

Design and Comparative Analysis of Different Hydraulic Cylinders by ANSYS

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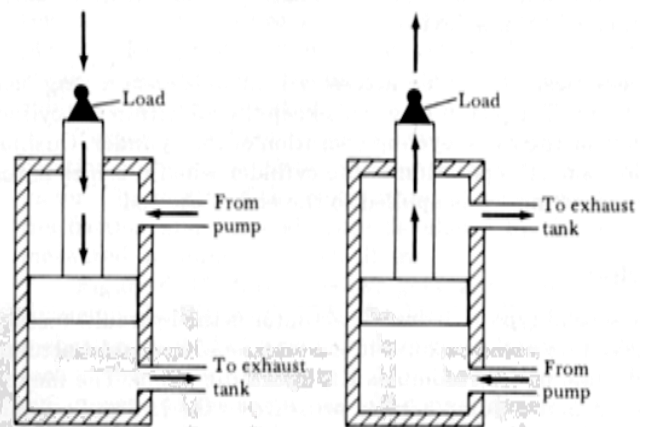
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Abstract— A Hydraulic cylinder is a mechanical actuator that is utilized to give a unidirectional drive through a unidirectional stroke. It has numerous applications, outstandingly in development gear, producing apparatus and structural building. "Hydraulics" by and large alludes to control delivered by moving liquids. Modern hydrodynamics is characterized as the utilization of restricted fluid to transmit control, increase compel, or create movement. A water driven cylinder comprises of these parts-cylinder barrel, cylinder top, cylinder head, cylinder, cylinder pole, organ and seals. In the present work the geometric model is made in Catia Software and imported to hyper work for focalized Finite element method and examination. Stretch and relocations distinctive water driven cylinders are figured by utilizing Ansys programming.

Key words: ANSYS, Hydraulic Cylinders

- 1) simple in structure,
- 2) reliable in operation,
- 3) Convenient in assemble and disassemble easy in maintenance

The amazing amount of force a cylinder exerts is due to the simple mechanical principle of pressure exerted on the surface area of the piston. Simply put, the larger the diameter of the cylinder, the more it will lift. The formula for this is $\text{area} \times \text{psi (Pounds per square inch)} = \text{Force}$.



B. Stroke action

Hydraulic driven and pneumatic system supplies are the essential segments of designing applications. Particularly water driven and pneumatic cylinders are utilized as a part of numerous designing applications like; programmed assembling and montage lines, substantial development supplies, control frameworks, delicate estimation and test frameworks. A standout amongst the most essential components considering at the outline venture of these types of gear is working states of cylinder. Cylinders have diverse working frequencies as indicated by their utilization fields. While the enormous estimated cylinders utilized as a part of frameworks that requires higher constrain and minute sources of info, works for the most part in lower frequencies, the little measured cylinders utilized as a part of touchy application fields like test and estimation frameworks can have higher working frequencies. At the lower working recurrence circumstances, weight impact on the cylinder is considered as static load, and the water driven framework types of gear are planned by model. Other than this, at the plan method of cylinders with higher working frequencies, the dynamic impact as for quick change of weight must be contemplated and also the static investigation.

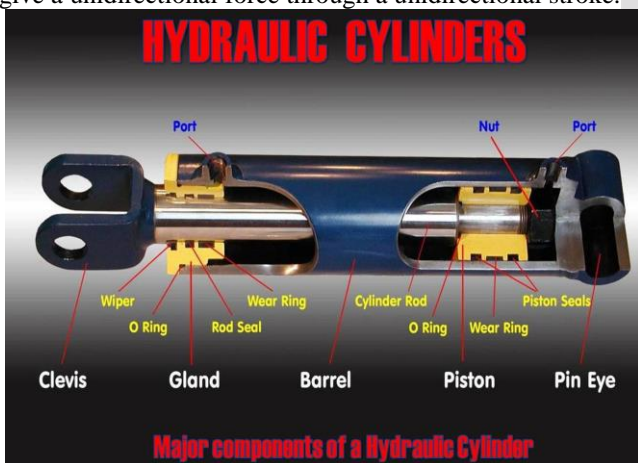
B. Pumps:

Main pumps: 2 variable displacement axial piston type.
Maximum flow: 2 x 121 L/min (2 x 26.6 UK GPM).
Servo pump: Gear type.
Maximum flow: 20 L/min (4.4 UK GPM).

I. INTRODUCTION

A. Hydraulic Cylinder:

Hydraulic cylinder is a mechanical actuator that is used to give a unidirectional force through a unidirectional stroke.



