International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Non linear Analysis by using C.A.E software for chain

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ABSTRACT

Determining safe load for the chain and the ability of the same to withstand the using Finite Element Modeling would be the core objective of this work. An existing chain link would be used for benchmarking the research work. Suitable Finite Element Analysis tools like ANSYS would be deployed to find the performance of the chain link under tensile loads. Recommendation over the best suited geometry and material would be presented to conclude the work. Experimentation is planned over the benchmark chain link for the validating the methodology in the first phase of the research work.Benchmark chain link to be tested for Tensile Loading by using tensile load testing machine with Data logger suitable prototype would be built for testing purpose. The weakest element would be tested for comparing the results with those obtained by Numerical (Computational) Methodology.

Keywords : ANSYS, Chaim link, Finite Element Model, Tensile load.

I. INTRODUCTION

In the recent trend in automobile sector regarding vehicle performance improvement, research works on both transmission chains attempted by many scholars and other related research works on chain are discussed. In early part of the 20th century in automotive field, most of the studies were concentrated on performance of engines and gear boxes. Global competition has initiated aggressive industrial and economic progress. This trend demands higher productivity levels in automotive manufacturing sector. Since there is a demand to improve the performance and reliability of two wheelers, especially motorcycles, there is a need to improve its components' performances also to increase the total reliability.

All chains 'stretch' during their lifetime and eventually need replacing. Chains don't stretch in the same way elastic bands do they get longer because the metal in the links gradually wear away and makes the overall length of the chain increase. As the chain stretches, the amount of free play increases and you eventually have to move your rear wheel back a bit to take up the slack. If there's too much slack, the chain will jump around lots whenever you change speed. If there is too little slack, the chain will get over tensioned when you slow down and the back end of the bike becomes un weighted. When you replace the chain, always replace the sprockets too – they're much cheaper than the chain anyway. It's a false economy not to, since putting a new chain over worn sprockets will make your chain wear out faster. It's much easier to loosen the bolt which holds the front sprocket when the chain is still on the bike. You put the bike into a high gear and get someone to stand on the rear brake while you loosen the holding bolt a bit. Since the front sprocket is still attached by the chain to the rear sprocket, it can't spin around while you try to loosen it

Motorcycles are high-speed applications that operate in tough conditions-rain, dirt, sand, and high shock loads. These specially developed chains are used as the part of the drive train to transmit the motor power to the back wheel. Motorcycles are getting faster and more powerful. Therefore, Motorcycle Chains must have greater durability. At the same time, motorcycles are getting lighter and smaller. Roller chains are widely used as pulling and driving members of chain mechanisms in motorcycle. Roller chain is content of inner link plate, outer link plate, pin, bushing, and roller. Manufacturers are working on new materials, sizes, and heat treatments to improve the performance of the chain. Roller Chain is under tension which causes failure of chain assembly which is the major problem for automobiles and industrial sector. Causes of this failure are improper design. It is important to study the influence of these parameters.

II. METHODOLOGY

In the present work, existing transmission chains are considered for studying and improving performance. The aim of the work is to find the strength for the chain link to be used for the demanding application without failure. Severe loading conditions exist during the usable life of the chain. The chain to be analyzed using F.E .Methodology for the given application. To study existing Roller chain in Indian market for possible design modifications. The inputs for Design would be secured from the Sponsoring Company. The same is normally created using a modeling interface like CATIA V5.

The input geometry received shall be discretized using pre-processor like ANSYS. The quality for the mesh shall be adhered to while meshing the geometry.

Define the application along with the loads and the boundary conditions

Use CAE for determining the solution

Alter the design parameters and check its effect over the performance

Recommend and reinforce the solution upon validation

Loads and boundary conditions shall be applied to the model in the pre-processor. The input deck for the designated solver shall be prepared. Suitable solver for structural analysis (like ANSYS) would be deployed for finding the solution. Post-processor in HyperWorks would be used to visualize the results obtained. Recommendation to be made upon evaluating the results.

The proposed method utilizes software in the FEA domain for analysing the effects of the variation in the values of the design parameters influencing the performance criterion and corresponding stress would be recorded for changing load within given range .The FEM method is used to analyse the stress state of an elastic body with a given geometry, such as chain link. In this synopsis the analysis of chain link in motorcycle is intended for study using FEM software (ANSYS). Benchmark chain link to be tested for Tensile Loading by using tensile load testing machine with Data logger suitable prototype would be built for testing purpose. The weakest element would be tested for comparing the results with those obtained by Numerical (Computational) Methodology.

The best configurations will be suggested to the company. This shall be done upon verifying the structural strength of the recommended solution.

it is observed that there is a growing demand for two wheelers and especially for motorcycles in this country. In motorcycles, the final transmission is carried out by roller chain and sprockets and those chains have some problems as reported , that need to be studied in detail. In this regard, to understand the problems of chain, general construction, properties and constraints in manufacturing of chains are studied and discussed. Moreover, motorcycle transmission chains affect the performance of motorcycles and greatly influence customer satisfaction. In this aspect, in order to carryout possible improvement in its performance, the various research works on chains that have been carried out are studied using literature survey.

