- **Annexure:- 1**
- **Final Product specifications (It's for lab model)**

| Event no. | Particular | Fig no. | Qty | Material specification |
|---|---|---|---|---|
| 1 | Upper cover | 1 | 1 | MS Steel |
| 2 | Lower cover | 2 | 1 | MS Steel |
| 3 | Centre chassis support | 3 | 1 | MS die mould |
| 4 | Servo motor | 4 | 1 | VTS 08A |
| 5 | Supporting conical flask | 5 | 1 | MS Steel |
| 6 | Support roller 1 | 6 | 1 | 316 MS |
| 7 | Support roller 2 | 7 | 1 | 316 MS |
| 8 | Spring Support Assembly | 8 | 1 | Brass (mould) |
| 9 | Springs | 9 | 4 | F42 Iron |
| 10 | Motor Gear Seal | 10 | 1 | Plastic Moulding |
| 11 | Lock nut | 11 | 3 | MS |
| 12 | Main Roller | 12 | 1 | 316 MS |
| 13 | Motor Chassis (1) | 13 | 1 | Al |
| 14 | Motor Chassis (2) | --- | 1 | Al |
| 15 | Spring Rods | --- | 4 | Steel |
| 16 | Bearings | --- | 2 | SKF |
| 17 | Servo motor circuit design | --- | 1 | Parallel circuit mgf. |
| 18 | Motor Gear | | 1 | Brass |
| 19 | Gear (1) | | 1 | Brass |
| 20 | Gear (2) | | 1 | Brass |
| 21 | Gear (3) | | 1 | Brass |
| 22 | Side Gear (1) | | 1 | Brass |
| 23 | Side Gear (2) | | 1 | Brass |
| 24 | Side Gear (3) | | 1 | Brass |
| 25 | Side gear plate | | 1 | MS |

| | | | | |
|---|---|---|---|---|
| 22 | Cone ring inner | | 1 | Al |
| 23 | Cone ring Outward | | 1 | Al |
| 24 | Chassis holder stud | | 1 | Al |
| 25 | Roller (1) Stud | | 1 | MS |
| 26 | Main Roller Stud | | 1 | MS |
| 27 | Electrical Control Systems | | 1 | Electrical parts |
| 28 | Right Pulley | | 1 | Al |
| 29 | Left Pulley | | 1 | Al |
| 30 | Boom Support | | 1 | Acrylic, laser cutting |

- **Annnexure:- 2**
- **Follow Up, Trial and Error, Research and Development and tendor charges**

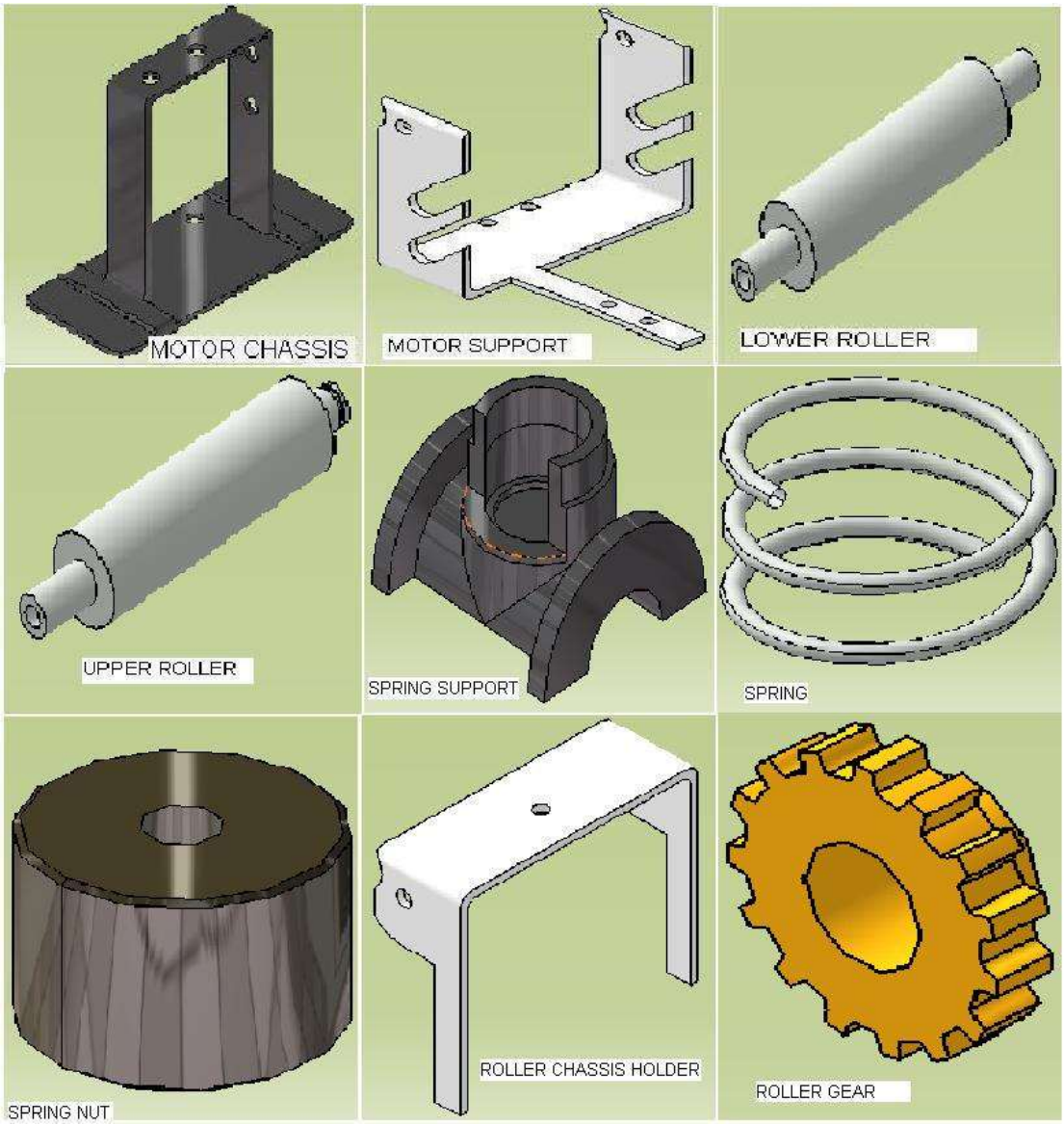
| | | | | |
|---|---|---|---|---|
| 1 | Upper cover die (male/female) | --- | 1 | Hard steel, shrinkage eliminator, trials, finishing, Powder coating, analysis, Chamfering. |
| 2 | Lower cover die (male/female) | --- | 1 | Annealing process, shrinkage eliminator, trials, finishing, Powder coating, analysis, chamfering, |
| 3 | Centre Chassis die (male/female) | --- | 1 | Electro plating, shrinkage eliminator, trials, finishing, Powder coating, analysis, Buffing. |
| 4 | Right Pulley Die | --- | 1 | Hard steel, shrinkage eliminator, trials, finishing, Powder coating, analysis. |
| 5 | Left Pulley Die | --- | 1 | Hard steel, shrinkage eliminator, trials, finishing, Powder coating, analysis. |
| 6 | Motor Gear | --- | 1 | Jig & fixture, Extra material, SPM tool, Trials, grinding, surface finishing |