The piston partitions within the cylinder into two chambers, the base chamber (top end) and the piston bar side chamber (pole end/head end). Flanges, trunnions, clevises, Lugs are regular cylinder mounting alternatives. The piston pole likewise has mounting connections to interface the cylinder to the protest or machine segment that it is pushing/pulling. A water powered cylinder is the actuator or "engine" side of this framework.

If we assume that the oil enters from cap end, during extension stroke, and the oil pressure in the rod end / head end is approximately zero, the force F on the piston rod equals the pressure P in the cylinder times the piston area A :

$$F = P \cdot A$$

The hydraulic cylinders are double acting single rod piston cylinder. Its features are

C. Relief valve setting:

- ARM(4610lbf/sq.in)
- With power boost 343 bar (4975lbf/sq.in)
- Swing circuit 279 bar (4045lbf/sq.in)
- Travel circuit 343 bar (4975lbf/sq.in)
- Pilot control 40 bar (569lbf/sq.in)

A separate Cushion Control valve in the servo system provides cushioning of the boom and dipper spools selection and quick warm-up of the servo system.

D. Hydraulic Cylinder:

Dimensions:

BOOM

Bore 100mm (3.9in)

Rod 75mm (3.0in)

Stroke 1081mm (42.5in)

II. MANUFACTURING PROCESS

A. Welding:

Notwithstanding dissolving the base metal, a filler material is regularly added to the joint to frame a pool of liquid material (the weld pool) that cools to shape a joint that can be as solid as the base material

1) Shielded metal arc welding (SMAW):-

also known as "stick welding", uses an electrode that has flux, the protectant for the puddle, around it. The electrode holder holds the electrode as it slowly melts away. Slag protects the weld puddle from atmospheric contamination. Gas tungsten arc welding (GTAW) - also known as TIG (tungsten, inert gas), uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas such as Argon or Helium Gas metal arc welding (GMAW)

2) Flux-cored arc welding (FCAW):

almost identical to MIG welding except it uses a special tubular wire filled with flux; it can be used with or without shielding gas, depending on the filler. Submerged arc welding (SAW) - uses an automatically fed consumable electrode and a blanket of granular fusible flux. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under the flux blanket

3) Electro slag welding (ESW):

A highly productive, single pass welding process for thicker materials between 1 inch (25 mm) and 12 inches (300 mm) in a vertical or close to vertical position.

B. Blast finishing:

Blasting is the procedure where little precise or round particles are impelled at a section by compacted air, or mechanical rapid turning wheels or water pumps. The impact media sort, shape, size, thickness, and hardness, alongside media quickening and volume of media, joined with blasting separation from the work piece, edge of effect and time cycles are imperative considers the impact procedure capacities. The blasting hardware is created to convey, recover and contain the media, contain the part to be impacted and gather the tidy from the blasting procedure. Parts can be prepared exclusively as a bunch procedure or can be computerized through the framework.

1) Factors affecting blast finishing:

- Media delivery systems
- Blast containment enclosures, media recovery and dust collection systems.
- Media used in industrial blasting systems

III. DESIGN AND ANALYSIS

A. CAD/CAM:

The Modern world of design, development, manufacturing so on, in which we have stepped can't be imagined without interference of computer. The usage of computer is such that, they have become an integral part of these fields. In the world market now the competition in not only cost factor but also quality, consistency, availability, packing, stocking, delivery etc. So are the requirements forcing industries to adopt modern technique rather than local forcing the industries to adapt better techniques like CAD / CAM / CAE, etc.

This penetration of technique concern has helped the manufacturers to

- Increase productivity
- Shortening the lead-time
- Minimizing the prototyping expenses
- Improving Quality
- Designing better products

B. FE Analysis:

In the limited component strategy, the real continuum of group of matter like strong, fluid or gas is spoken to as a collection of sub divisions called Finite components. These components are thought to be entomb associated at indicated focuses known as hubs or nodal focuses. These hubs as a rule lie on the component limits where a neighboring component is thought to be associated. Since the genuine variety of the field factors (like Displacement, stretch, temperature, weight and speed) inside the continuum are is not know, we expect that the variety of the field variable inside a limited component can be approximated by a basic capacity. These approximating capacities (additionally called insertion models) are characterized regarding the qualities at the hubs. At the point when the field conditions (like balance conditions) for the entire continuum are composed, the new obscure will be the nodal estimations of the field variable. By tackling the field conditions, which are by and large as the grid conditions, the nodal estimations of the field factors will be known. Once these are known, the approximating capacity characterizes the field variable all through the collection of components.