The new motorcycle to be launched in the automobile market needs to be ensured for safety and efficiency. Chain drives being efficient means of power transmission are preferred for this product the limitation of course being catastrophic failure at virtually no prior notice. At high speed, accidents are very likely in case of failure in the chain link. Transmission chains used in two wheelers are single strand roller chains with mostly 12.7 mm . Smaller pitch chains are suitable for high speed applications compared to larger pitches due to small variation in velocity, whereas larger pitch chains are suitable for transmitting high torques. Two wheeler manufactures use different design parameters to highlight their product features, with different engine power, torque and acceleration characteristics and the total number of chain links for each model are either same or different.

Chains are lubricated with grease and are totally enclosed in two wheelers, to avoid dirt and dust particles accumulation, thereby reducing the wear rate. The main problem associated with transmission chain is elongation due to wear. Even though wear is inevitable, any reduction in wear will reduce the chain elongation and consequently reduce noise due to impact and vibrations. The following are the contributions in the literature on stress analysis of chain links, timing and transmission chains aspects of wear and lubricants by many scholars.

Observing the gaps in literature, development of a complete model for FE analysis of the drive chain is attempted to develop. The model is first planned to develop for a structural analysis for tensile testing. Study chain link design parameters in drive chain. The results of these models are validated with the results of standard one as the practical use. The same has been collected from a leading drive chain manufacturing company in North India.

The design for the chain would be subjected to F.E Analysis to find the effect of loads (tension) on the link. The link being a `unit' of the existing chain would be assessed for performance while tensile loads are exerted at both its ends. Safe loads would be determined and the design tested for safe use in the Automobile. The problem for thiswork is being evaluation of the design using software in the FEA followed by experimentation to validate the theoretical outcome.

In motorcycles, chains are fitted with drive and driven sprockets and are enclosed in a cover to avoid dust and sand accumulation. There is no auto tensioner or tensioning idler sprocket. The chain tension is adjusted, when chain elongates, by adjusting the tension adjustment bolt provided in the rear wheel. The chain alignment and tensioning adjustment should be properly done; otherwise, excessive load will act on links causing twisting and quicker deformation. The upward movements of rear wheel along with rear sprocket due to road undulation like bumps, potholes may not cause appreciable load variation in chain due to slackness in the driven side of chain.

III.DESIGN CONSIDERATIONS

Roller chains are used in a wide variety of applications, but most roller chain is used in drives. The shaft speeds of the drives range from less than 50 rpm to nearly 10,000 rpm, and the amount of power transmitted ranges from a 1 kW to 1000 kW. The main design considerations for a roller chain to be used on a drive are the various tensile loads.

3.1 Ultimate Tensile Strength

The ultimate tensile strength of a chain is the highest load that the chain can withstand in a single application before breaking. It is not a major consideration in designing roller chains. It is only important because yield strength and fatigue strength depend on ultimate tensile strength. Minimum ultimate tensile strength (MUTS) is a requirement in the ASME standards that govern roller chains. A well-made roller chain almost always meets the standard.

3.2 Yield Strength

The yield strength of a chain is the maximum load from which the chain will return to its original state (length). For many standard chains, the yield strength is approximately 40% to 60% of the minimum ultimate tensile strength.

IV. FINITE ELEMENT ANALYSIS

4.1 CAD Model Generation

Two wheeler transmission roller chains are chains with 12.7 mm pitch. Motorcycle chains, which are being used in existing motorcycles, pin diameter and inner plate thickness compared with regular 12.7 mm standard chain used in Motorcycle. Construction is similar to that of standard roller chains and the total number of pitches differs for each type of motorcycle based on two wheeler manufacturers' design shows structure of roller chain as per chain specification of chain part.CATIAV5 were used to create model. Part Modeling shows how to draft a 2D conceptual layout, create precise geometry using basic geometric entities, and dimension and constrain geometry. It also shows how to build a 3D parametric part from a 2D sketch by combining basic and advanced features, such as pad, pocket, holes, and arrays. The pin diameter of 12.7 mm pitch motorcycle chain is 4.45 mm max. Thickness of chain is 1mm

Model for tensile test was easy to be created and is shown in Figure 3.1 and moreover, a parametric model could be easily developed which rejected the need of external data files. However the model for endurance and fatigue testing is a complex model, had a lot of geometrical operations and needs special care.

4.2 ANALYSIS OF MODEL

Numerical techniques consist of three basic steps: "pre-processor, processor and post-processor". The pre-processing stage consists of the procedures as constituting creating the model as per dimension. In ANSYS the Cad Model of Chain link is developed. After that for analysis the Finite element model is generated In engineering data define defining material properties. In that entering the physical and material properties of the model to the software,

defining the element type meshing criteria, Mesh body consisting of total solid body is created.

- The following two types of elements are used for analysis.
- Solid 186
- Solid 187
- SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behavior. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element supports plasticity, hyperelasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyperelastic materials

- SOLID187 element is a higher order 3-D, 10-node element. SOLID187 has a quadratic displacement behavior and is well suited to modeling irregular meshes (such as those produced from various CAD/CAM systems).
- The element is defined by 10 nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element has plasticity, hyperelasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyperelastic materials.