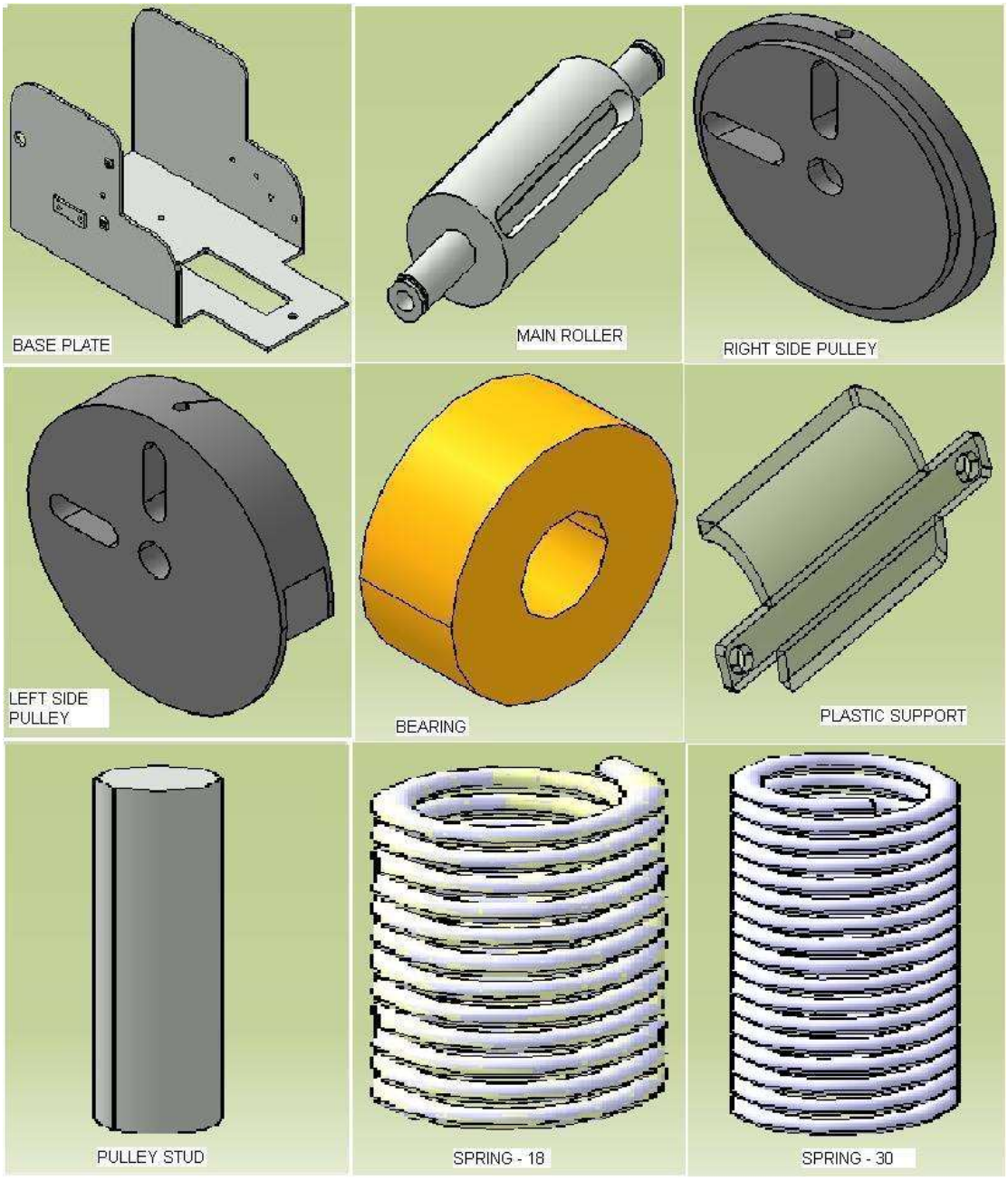
| | | | | |
|---|---|---|---|---|
| 7 | Gear (1) | --- | 1 | Jig & fixture, Extra material, SPM tool, Trials, grinding, surface finishing |
| 8 | Gear (2) | | 1 | Jig & fixture, Extra material, SPM tool, Trials, grinding, surface finishing |
| 9 | Gear (3) | | 1 | Jig & fixture, Extra material, SPM tool, Trials, grinding, surface finishing |
| 10 | Side gear (1) | | 1 | Jig & fixture, Extra material, SPM tool, Trials, grinding, surface finishing |
| 11 | Side Gear (2) | | 1 | Jig & fixture, Extra material, SPM tool, Trials, grinding, surface finishing |
| 12 | Side Gear (3) | | 1 | Jig & fixture, Extra material, SPM tool, Trials, grinding, surface finishing |
| 13 | Main Roller | | 1 | EDM process, milling, Internal finishing, grinding, slot cutting, extra material. |
| 14 | Boom | | 1 | Trial and error, Spring steel material, Constant temp heater process, excess material. Material analysis. |
| 15 | Constant temperature ceramic heater coil | | 1 | Designed and built up. |