It is necessary to identify the tedious and time consuming steps and try to automate them to reduce the FE simulation time and to avoid the constant interaction of the user with the FE tool. Following the list of steps are presented.

Basic approach for any finite element analysis (FEA) can be divided in to three parts

- Pre – processors
- Solver
- Post – Processor

C. ANSYS:

ANSYS design optimization enables the engineers to reduce the number of costly prototypes, tailor rigidity and flexibility

to meet objectives and find the proper balancing geometric modifications.

Competitive companies look for ways to produce the highest quality product at the lowest cost. ANSYS (FEA) can help significantly by reducing the design and manufacturing costs and by giving engineers added confidence in the products they design. FEA is most effective when used at the conceptual design stage. It is also useful when used later in manufacturing process to verify the final design before prototyping.

The ANSYS program operates on Pentium based PCs running on Windows95 or Windows NT and workstations and super computers primarily running on UNIX operating system. ANSYS Inc. continually works with new hardware platforms and operating systems.

Analysis types available:

- 1) STRUCTURAL STATIC ANALYSIS.
- 2) STRUCTURAL DYNAMIC ANALYSIS.
- 3) STRUCTURAL BUCKLING ANALYSIS.
 - LINEAR BUCKLING
 - NON LINEAR BUCKLING
- 4) STRUCTURAL NON LINEARITIES
- 5) STATIC AND DYNAMIC KINEMATICS ANALYSIS.
- 6) THERMAL ANALYSIS.
- 7) ELECTROMAGNETIC FIELD ANALYSIS.
- 8) ELECTRIC FIELD ANALYSIS
- 9) FLUID FLOW ANALYSIS
 - COMPUTATIONAL FLUID DYNAMICS
 - PIPE FLOW
- 10) COUPLED-FIELD ANALYSIS
- 11) PIEZOELECTRIC ANALYSIS

IV. MODELLING AND MESHING

A. Catia Modelling:

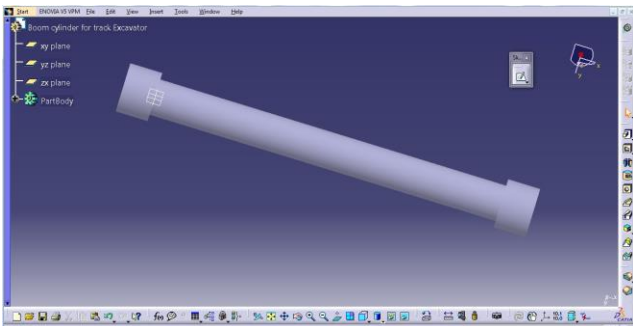
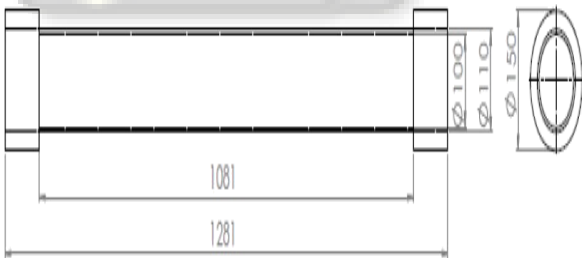