V. NONLINEARITY FOR CHAIN LINK

As discussed in an earlier chapter on Types of Analysis, when the structural response (deformation, stress and strain) is linearly proportional to the magnitude of the load (force, pressure, moment, torque, temperature etc.), then the analysis of such a structure is known as linear analysis. When the load to response relationship is not linearly proportional, then the analysis falls under nonlinear analysis

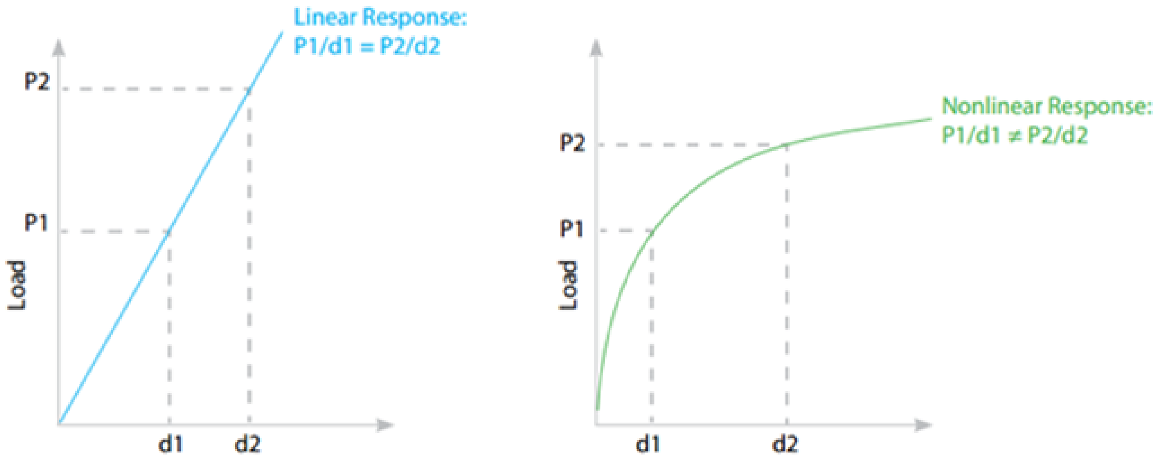

Figure 5.1 Comparison of Linear and Non Linear Response

For example, when a compact structure made of stiff metal is subjected to a load relatively lower in magnitude as compared to the strength of the material, the deformation in the structure will be linearly proportional to the load and the structure is known to have been subjected to linear static deformation. But most of the time either the material behavior is not linear in the operating conditions or the geometry of the structure itself keeps it from responding linearly. Due to the cost or weight advantage of nonmetals (polymers, woods, composites etc.) over metals, nonmetals are replacing metals for a variety of applications.

These applications have nonlinear load to response characteristics, even under mild loading conditions. Also the structures are optimized to make most of its strength, pushing the load level so close to the strength of the material, that it starts behaving nonlinearly. In order to accurately predict the strength of the structures in these circumstances, it is necessary to perform a nonlinear analysis.

5.1 Nonlinearities are classified into three major types

1 Geometric Nonlinearities

2 Material Nonlinearities

3 Contact and other changing status Nonlinearities

5.1.2 Geometric Nonlinearities:

It leads to two types of phenomenon: change in structural behavior and loss of structural stability.

5.1.2.1 Physical Source of Geometric Nonlinearities:

Change in geometry as the structure deforms is taken into account in setting of the strain displacements and equilibrium equations. Applications of geometric nonlinearity are in slender structures in aerospace, civil and mechanical engineering, Tensile structures such as cables and inflammable membranes. Strain displacement source equations is represented in following way

$e = D(u)$

Where D is nonlinear when finite strains are expressed in terms of displacements. The term geometric nonlinearity models are multitude of physical problems.

5.1.2.2 Large Strain:

The strains themselves may be large say over 4 to 5% e.g. rubber structures (tires, membranes, air bags, polymer damper) and metal forming. These are frequently associated with material nonlinearities. Small strains but finite displacement and/or rotations: - Slender structures undergoing finite displacements and rotations although the deformations strains may be treated as infinite e.g. cables, arches, bars.

5.1.2.3 Linearized Pre Buckling:

When both strains and displacements are treated as infinitesimal before loss of stability by buckling, these may be viewed as initially stressed members, e.g. many civil engineering structures such as building and stiff bridges.

5.1.3 Material Nonlinearities:

Material nonlinearity results from the nonlinear relationship between stresses and strains, considerable progress has been made in attempts to derive the continuum or macroscopic behaviors of materials from microscopic backgrounds, but up to now commonly accepted constitutive laws are phenomenological. Inaccuracies in experimental data, mini pretention of material model parameters and errors in user defined material law are some common sources of error in the analysis from the materials viewpoints. It is useful to check material behavior by running a small model with prescribed displacement and load boundary conditions in uniaxial tension and shear.

5.1.3.1 Physical Source of Material Nonlinearities :

Material behavior depends on current deformation state and possibly past history of the deformation other constitutive variable i.e. pre-stress, temperature, time, moisture, electromagnetic fields, etc. may be involved. Applications of this nonlinearity in structures undergoing nonlinear elasticity, plasticity, viscoelasticity, creep or inelastic rate effects. Constitutive equations that relate stresses and strains for a linear elastic material

$\sigma = E.e$ or $e = C.\sigma$

In which the elasticity matrix E contains elastic modulus and the compliance matrix C = E-1 (if E is nonsingular). If the material does not fit the elastic model, generalization of this equation are necessary and a whole branch of continuum mechanics is devoted to the formulation, study and validation of constitutive equations.