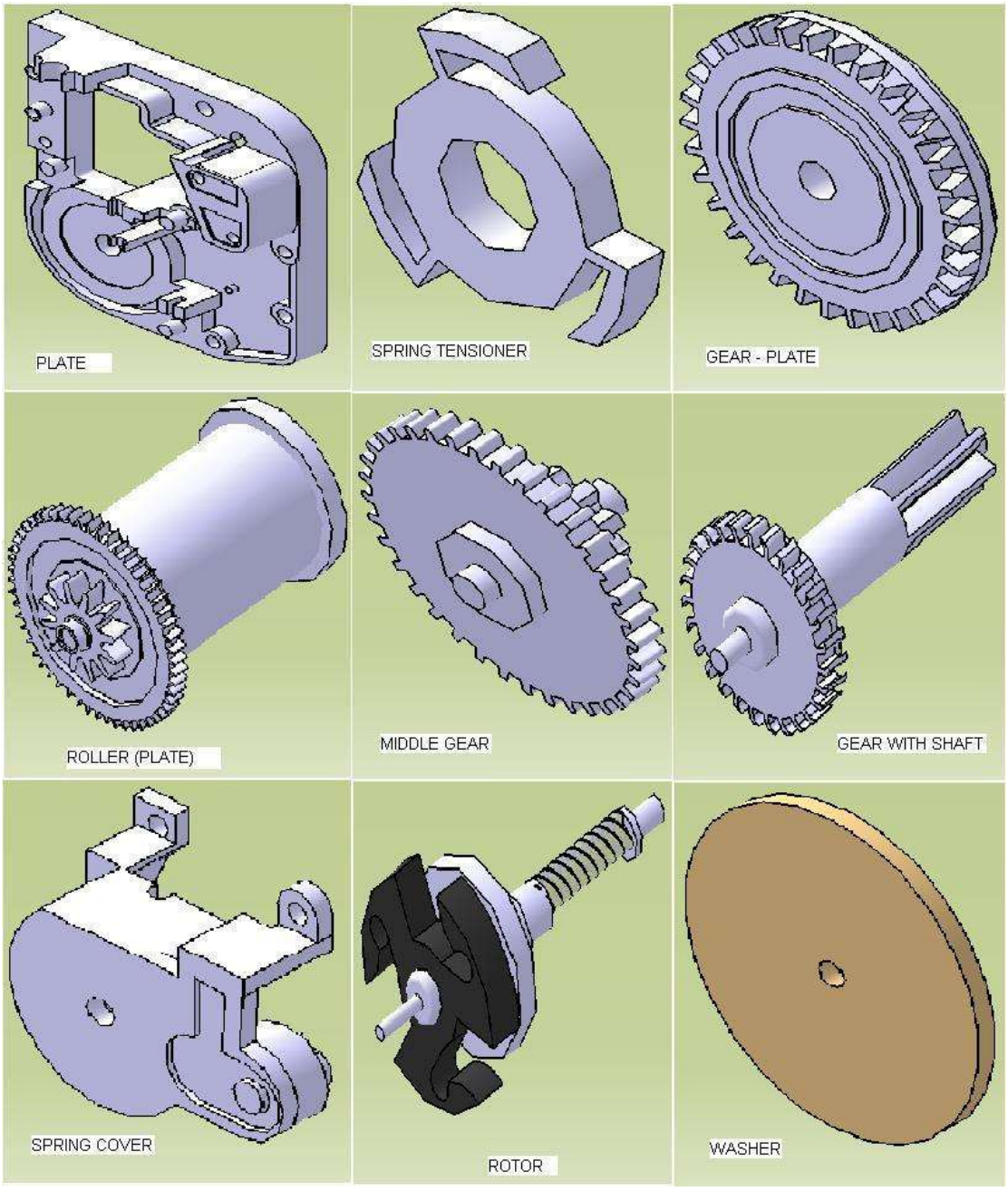
| | | | | |
|---|---|---|---|---|
| 16 | Accessories | | ---- | Nuts and Bolts, gears, Alenkeys, springs, |
| 17 | Machining charges | | | All Parts |

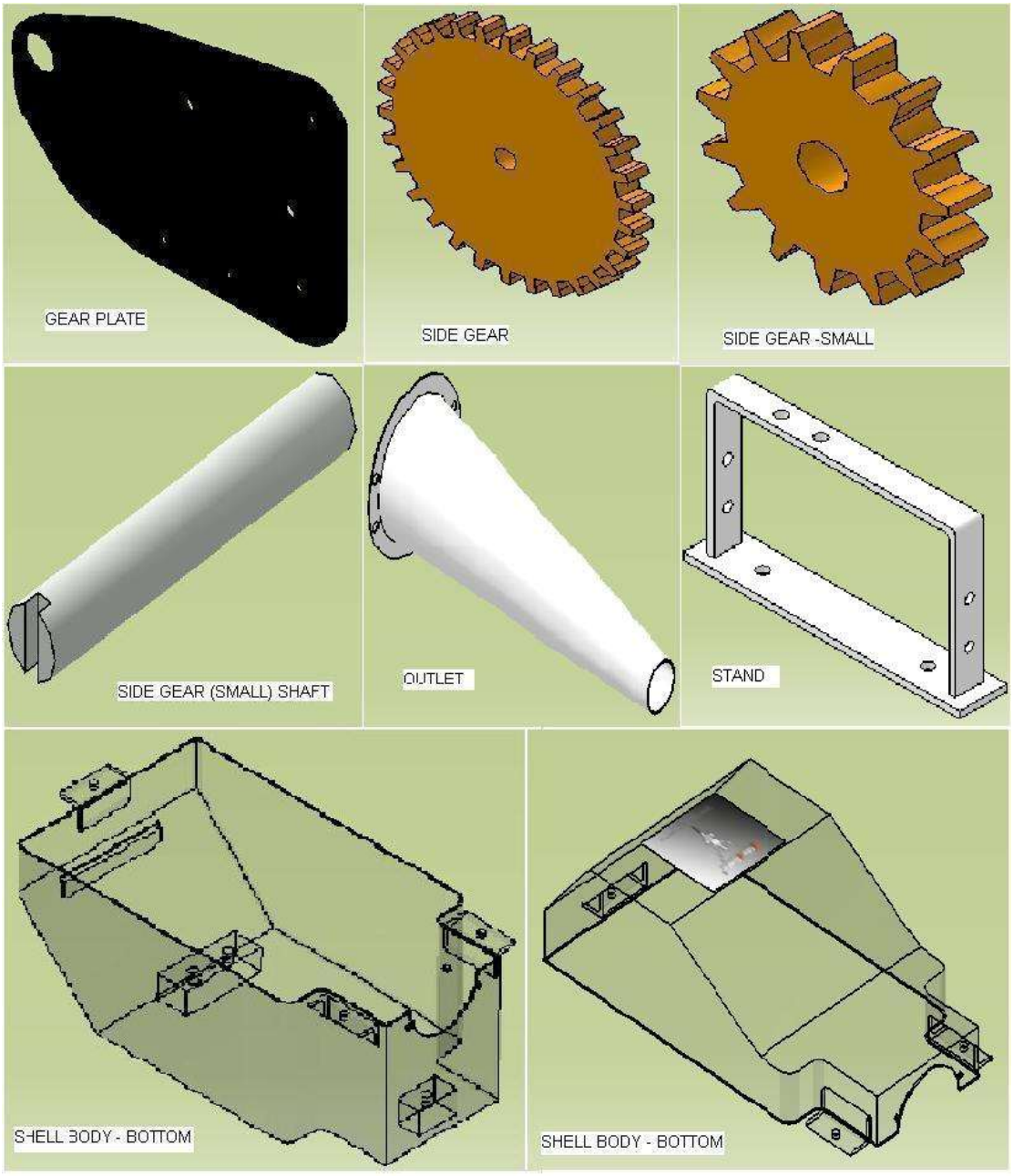
- **Annexture:- 3**
- **Designing And Consultation Charges**

