminium is that is has a more jarring ride than the other materials. But, while this used to be the case in its early years, it's not a problem today thanks to new aluminium alloys, tubing enhancements and improved construction techniques. These allow the frames to absorb shock better than ever while still offering the wonderfully lively ride that makes aluminium all the rage today.

***Titanium**:* Titanium (also called "ti") is one of the longest lasting, strongest, and most expensive frame materials. Many cyclists and experts feel that it combines the best characteristics of all the other frame materials. It rivals aluminium in weight, is as comfortable as steel and it has a sprightly ride and electric handling that many riders swear by. The frames feel "alive," as if each pedal stroke gets a boost from an inherent springiness in the frame. Titanium is hard on metalworking tools, requires expensive titanium welding rod and must be joined carefully in a controlled environment. Consequently, titanium frames are very expensive to produce, which explains their high purchase price.

Carbon Fibre: Carbon fibre (also called "carbon" and "graphite") is a relatively new material and unique because it's not a metal. It's a fabric that's impregnated with a glue called resin that allows shaping and joining the material. Carbon frames are extremely light, stiff and durable. Its greatest advantage is that carbon can be manipulated essentially in endless ways (because builders can orient the fabric strands however they want), which means it can be fine-tuned to provide just about any ride qualities desired. It's also impervious to corrosion and can be built into beautiful shapes producing Ferrari-like looks.

LITERATURE REVIEW

A Bi-cycle frame should have low weight, high lateral stiffness and moderate vertical stiffness. Because of chain load, frame lateral deformation during pedaling is bigger when the rider pushes on right pedal (a pro rider may apply a force up to two times his weight). Most of the bicycles built today utilize heat treated steel or aluminium or titanium alloy tubing to minimize their weight. The tubes are then welded together to create the desired fork or frame geometry. In recent years, as manufacturers of racing bicycles and bicycle components have turned to wind tunnel testing to optimize component design3, the athletes themselves are now able to purchase time in wind tunnels to refine and perfect their riding positions. Comprehensive reviews by Burke4 and Lukes cite many efforts which validate the conventional wisdom that the main contributors to overall drag are the rider, the frame including fork and aero bars, and the wheels. Greenwell et.al.6 have concluded that the drag contribution from the wheels is on the order of 10% to 15% of the total drag, and that with improvements in wheel design, an overall reduction in drag on the order of 2% to 3% is possible. Since their invention in 1817, bicycles have proven to be a healthy and environmentally friendly mode of transportation for both enthusiasts and commuters alike. Although the bicycle has remained ubiquitous over time, the world has changed dramatically. Today, US roadways are dominated by automobiles, aggressive, modes of human transport. Unfortunately, bikers are considered second-class citizens as they attempt to share roadways with motorists. In fact, this has been the situation for most of the lifetime of the bicycle.

A schematic of bicycle frame size obtained from the riding experiment is shown in Fig. 1 Generally, the three key feature points: handlebars, the saddle and the central crank, were used as the kernel to mark the frame size. A represents the vertical distance from the saddle to the ground; B the vertical distance from the crank center to the ground; C the vertical distance from the handlebars to the ground; D the horizontal distance from the handlebars to the saddle; and, E the horizontal distance from the crank center to the saddle. By this marking method, different frame sizes for different human dimensions could be clearly illustrated. In this work CFD was used to explore the complex and unsteady nature of air flow around several commercially available front bicycle wheel configurations. Extending our previous work, this study examined more realistic front wheel geometry, adding the front fork, top tube, head tube, down tube, caliper and brake pads to the modeling domain: Three wheels, namely the Zipp 404, Zipp1080 and HED H3 Tri Spoke were considered. In addition, two commercially available front fork designs, the Reynolds Carbon fork and the Blackwell Bandit slotted fork, were also studied. To obtain a sense of the relative performance merits for the design configurations studied here, the overall power requirements were calculated for each combination of front wheel and fork; wheel only configurations were not included here.

INTRODUCTION TO CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Assault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Assault Systems product lifecycle management software suite. CATIA competes in the CAD/CAM/CAE market with Siemens NX, Pro/E, Autodesk Inventor, and Solid Edge as well as many others.