Material nonlinearity occurs most often in civil engineering that deals with nonlinear material such as concrete, soil and low strength steel. In mechanical engineering creep and plasticity are most important, frequently occurring in combination with strain-rate and thermal effects. In aerospace engineering material nonlinearity are important and tend to be local in nature e.g. cracking and localization failures of composite material. Material nonlinearities may give rise to very complex phenomenon such as path dependence, hysteresis localization, shakedown, fatigue, progressive failure.

5.1.4 Contact and other changing status nonlinearities:

This type of nonlinearities behavior is often characterized as status dependent. The stiffness of these items shifts abruptly between different values, depending on their status. Status dependent nonlinear analysis varies from simple to very difficult. The other changing status nonlinearities are force boundary condition nonlinearities, displacement boundary condition nonlinearities, force boundary conditions nonlinearities: In this nonlinearity the physical source are applied forces depending on deformation.

To determine contact in between two bodies, there are a number of contact types that may be defined for a practical case like: frictional, bonded, frictionless, rough etc. Each type of contact pair results into different output and hence has to be wisely used. At some places choosing a contact which can reduce the computing time and give an approximate result is good, but at some places exact contact has to be selected so as to have an exact result. The only place where the question of selecting proper contact was in between Pin and Bush, Bush and Roller. So bonded contact and frictional contact were checked as to which would give proper result and did the result really changed if these two contacts were swapped.

5.1.5 Bonded contact v/s Frictional contact.

Bonded is the default configuration and applies to all contact regions (surfaces, solids, lines, faces, edges). If contact regions are bonded, then no sliding or separation between faces or edges is allowed. Think of the region as glued. This type of contact allows for a linear solution since the contact length/area will not change during the application of the load. If contact is determined on the mathematical model, any gaps will be closed and any initial penetration will be ignored.

In frictional contact, the two contacting geometries can carry shear stresses up to a certain magnitude across their interface before they start sliding relative to each other. This state is known as "sticking." The model defines an equivalent shear stress at which sliding on the geometry begins as a fraction of the contact pressure. Once the shear stress is exceeded, the two geometries will slide relative to each other. The coefficient of friction can be any nonnegative value. Initially a model with one pair of pin and bush was considered as this could be simulated easily and in less time. Roller was ignored. Figure 6.2 shows the contact region in study.

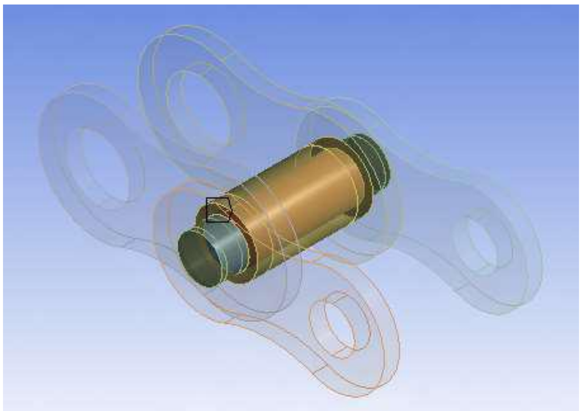

Figure 5.2: Contact region.

Model was simulated with bonded contact and frictional contact. When bonded contact was used, the model was solved in one iteration. But for frictional contact, as the connection became non-linear because of gap in between them, the model had to be changed from static to transient and then solve it. At the first glance, it could be easily commented that the bonded contact gave quicker and nearly same results. Value of equivalent von-Mises stress is same in both the cases. The deformation value is greater in frictional contact; it is due to the gap in between the bodies. If the gap is subtracted from the total deformation, the value becomes same as that of bonded contact. Even though the computing time is more and the number of iterations required is huge for frictional contact as compared to bonded contact but still frictional contact has capability of giving precise results. Using the contact tool, again both of the contacts are compared. Contact tool can be used to evaluate Status, Frictional Stress, Pressure and Sliding Distance between any contacting bodies. Pressure and Stress results based on this contact tool have been compared again.

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
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ISSN: 2319-8354

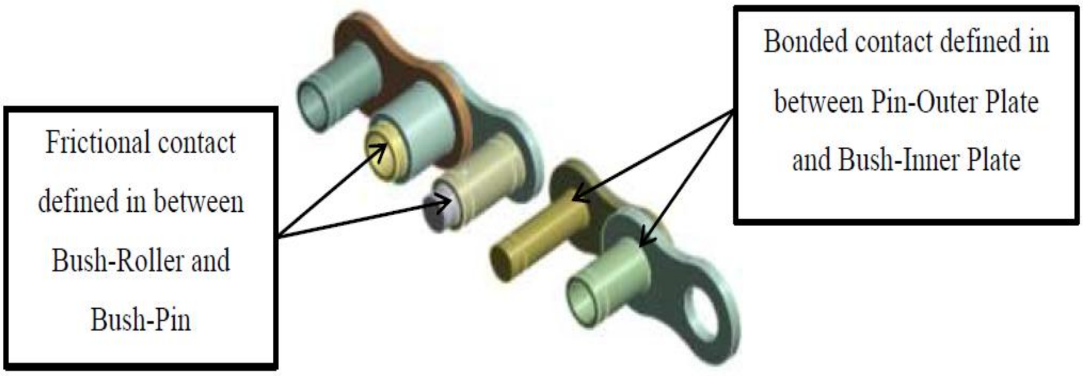

Figure 5.3 : Contacts details of the optimal model.