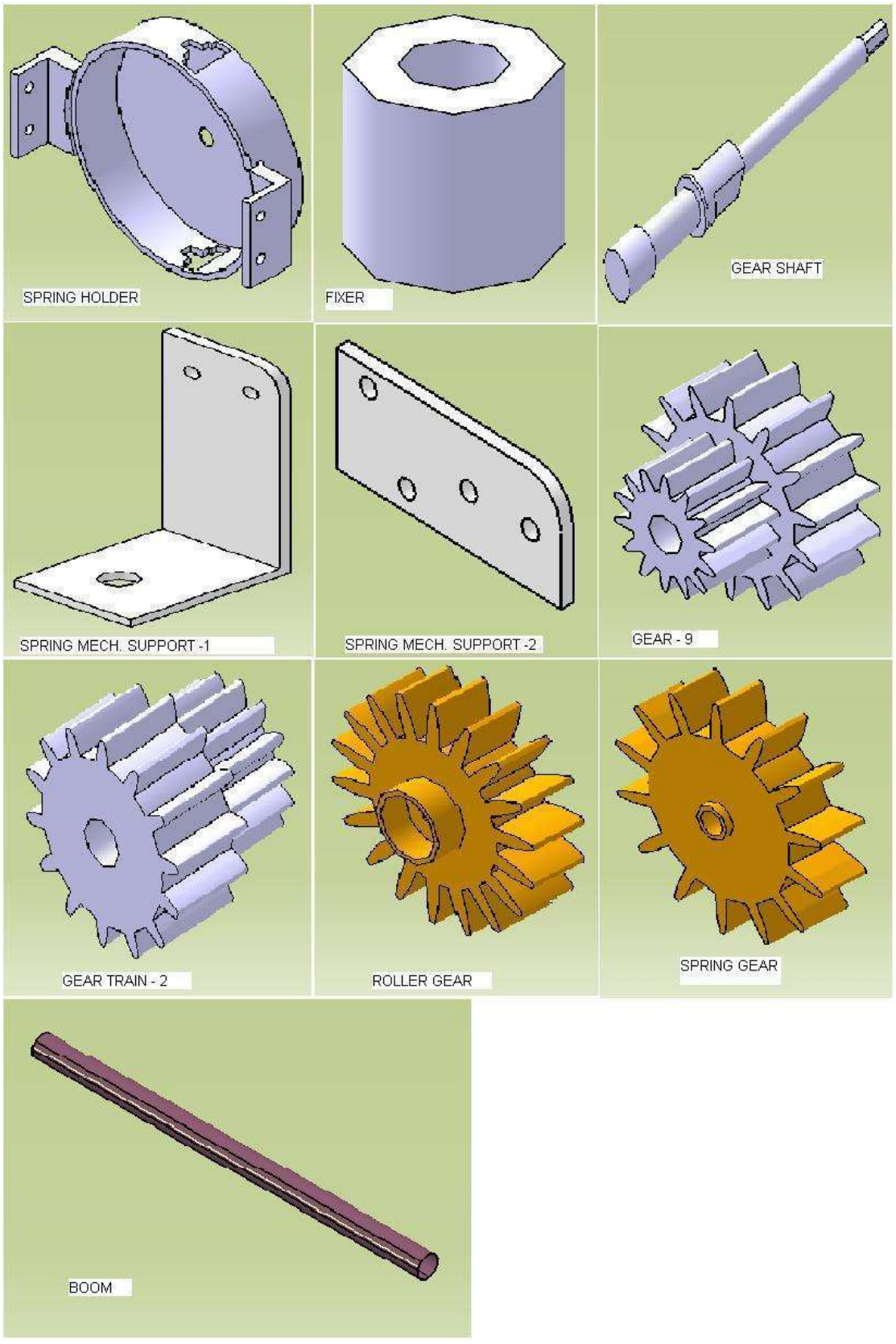
1) Designing
2) Consultations with prototype modelling (Over Heads):-