DETAILS OF CATIA:

Developer(s)	***Dassault`s Systems***
Stable release	V6R2011x / November 23, 2010
Operating system	Unix / Windows
Type	CAD software
License	Proprietary
Website	WWW.3ds.com

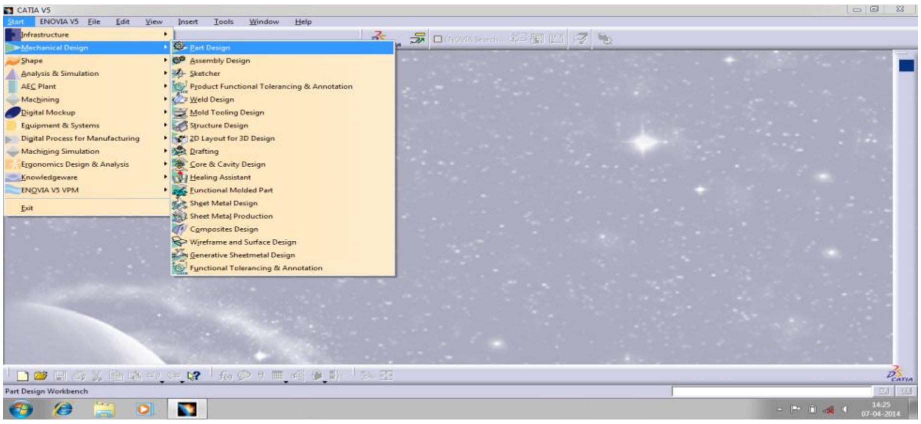
Scope Of Application:
Commonly referred to as 3D Product Lifecycle Management software suite, CATIA supports multiple stages of product development (CAx), from conceptualization, design (CAD), manufacturing (CAM), and engineering (CAE). CATIA facilitates collaborative engineering across disciplines, including surfacing & shape design, mechanical engineering, equipment and systems engineering.

*Surfacing & Shape Design***:**
CATIA provides a suite of surfacing, reverse engineering, and visualization solutions to create, modify, and validate complex innovative shapes. From subdivision, styling, and Class A surfaces to mechanical functional surfaces.

*Mechanical Engineering***:**
CATIA enables the creation of 3D parts, from 3D sketches, sheet metal, composites, and molded, forged or tooling parts up to the definition of mechanical assemblies. It provides tools to complete product definition, including functional tolerances, as well as kinematics definition.

*Equipment Design***:**
CATIA facilitates the design of electronic, electrical as well as distributed systems such as fluid and HVAC systems, all the way to the production of documentation for manufacturing.

Starting CATIA:
To start CATIA there may be icon on the desktop or you may have to look in start menu at the bottom of leaf of the screen windows taskbar .The program takes a while to load, so be patient the start-up is complete when your screen looks like the following figure ,which is a default CATIA screen.



REFERENCE ELEMENTS

Reference elements are used as references for constructing the model. They are not geometry features, but they aid in geometry construction by acting as references for sketching a feature, orienting the model, assembles, components, and so on. Because of their versatility references are frequently used.

1. Reference plane
2. Reference line
3. Reference points

Reference Planes:

Datum planes are used as reference to construct feature. Datum planes are considered feature, but they are not considered model geometry. Datum planes can be created and used as a sketch plane where no suitable exists. Reference plane options used are Thru plane, Offset plane, 9ffset coordinate system, Blend section, thru axis, Thru Point/Vertex, Normal to axis, Tangent to cylinder, Angle to the plane etc.,

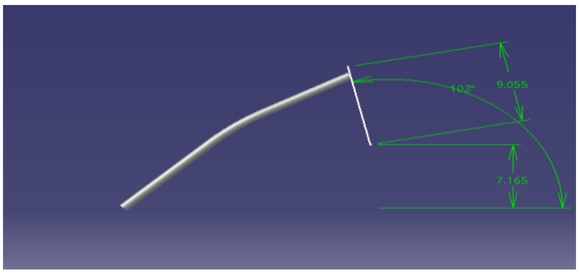
Reference Lines:

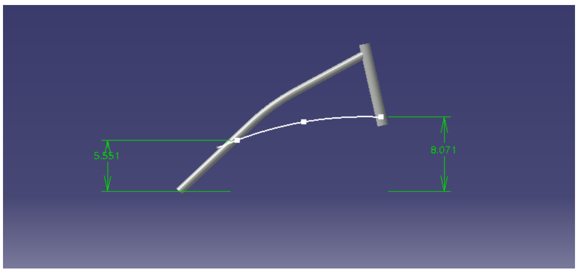
Reference lines are used to create surfaces and other features, or as a sweep trajectories. User sketch reference line in the same manner as any other features. Sketched curves can consist of one or more sketched segment and of one or more open or closed loop.