As it can be clearly seen in the Figure 6.3 and Figure 6.4, frictional contact gave the exact areas where maximum stress is developed according to the loading condition. In bonded contact, maximum stressed area is not along the line of contact, it is because both the areas are bonded together. Also frictional contact helped in easily visualizing the exact way the contact happened. Even though the analysis took iterations, the different values which could be extracted from frictional contact made its use worth where exact contacting details were required. Equivalent body stresses are same in both the cases, but the frictional stresses differ a lot in each case. Hence frictional contact is more superior to bonded contact. For an initial stress value, bonded joint can be used, but for exact and more accurate results, it is preferred to use frictional contact.

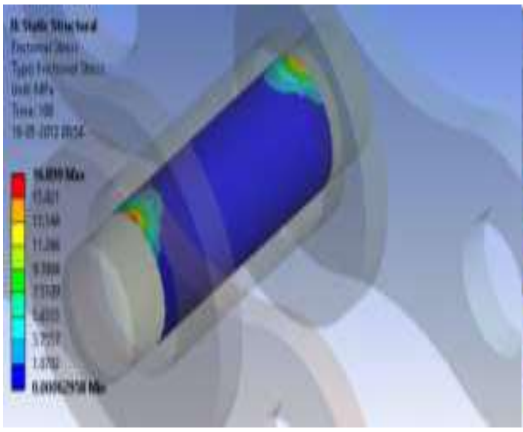

Figure 5.4 : Frictional stress with bonded contact

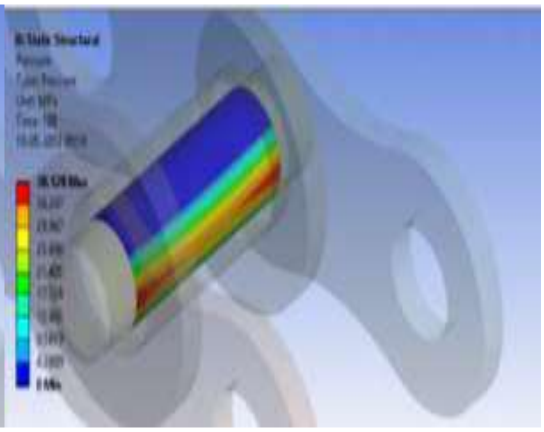

Figure 5.5 :Frictional stress with frictional contact in use.

6.2 Various Models to Simulate Depending upon type of Connections

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Contact between two objects is one of the most frequently encountered phenomena in engineering analysis. For a complete chain assembly, many types of joints and contacts are developed after the elements are assembled. This entirely depends on the fact that how these elements are joined with each other, like: with clearance gap, with press fitting etc. To incorporate these issues in modeling, different types of connections are discussed in terms of contact region and joints.

5.2.1 Contact Region

The faces of contacting bodies were picked individually and specify them as contact face or target face. A set of contact face and target face make a contact pair. Different types of contacts are explained below:

5.2.1.1 Bonded:

This is the default configuration and applies to all contact regions (surfaces, solids, lines, faces, edges). If contact regions are bonded, then no sliding or separation between faces or edges is allowed. Think of the region as glued. This type of contact allows for a linear solution since the contact length/area will not change during the application of the load. If contact is determined on the mathematical model, any gaps will be closed and any initial penetration will be ignored.

5.2.1.2 No Separation:

This contact setting is similar to the bonded case. It only applies to regions of faces (for 3-D solids) or edges (for 2-D plates). Separation of faces in contact is not allowed, but small amounts of frictionless sliding can occur along contact faces.

5.2.1.3 Frictionless:

This setting models standard unilateral contact; that is, normal pressure equals zero if separation occurs. It only applies to regions of faces (for 3-D solids) or edges (for 2-D plates). Thus gaps can form in the model between bodies depending on the loading. This solution is nonlinear because the area of contact may change as the load is applied. A zero coefficient of friction is assumed, thus allowing free sliding. The model should be well constrained when using this contact setting. Weak springs are added to the assembly to help stabilize the model in order to achieve a reasonable solution.

5.2.1.4 Rough:

Similar to the frictionless setting, this setting models perfectly rough frictional contact where there is no sliding. It only applies to regions of faces (for 3-D solids) or edges (for 2-D plates). By default, no automatic closing of gaps is performed. This case corresponds to an infinite friction coefficient between the contacting bodies.

5.2.1.5 Frictional:

In this setting, two contacting faces can carry shear stresses up to a certain magnitude across their interface before they start sliding relative to each other. It only applies to regions of faces. This state is known as "sticking." The model defines an equivalent shear stress at which sliding on the face begins as a fraction of the contact pressure. Once the shear stress is exceeded, the two faces will slide relative to each other. The coefficient of friction can be any non-negative value.