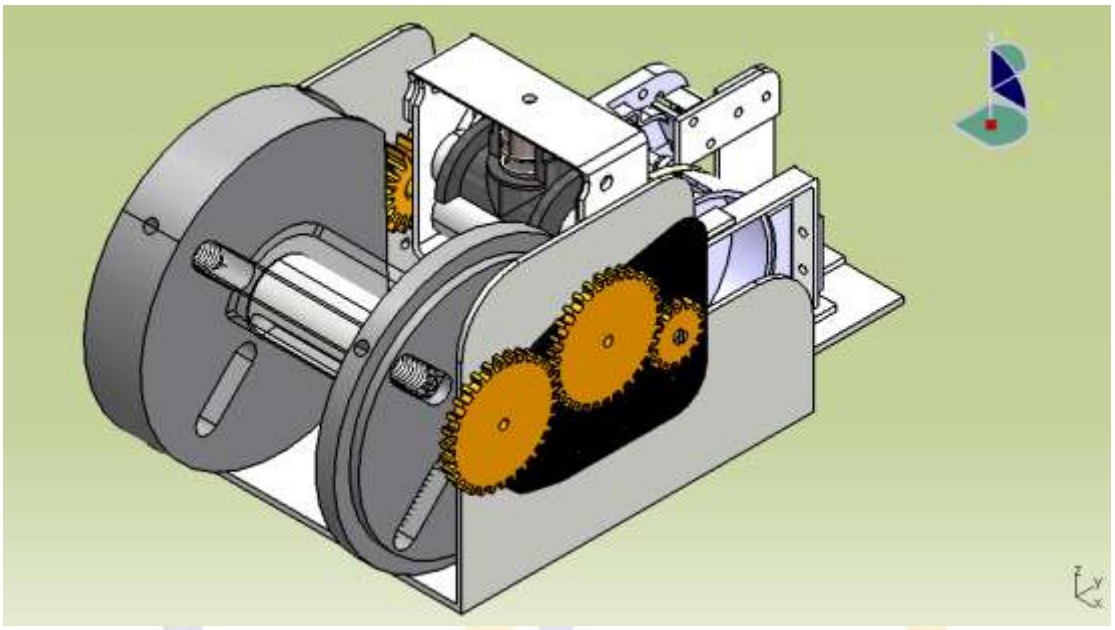


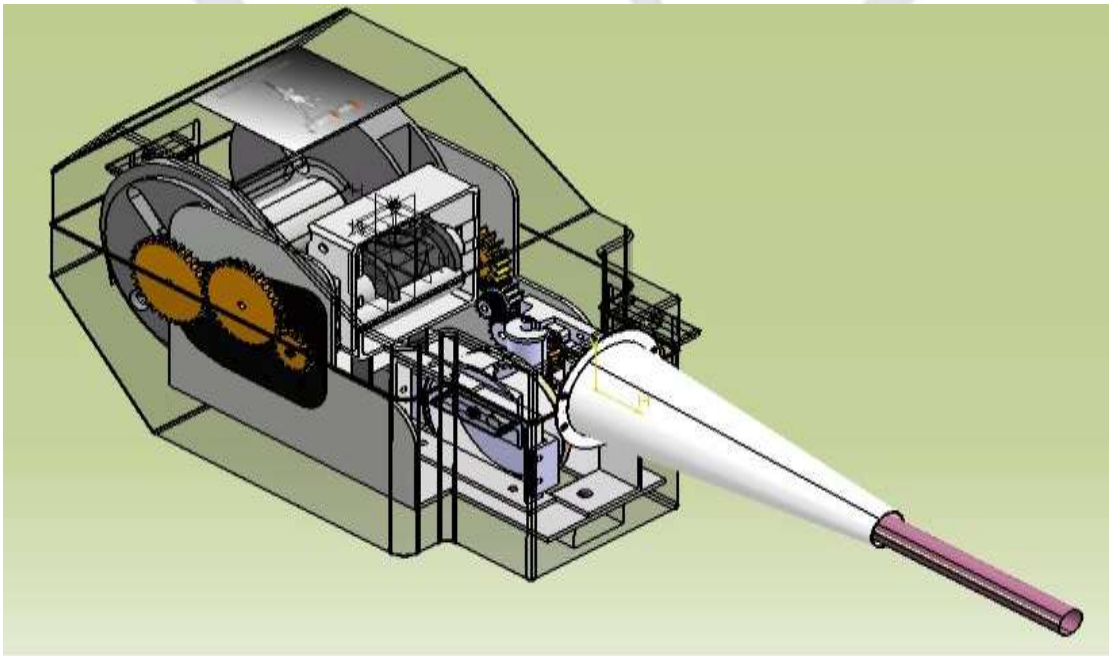






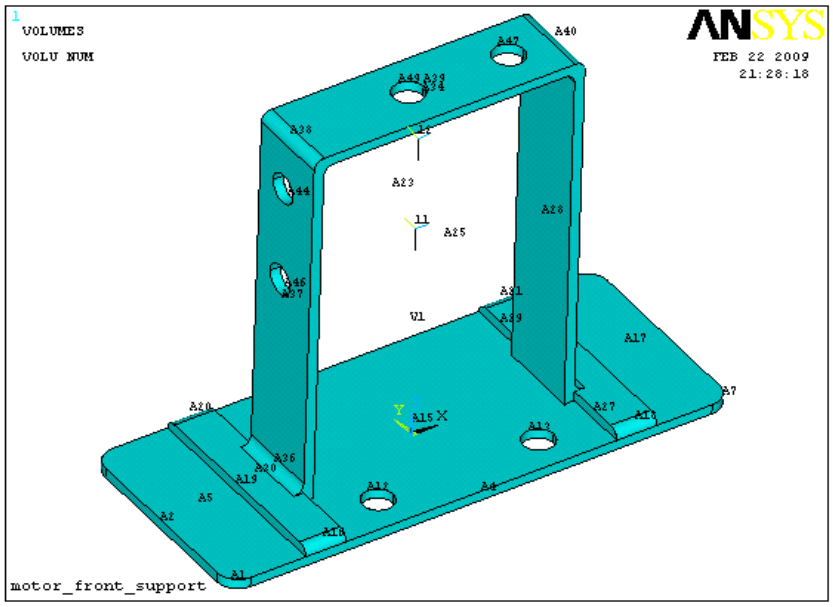




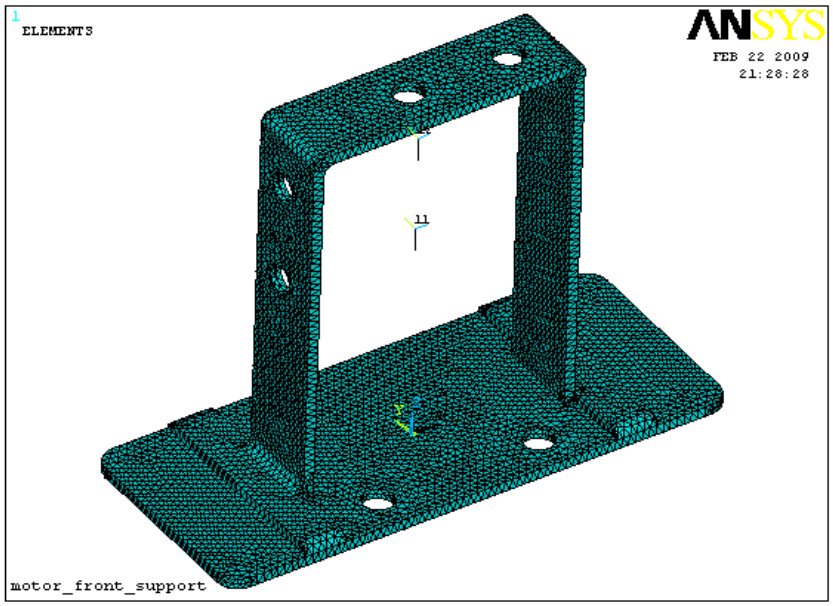


# Analysis of Motor front support

Objective: - The main objective of this analysis is to test the motor front support against maximum loading condition that occurs in case of stalling of gear train & the torque transmitted by motor (converted in to normal force) will act directly on front support & motor rear support.