Fig. 1: Hydraulic Cylinder Model

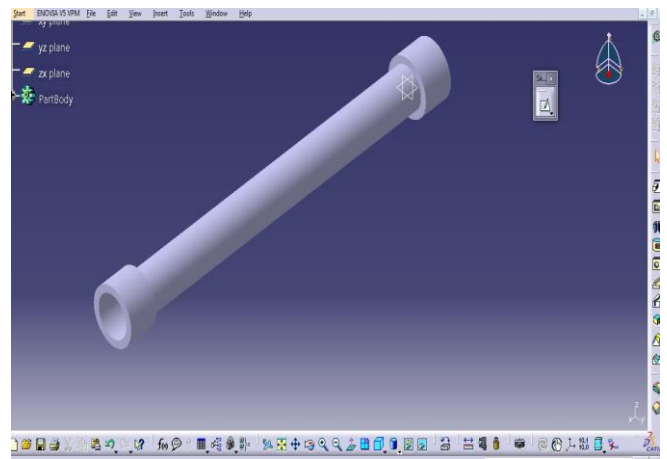


Fig. 2: Hydraulic Cylinder Isometric view

B. Catia Modeling Of Cylinder Used In Mining Rigs:

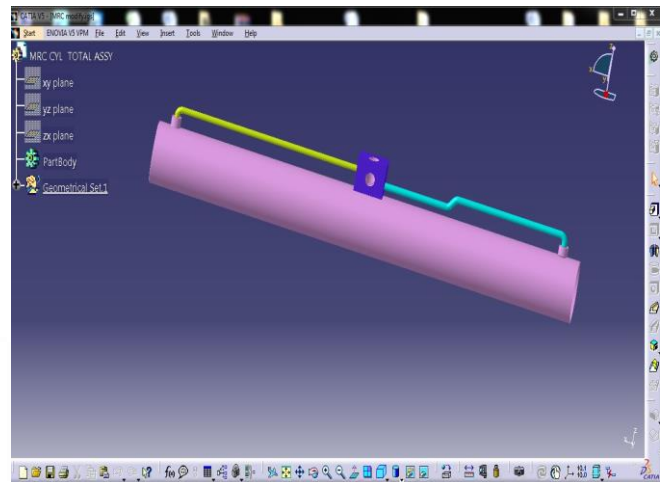


Fig. 3: Mrc Cylinder Model

C. Meshing:

Meshing is generated by using hyper mesh software. Mesh the geometry by using tetra hedral elements. Element type is solid 45.

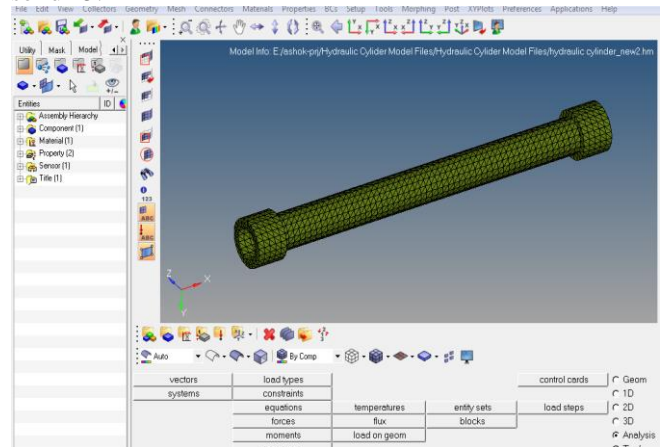


Fig. 4: Mesh model of cylinder used in mining

D. Static Analysis:

1) Boom Cylinder for Track Excavator:

a) Loads and Boundary Conditions:
mesh model of boom cylinder for track excavator is constrained (x, y and z-translations) at right side. Applied Internal pressure is 40 bar.