5.2.2 Advantages of bonded contact:

i. Faster solutions since there are no contact convergence issues. Convenient for a quick analysis of assemblies.

ii. Small-deflection cases can be run as linear analyses with one substep and one equilibrium iteration.

iii. Also allows large deflection analyses.

5.2.3 Connections and Boundary Conditions.

Finite element modeling of a chain having such a huge amount of bodies including contact non-linarites is time consuming as well as a process requiring huge amount of computational resources. While modeling the models for tensile test in Section 3.5 frictional contacts was used so to simulate the actual working of the test. Use of frictional contact gave us the correct result but use more time and computational resources. Hence bonded connection was used for each links. For connection between pin to bush, revolute joint was used which gave the required rotatory degree of freedom between them. Also including revolute joint instead of frictional contact helped in reducing the time and computational resources.

Sub-assemblies of pin with outer plate and bush with inner plate were created with bonded connection. In actual fitting also, the pin was press fitted with the outer plate and bush with the inner plate. Giving bonded connection applies a bond between these bodies with which the bodies stick to each other. Only the sticking can be assumed by bonded contact but the initial forces because of press fit were neglected. Now these sub-assemblies were connected to each other with the help of revolute joint. Revolute joint gave only one rotational degree of freedom to the two connecting bodies. Hence the sub-assembly containing pin with outer plate and bush with inner plate were connected to each other. Roller also was given revolute joint with each bush. Revolute joint would be preferred over frictional connection for this particular application as it reduced the degree of freedom automatically and also the computational time and resources. The only member coming in contact with the sprocket was the roller. As the sprocket rotated, roller came into contact, transmitted the forces to the respective members, and gave the revolute motion and rotational motion to the driven sprocket. Since the contact between the roller and sprocket was present only for a shorter duration of time, frictional contact had to be used at this place because only frictional contact had options in which the contact body keeps on searching for the target body.

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
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Seven main steps:

a. Create or import the geometry.

b. Mesh all of the contacting bodies.

c. Create the contact pair.

d. Specify the analysis type and solution controls.

e. Apply loads and boundary conditions.

f. Save the database.

g. Solve and review results.

Above steps were followed and contact regions for the chain assembly was created.

Numerical techniques consist of three basic steps: “pre-processor, processor and post-processor”. The pre-processing stage consists of the procedures as constituting creating the model as per dimension. In ANSYS the Cad Model of Chain link is developed. After that for analysis the Finite element model is generated In engineering data define defining material properties. In that entering the physical and material properties of the model to the software, defining the element type meshing criteria, Mesh body consisting of total solid body is created. After modeling of chain links then give the actual supporting boundary conditions are applied i.e. fixed support and horizontal support. In fixed support there is no any degree of freedom i.e. there is no displacement at any direction. But in horizontal support only horizontal motion is present and vertical motion is restricted.While modeling link, imprint faces are created which are useful for selecting particular faces at the time of applying boundary condition.The FEA results of Chain link for Direction deformation, Equivalent Elastic Strain and Equivalent (von-Mises) Stress as calculated by using C.A.E.

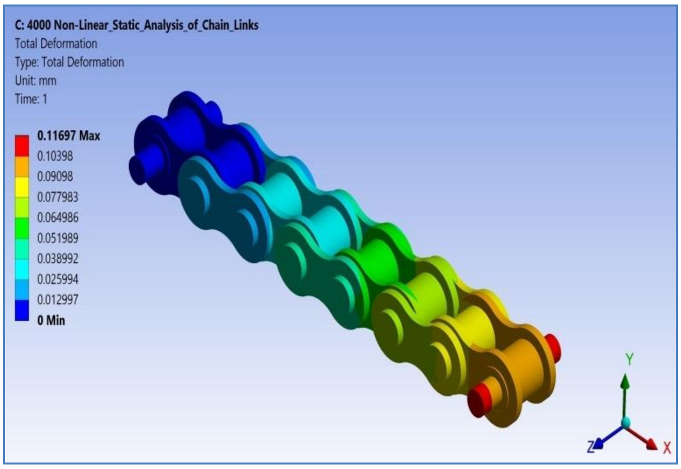

Figure 5.6 Total Deformation in Model

In Fig. 6.5 red face indicate maximum deformation occurs on pin which is 0.011697 mm. The FEA results of Chain link for Equivalent Elastic Strain is maximum at roller which is 2.9328e-003 mm/mm this result as shown in Fig. 5.20