Meshing: - Total no. of elements created = 39241



Boundary conditions:-

1) Constrains: - The motor front support is attached to base plate at bottom & to roller support at top with the help of nut & bolt.

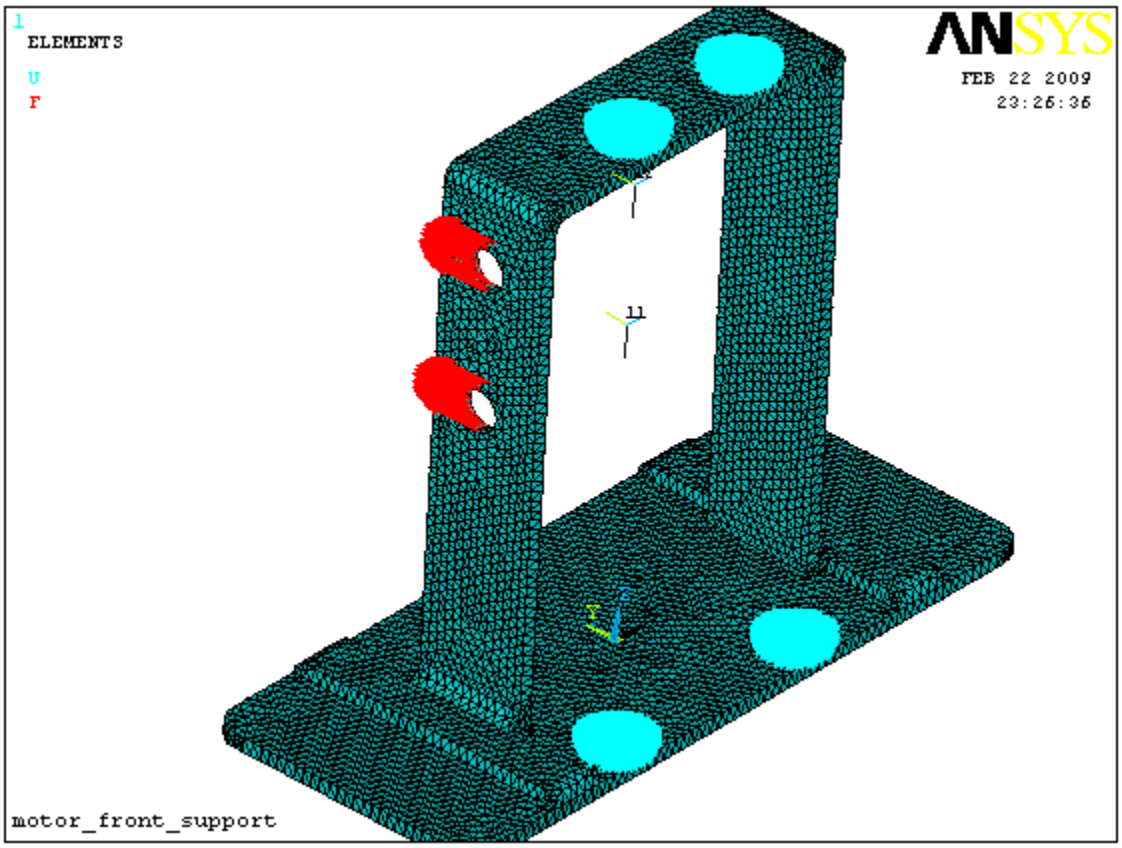
   Therefore all the nodes on internal surfaces of holes (quantity = 3) provided for bolting purpose are constrained in all direction (x, y & z).

2) Loads: - The total tangential load transmitted from first gear to second gear will be directly acted on motor support in case of gear train stalling.

   This total force 2182 N. will be assumed to be get divided equally on motor front & back support.

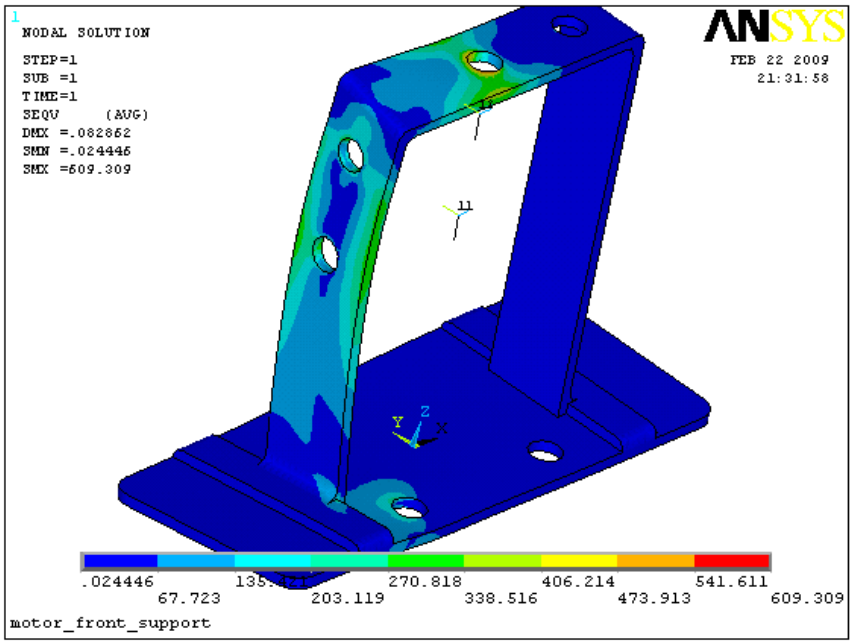
   Therefore the total force loading the motor front support = 1091 N. acted on two holes.

   Therefore normal force is applied on all the nodes on internal surfaces of holes (quantity = 2) provided for bolting the motor to support considering 180 degree contact angle between hole & bolt surface.