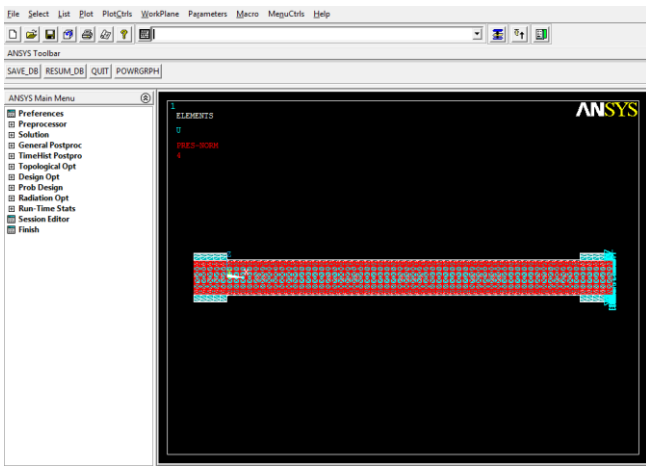


Fig. 5: Loads and boundary conditions of boom cylinder for track excavator

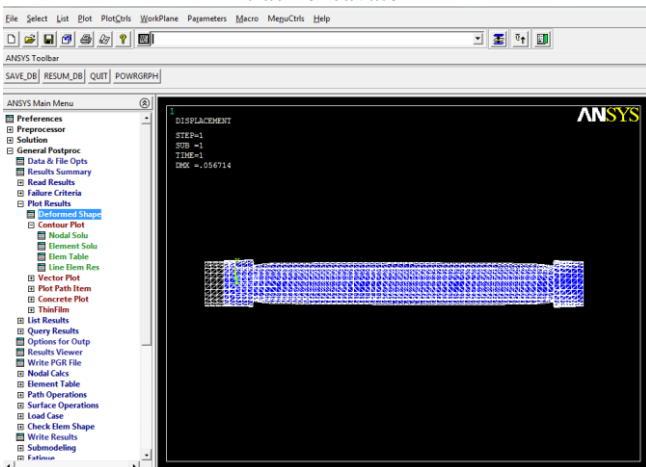


Fig. 6: Deformed –un deformed of boom cylinder for track excavator

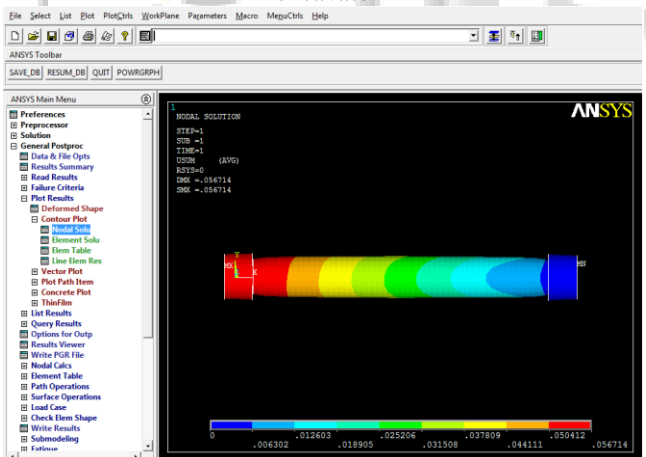


Fig. 7: displacement vector sum of boom cylinder for track excavator is 0.056 mm

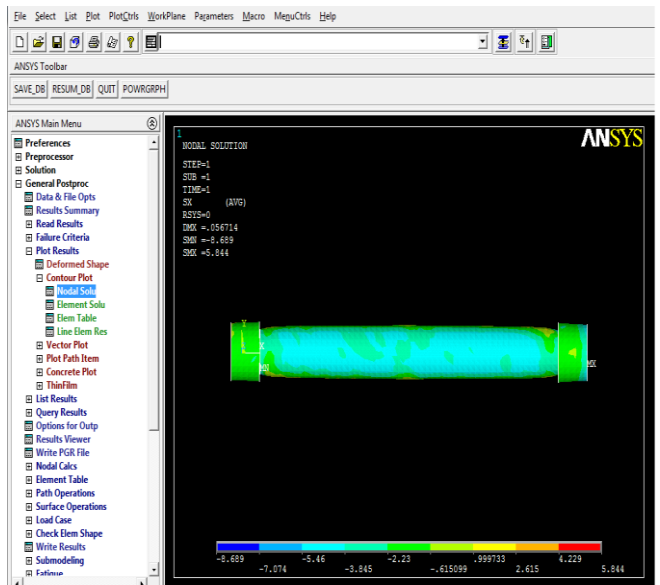


Fig. 8: Stress in x-direction of boom cylinder for track excavator is 5.84 N/mm²

The following table represents the stresses of two hydraulic cylinders in different Pressure loads:

Stress(N/mm ²)	Boom cylinder for track exca vator(pressure 40 bar)	Cylinder used in mining rigs (pressure 80 bar)
Stress in x-direction	5.84	26.64
Stress in y-direction	42.54	124.31
Stress in z-direction	38.84	117.48
Shear stress in xy	4.13	53.69
Shear stress in yz	19.54	59.57
Shear stress in xz	3.482	21.52
Vonmises stress	40.95	121.83

Table 1:

V. CONCLUSION

The diverse hydraulic cylinders at various weight burdens were dissected by finite element strategies. From the above results the Maximum Vonmises push for blast cylinder for track excavator watched is 40.95 N/mm² and the cylinder utilized as a part of mining apparatuses watched is 121.83 N/mm².this esteem is under safe load condition.

The Maximum Displacement for blast cylinder for track watched is 0.056mm, and the cylinder utilized as a part of mining apparatuses watched is 0.328.

The Stress Levels for various cylinders was checked under max weight stack condition and turned out to be protected plan and proposed to use for lifting of overwhelming burdens and boring apparatus operations.

REFERENCES

- [1] "FEA analysis of bullock cart axle under static and dynamic loading condition," by Mulani Nawaj A and

- Mirza M M, at ISSN (Print): 2321-5747, Volume-1, Issue-2, 2013.
- [2] C. Bisua*, L. Olteanu, R. Laheurteb, Ph. Darnisb, O. Cahucb, “Experimental approach on torsor dynamic analysis for milling process monitoring and diagnosis” 8th CIRP Conference on Intelligent Computation in Manufacturing Engineering, Procedia CIRP 12 (2013) 73 – 78 .
- [3] Hamid M. Sedighi *, Kouros H. Shirazi, “Bifurcation analysis in hunting dynamical behavior in a railway bogie: Using novel exact equivalent functions for discontinuous nonlinearities”, Scientia Iranica B (2012) 19 (6), 1493–1501.