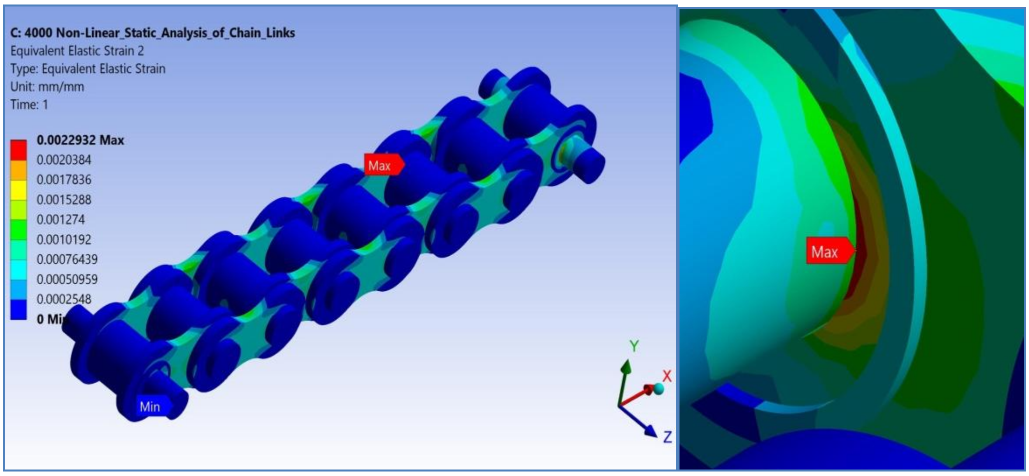

Figure 5.7 Equivalent Elastic Strain

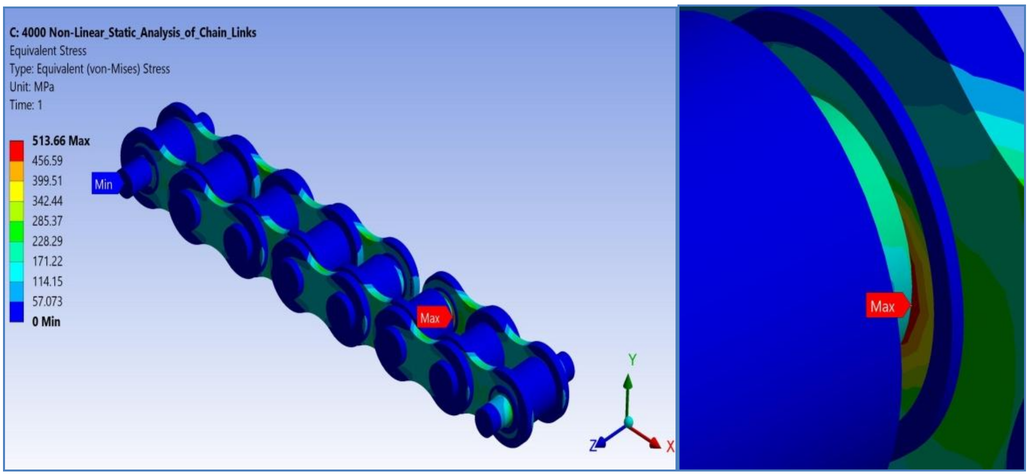

Figure 5.8 Stress Distributions in Model

Equivalent (von-Mises) Stress for inner link plates and outer link plates, pin ,roller, bush as calculated by using C.A.E.