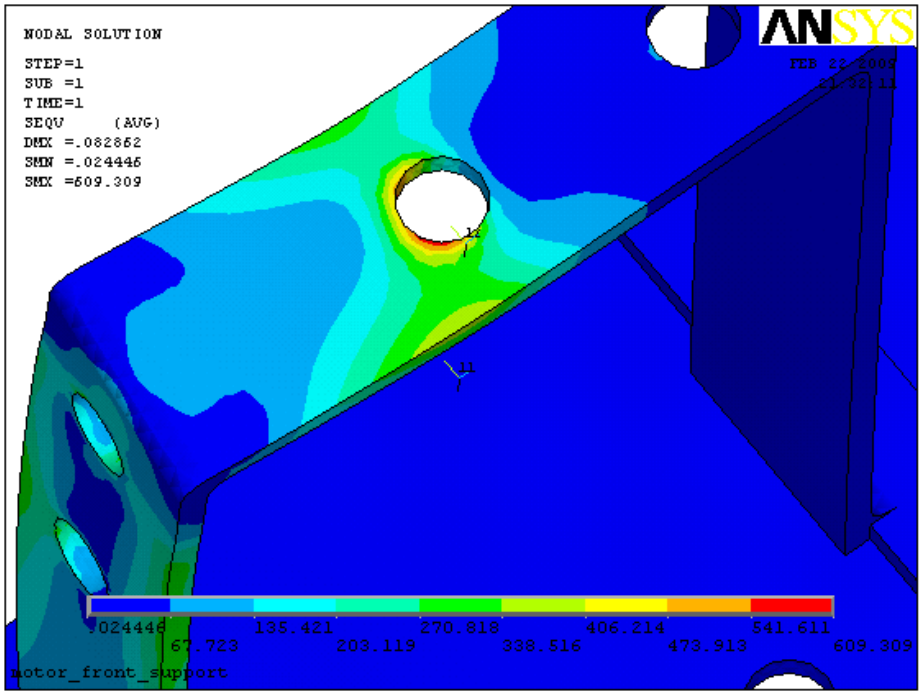
RESULTS

VON-MISSES STRESSES

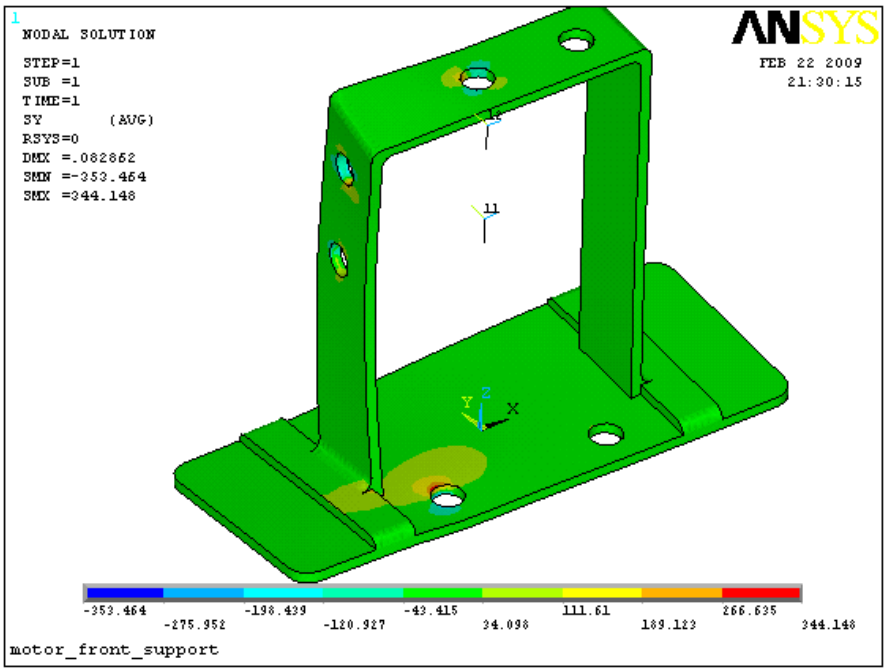



The von-misses stresses at higher range at sharp edges which can be eliminated by removing sharp edges otherwise at other portions stresses are within limit and strengthening of structure should

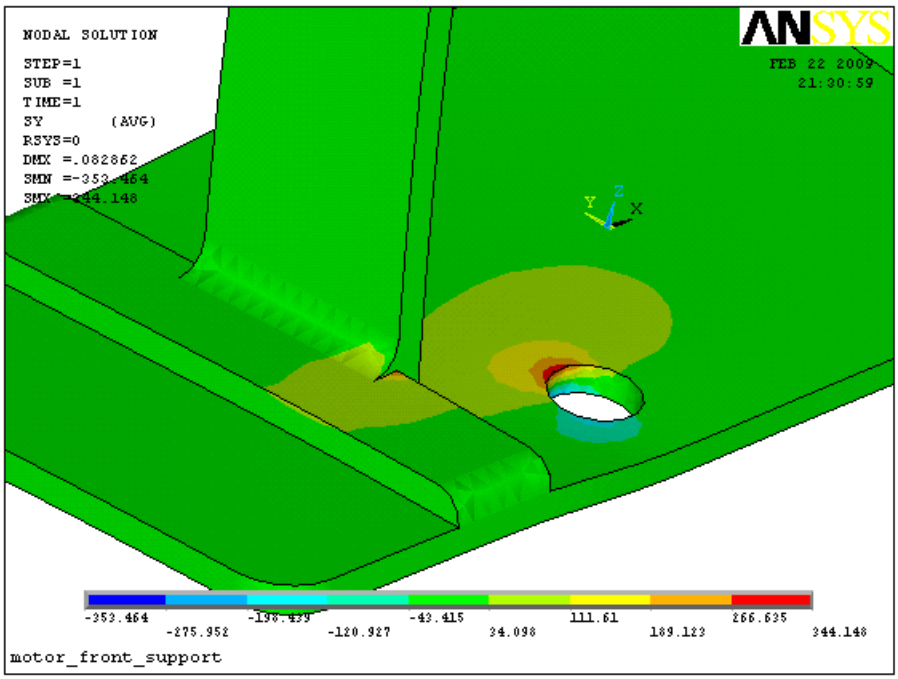
have to do according to FOS requirement.