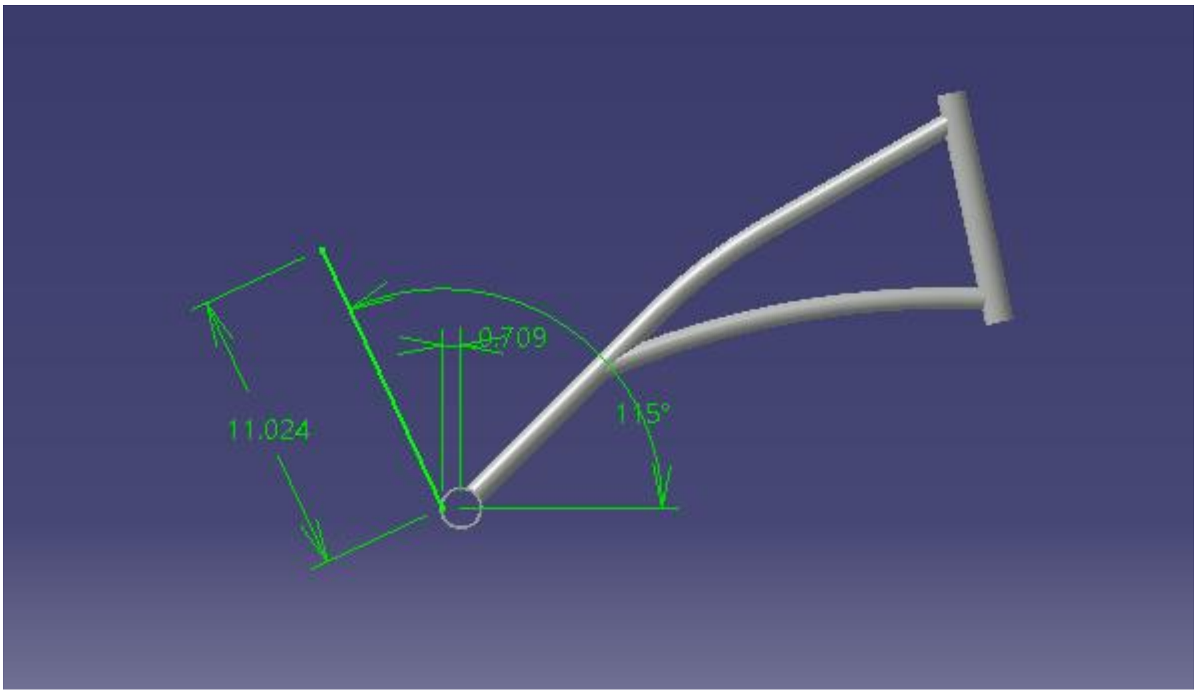
Reference lines option used are: Sketch, Intersection surface, thru point, Form files, Composite, Projected, Formed, Split, Offset from surface, from curve, from curve, from boundary, Offset curve, Form equation etc. Points are used to specify point loads for mesh generation, attach datum targets and notes in drawings, and create coordinate systems and pipe feature trajectories. User can also place axis, planes, holes and shafts at a point.

SKETCH DRAWING:

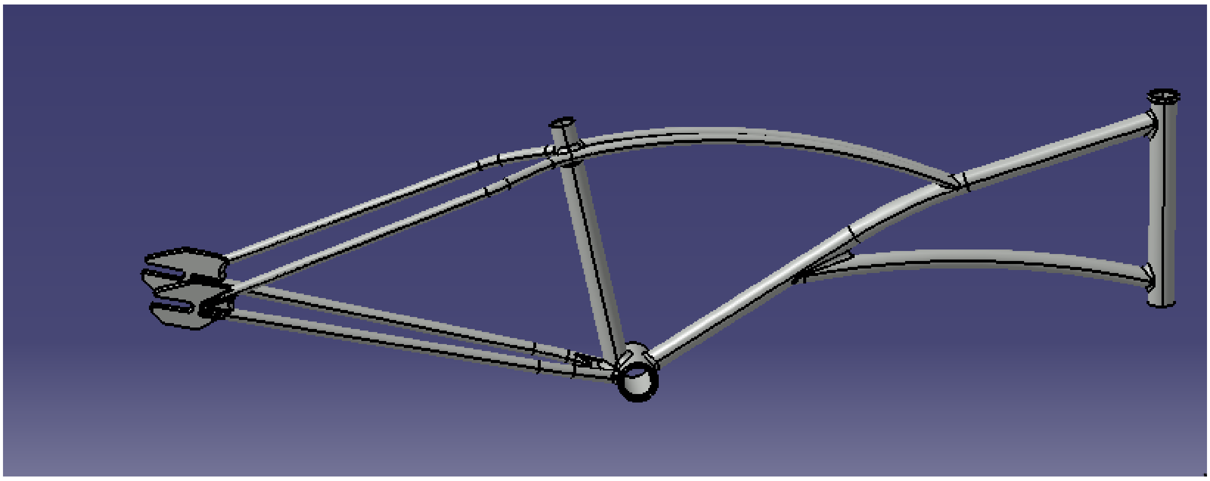
Draw the skecth in 2D







Final Model:

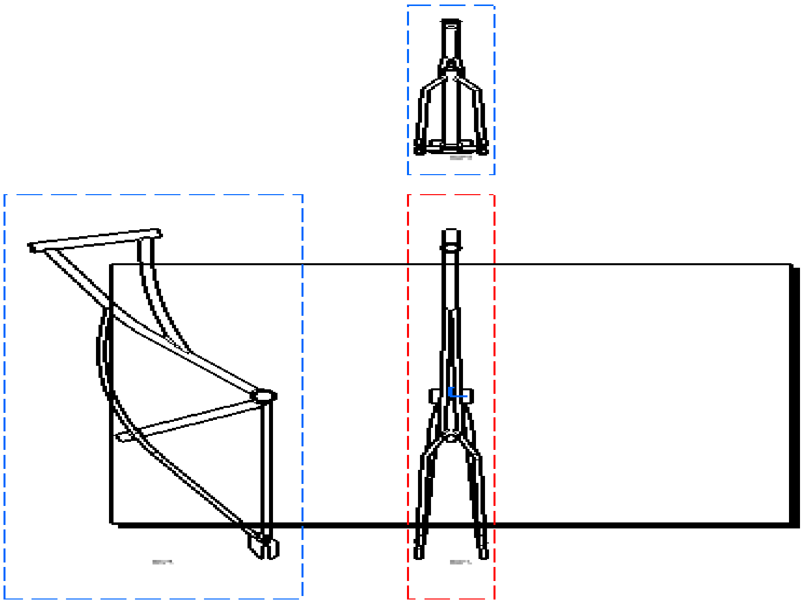


Views

Front View - A front view is a projection see acquired by drawing perpendiculars from all focuses on the edges of the part to the plane of projection. The plane of projection whereupon the front view is anticipated is known as the frontal plane.

Projection View - Projection sees are sees imagined to be drawn or anticipated onto planes known as projection planes. A straightforward plane or sheet of glass speaking to a projection plane is found parallel to the front surfaces of the part.

Isometric View - The Isometric View charge empowers to make a 2D see with any introduction, this introduction being the same as the one in the 3D watcher. Among different outcomes, and relying upon how the 3D watcher is arranged when made the view, can get a consistent X-Y-Z isometric view.



ANSYS

ANSYS is universally useful limited component examination (FEA) programming bundle. Limited Element Analysis is a numerical technique for deconstructing a perplexing framework into little pieces (of client assigned size) called components. The product actualizes conditions that represent the conduct of these components and fathoms them all; making a far reaching clarification of how the framework goes about all in all. These outcomes at that point can be exhibited in arranged or graphical structures. This sort of investigation is normally utilized for the outline and enhancement of a framework very mind boggling to break down by hand. Frameworks that may fit into this class are excessively perplexing due, making it impossible to their geometry, scale, or representing conditions.

ANSYS is the standard FEA showing device inside the Mechanical Engineering Department at numerous schools. ANSYS is additionally utilized as a part of Civil and Electrical Engineering, and also the Physics and Chemistry offices. ANSYS gives a financially savvy approach to investigate the execution of items or procedures in a virtual situation.

Build Geometry:

Build an a few dimensional portrayal of the protest be displayed and tried utilizing the work plane directions framework inside ANSYS.