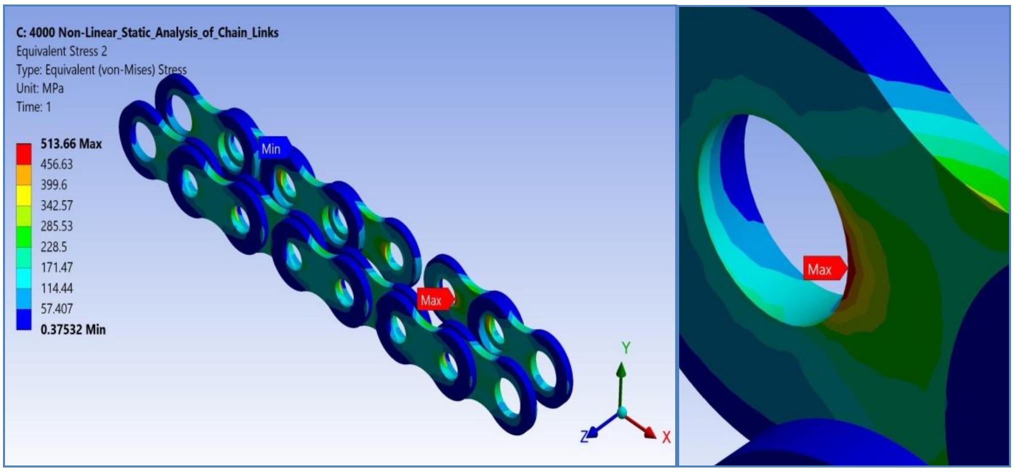

Fig. 5.9 Stress Distribution in Inner Link Plate and Outer Link Plate

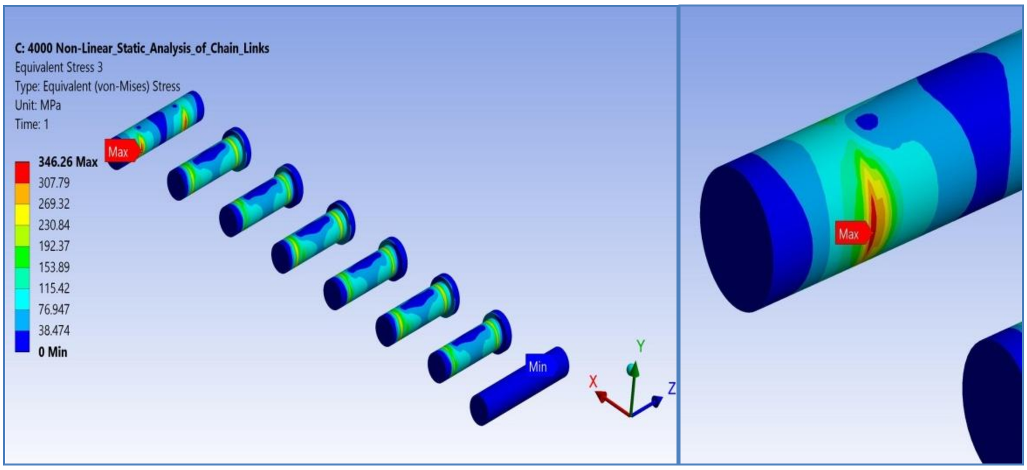

Fig. 5.10 Stress Distribution in Pin

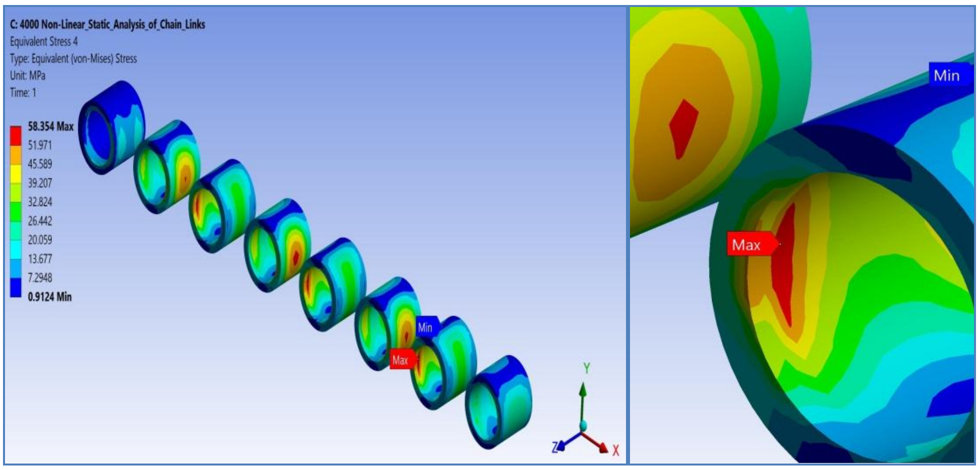

Fig. 5.11 Stress Distribution in Roller

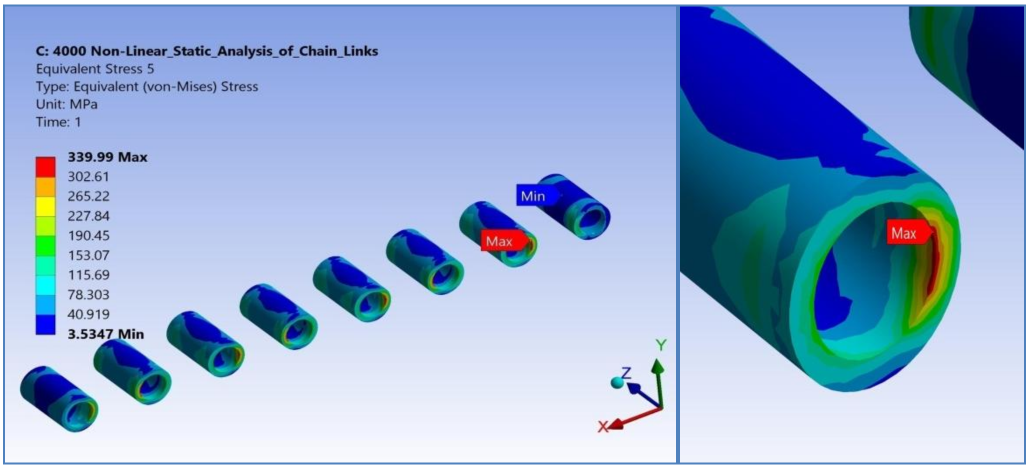

Fig. 5.12 Stress Distribution in Bushes

Sr.No	Design Parameter	Maximum Tensile stress, (MPa)	Maximum deformation(mm)	Maximum Equivalent Elastic Strain (mm/mm)
1	Non Linear Assembly	513.66	0.07697	2.9328e-003
	Inner Link Plates and Outer Link Plates	513.66		
	Pin	346.26		
	Roller	58.35		
	Bush	339.99		

VI. CONCLUSION

The design for the chain would be subjected to F.E Analysis to find the effect of loads (tension) on the link. The proposed method utilizes software in the FEA domain for analyzing the effects of the variation in the values of the design parameters influencing the performance criterion. The FEM method is used to analyze the stress state of an elastic body with a given geometry, such as chain link. we have considered only Geometric and Contact Nonlinearities.

In geometric nonlinearity we have considered effect of large deflections and in contact nonlinearity we have considered the actual real life contact scenario of system. That is there is standard contacts between rollers and links which means there is only sliding can occur in these two bodies no penetration or no load transfer will occur. Similarly in case of two links both are sliding against the o ring where as they are rigidly connected to pin that is outer link and inner link to bush.

Contact non-linearity is successfully simulated with the help of frictional contact. Non-linearity and the stress, strain, deformation variation over the model can be successfully observed.

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