Define Material Properties:

Since the part exists, characterize a library of the vital materials that form the question (or venture) being demonstrated. This incorporates warm and mechanical properties.

Generate Mesh:

Now ANSYS comprehends the cosmetics of the part. Presently characterize how the displayed framework ought to be separated into limited pieces.

Apply Loads:

Once the framework is completely planned, the last errand is to trouble the framework with requirements, for example, physical loadings or limit conditions.

Obtain Solution:

This is really a stage, on the grounds that ANSYS needs to comprehend inside what state (enduring state, transient… and so on.) the issue must be explained.

Present the Results:

After the arrangement has been gotten, there are numerous approaches to show ANSYS' comes about, browse numerous alternatives, for example, tables, diagrams, and shape plots.

SPECIFIC CAPABALITIES OF ANSYS:

Structural:

Basic examination is presumably the most widely recognized use of the limited component technique as it suggests extensions and structures, maritime, aeronautical, and mechanical structures, for example, send frames, air ship bodies, and machine lodgings, and mechanical segments, for example, cylinders, machine parts, and apparatuses.

1. *Static Analysis* - Used to decide removals, stresses, and so forth under static stacking conditions. ANSYS can figure both straight and nonlinear static examinations. Nonlinearities can incorporate versatility, push solidifying, expansive avoidance, extensive strain, hyper flexibility, contact surfaces, and crawl.
2. *Transient Dynamic* - Analysis - Used to decide the reaction of a structure to self-assertively time-shifting burdens. All nonlinearities specified under Static Analysis above are permitted.
3. *Buckling Analysis* - Used to compute the clasping loads and decide the clasping mode shape. Both direct (Eigen esteem) clasping and nonlinear clasping investigations are conceivable.

Notwithstanding the above examination sorts, a few uncommon reason highlights are accessible, for example, Fracture mechanics, Composite material investigation, Fatigue, and both p-Method and Beam investigations.

Thermal Analysis:

ANSYS is fit for both enduring state and transient examination of any strong with warm limit conditions. Enduring state warm examinations figure the impacts of consistent warm loads on a framework or part. Clients frequently play out an unfaltering state examination before doing a transient warm investigation, to help set up beginning conditions. A consistent state examination additionally can be the last stride of a transient warm investigation; performed after every single transient impact has reduced. ANSYS can be utilized to decide temperatures, warm inclinations, warm stream rates, and warmth fluxes in a question that are caused by warm loads that don't differ after some time. Such loads incorporate the accompanying:

1. Convection
2. Radiation
3. Heat stream rates
4. Heat fluxes (warm stream per unit zone)
5. Heat era rates (warm stream per unit volume)+Constant temperature limits.

A relentless state warm investigation might be either straight, with steady material properties; or nonlinear, with material properties that rely upon temperature. The warm properties of most material differ with temperature. This temperature reliance being considerable, the investigation winds up noticeably nonlinear. Radiation limit conditions additionally make the examination nonlinear. Transient figuring's time ward and ANSYS can both tackle circulations and in addition make video for time incremental presentations of models.

Model Analysis:

A model examination is ordinarily used to decide the vibration attributes (normal frequencies and mode shapes) of a structure or a machine segment while it is being planned. It can likewise fill in as a beginning stage for another, more nitty gritty, dynamic investigation, for example, a consonant reaction or full transient dynamic examination. Show examinations, while being a standout amongst the most fundamental dynamic investigation sorts accessible in ANSYS, can likewise be more computationally tedious than a regular static investigation. A diminished solver, using naturally or physically chose ace degrees of flexibility is utilized to definitely lessen the issue size and arrangement time.

Fluid flow Analysis

The ANSYS/FLOTRAN CFD (Computational Fluid Dynamics) offers complete instruments for breaking down two-dimensional and three-dimensional liquid stream fields. ANSYS is fit for displaying an immense scope of investigation sorts, for example, airfoils for weight examination of plane wings (lift and drag), stream in supersonic spouts, and perplexing, three-dimensional stream designs in a pipe twist. What's more, ANSYS/FLOTRAN could be utilized to perform undertakings including:

1. Calculating the gas weight and temperature conveyances in a motor ventilation system.
2. Studying the warm stratification and separation in funneling frameworks.
3. Using stream blending concentrates to assess potential for warm stun.
4. Doing regular convection examinations to assess the warm execution of chips in electronic fenced in areas.
5. Conducting warmth exchanger examines including distinctive liquids isolated by strong locales.

FLOTRAN investigation gives an exact approach to ascertain the impacts of liquid streams in complex solids without using the run of the mill warm exchange similarity of warmth flux as liquid stream.

Types of FLOTRAN analysis that ANSYS is able to perform include:

Laminar or Turbulent Flows

Compressible or incompressible Flows

Thermal Fluid Analysis

Newtonian or Non-Newtonian Fluids

Adiabatic Conditions

Multiple species transport

Free surface Flow

*NOTE: These types of analyses are not mutually exclusive. For example, a laminar analysis can be thermal or adiabatic.

A turbulent analysis can be compressible or incompressible.

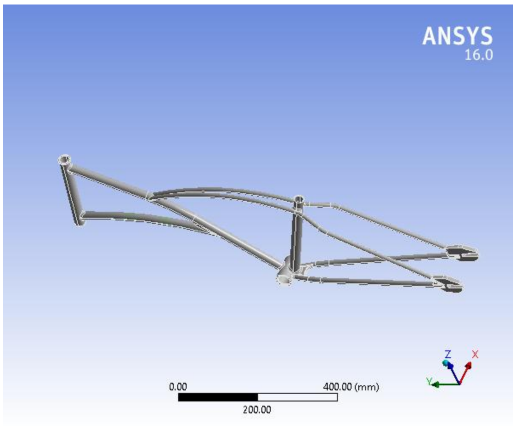
Harmonic Analysis:

Utilized broadly by organizations who deliver turning hardware, ANSYS Harmonic investigation is utilized to foresee the maintained dynamic conduct of structures to steady cyclic stacking. Cases of pivoting machines which delivered or are subjected to symphonious stacking are:

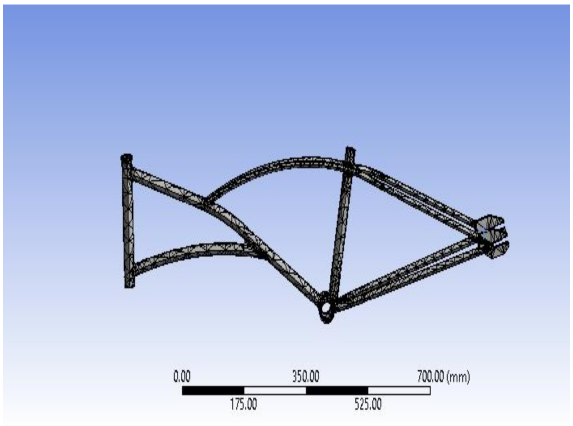
1. Turbines
2. Turbo pumps
3. Internal Combustion engines
4. Electric motors and generators
5. Gas and fluid pumps and
6. Disc drives. A harmonic analysis can be used to verify whether or not a machine design will successfully overcome resonance, fatigue, and other harmful effects of forced vibrations.

Result And Descusion

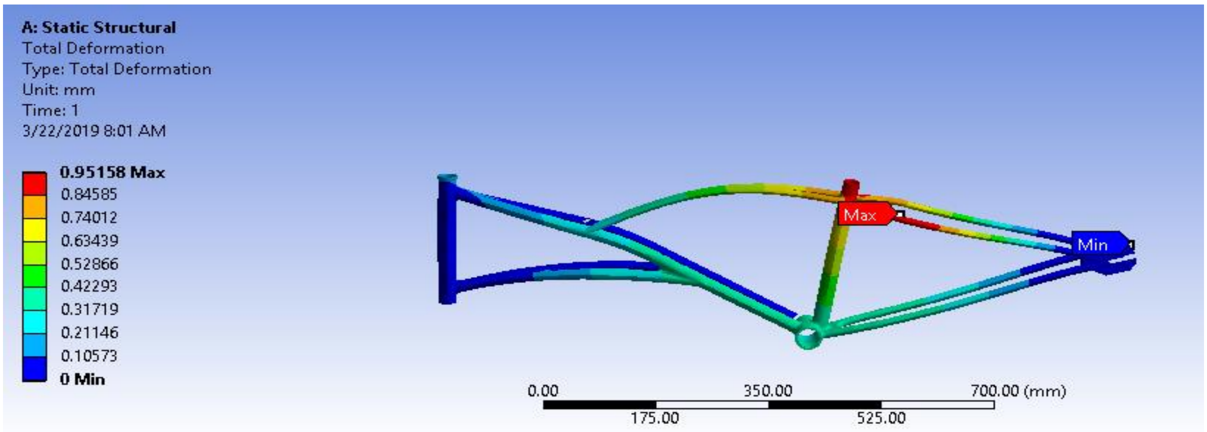
ANSYS Model:



Meshing Of The Frame:



Total Deformation On Steel Material



structural Steel > Compressive Ultimate Strength:

Compressive Ultimate Strength MPa
0

Structural Steel > Compressive Yield Strength:

Compressive Yield Strength MPa
250

Structural Steel > Tensile Yield Strength:

Tensile Yield Strength MPa
250

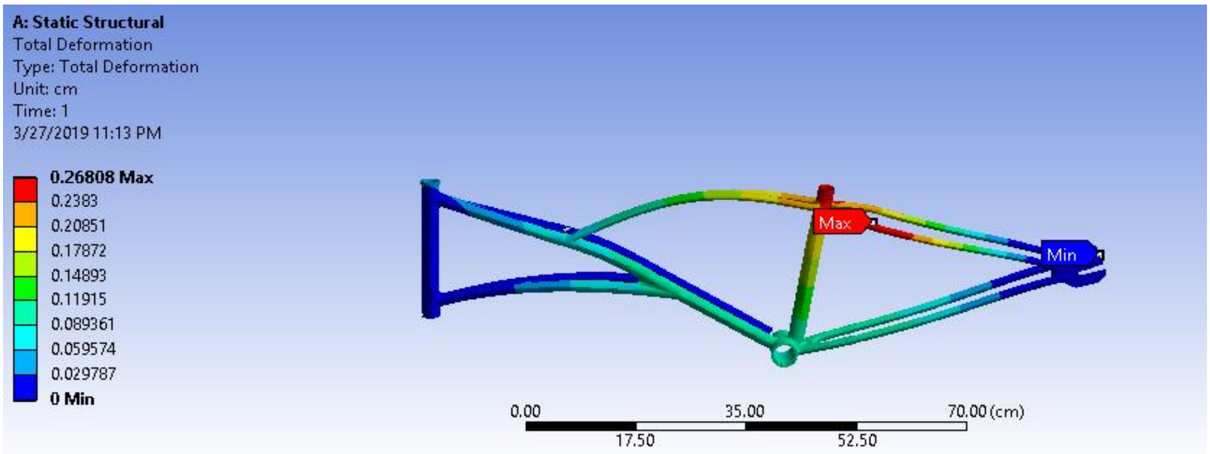
Structural Steel > Tensile Ultimate Strength:

Tensile Ultimate Strength MPa
460

Structural Steel > Isotropic Secant Coefficient of Thermal Expansion:

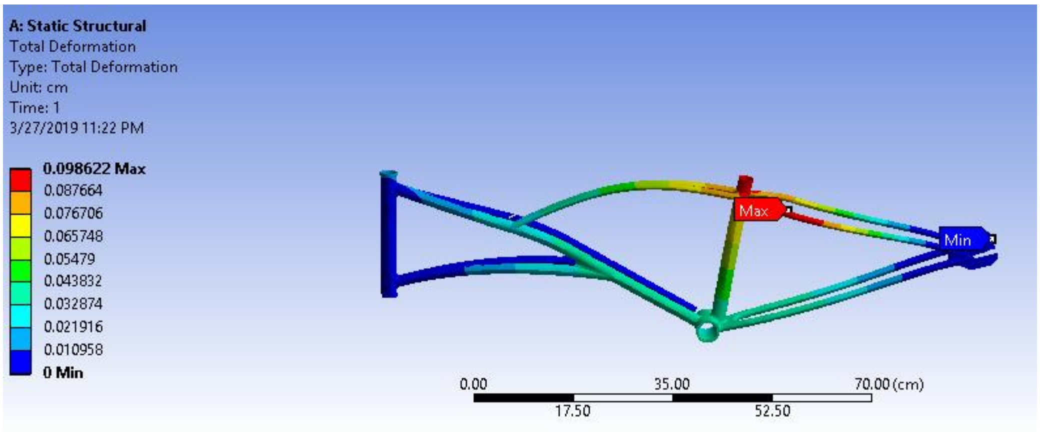
Reference Temperature C
22

Total Deformation On Aluminium Alloy:



Temperature C	*Young's Modulus dyne cm^-2*	*Poisson's Ratio*	*Bulk Modulus dyne cm^-2*	*Shear Modulus dyne cm^-2*
	7.1e+011	0.33	6.9608e+011	2.6692e+011

Total Deformation On Stainless Stee:



Stainless Steel > Tensile Yield Strength:

Tensile Yield Strength dyne cm^-2
2.07e+009

Stainless Steel > Tensile Ultimate Strength:

Tensile Ultimate Strength dyne cm^-2
5.86e+009

Stainless Steel > Isotropic Secant Coefficient of Thermal Expansion:

Reference Temperature C
22

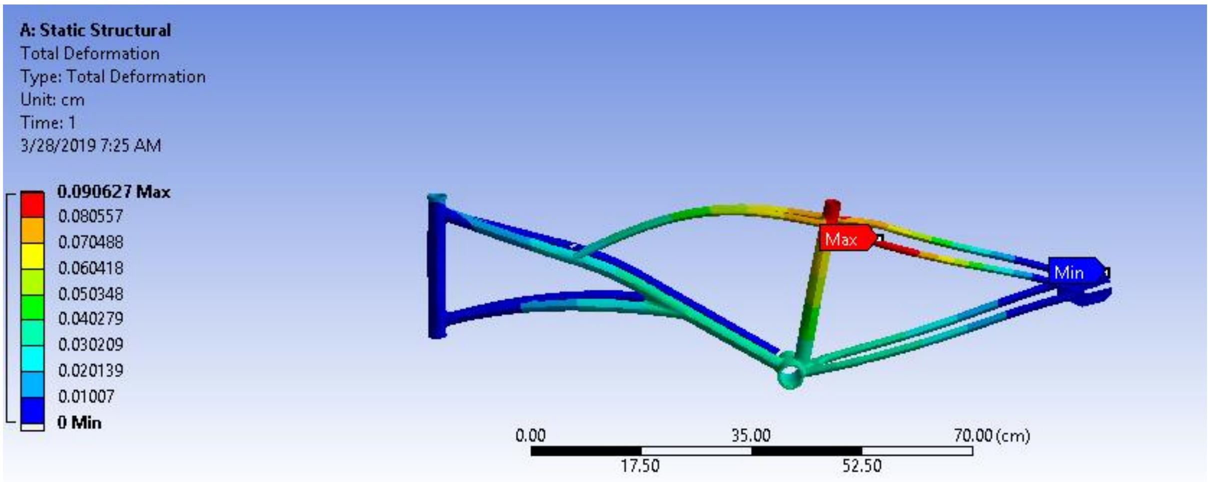
Stainless Steel > Isotropic Elasticity:

Temperature C	Young's Modulus dyne cm^-2	Poisson's Ratio	Bulk Modulus dyne cm^-2	Shear Modulus dyne cm^-2
	1.93e+012	0.31	1.693e+012	7.3664e+011

Stainless Steel > Isotropic Relative Permeability:

Relative Permeability
1

Total Deformation On AISI 1040 steel:



AISI 1040 steel > Isotropic Elasticity:

Temperature C	*Young's Modulus dyne cm^-2*	*Poisson's Ratio*	*Bulk Modulus dyne cm^-2*	*Shear Modulus dyne cm^-2*
	2.1e+012	0.3	1.75e+012	8.0769e+011

AISI 1040 steel > Tensile Yield Strength:

Tensile Yield Strength dyne cm^-2
4.15e+009

AISI 1040 steel > Tensile Ultimate Strength:

Tensile Ultimate Strength dyne cm^-2
6.2e+009

CONCLUSION

The modelling is done in CATIA V5. Presently we are using cast iron material to produce motor bike frame. In this project we have analyzed motor bike frame using “COSMOS “FEM based software by applying Steel and Aluminium material properties. We are replacing the material with Steel and Aluminium material since its density is less than that of Cast Iron, thereby reducing the weight of the component.

By observing the displacement, stress and strain we are concluding that Steel and Aluminium material is better option for the manufacturing of bike frame. By observing the results, using Steel and Aluminium material for motor bike frame is safe. And we have designed mould tool for the same and generated for the core and cavity.

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