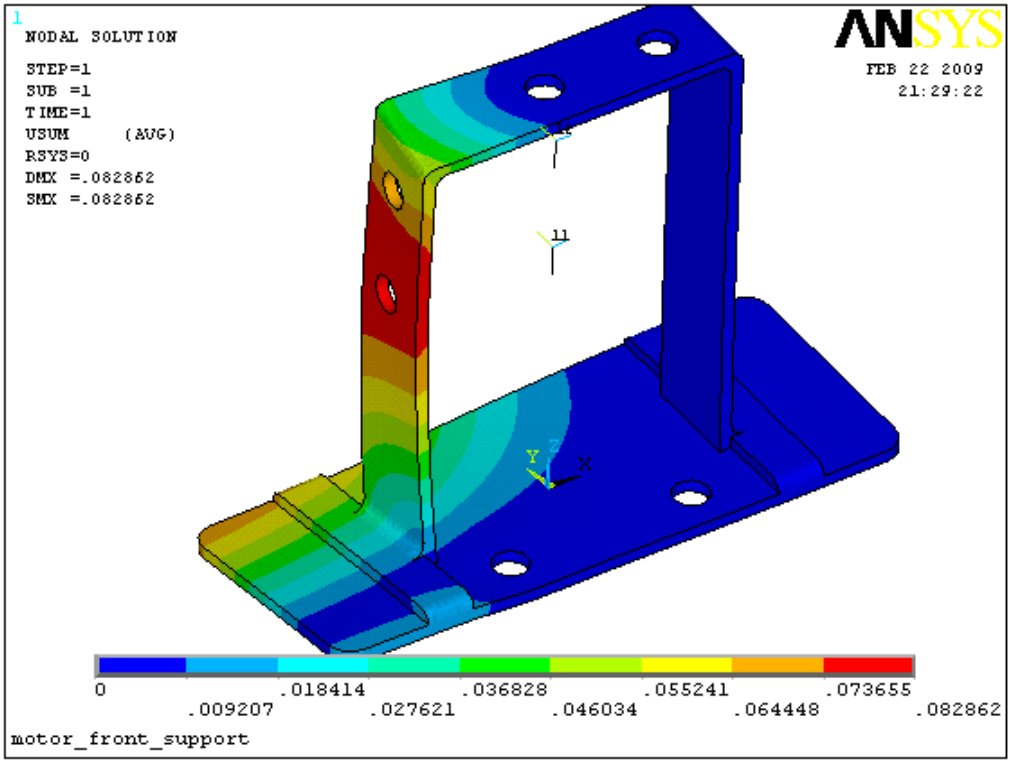

STRESSES IN Y DIRECTION



MAGNIFIED VIEW AT STRESSED LOCATION

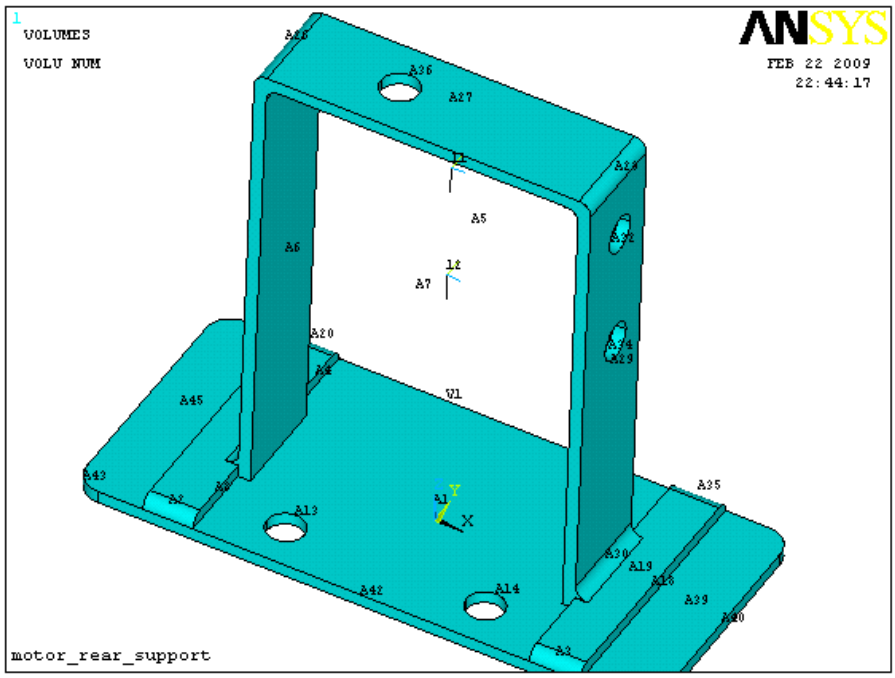



Displacement Vector Sum



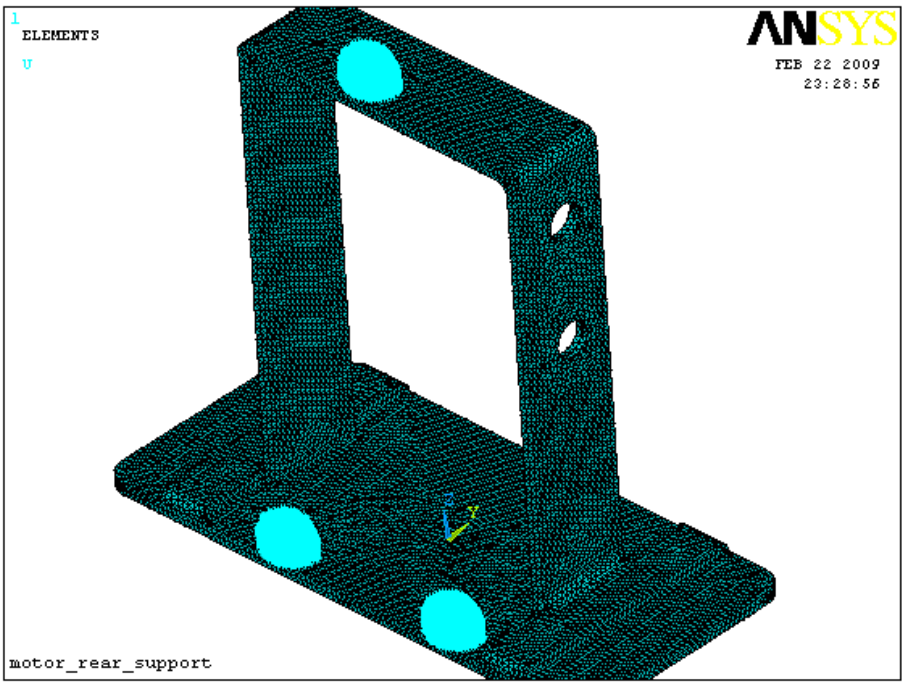

The stress concentration occurred at the bolt locations is due to the sharp edges at ends in actual model the care should have to take about highly stressed locations and some changes in design which will improve the strength.

# Analysis of Motor Rear Support

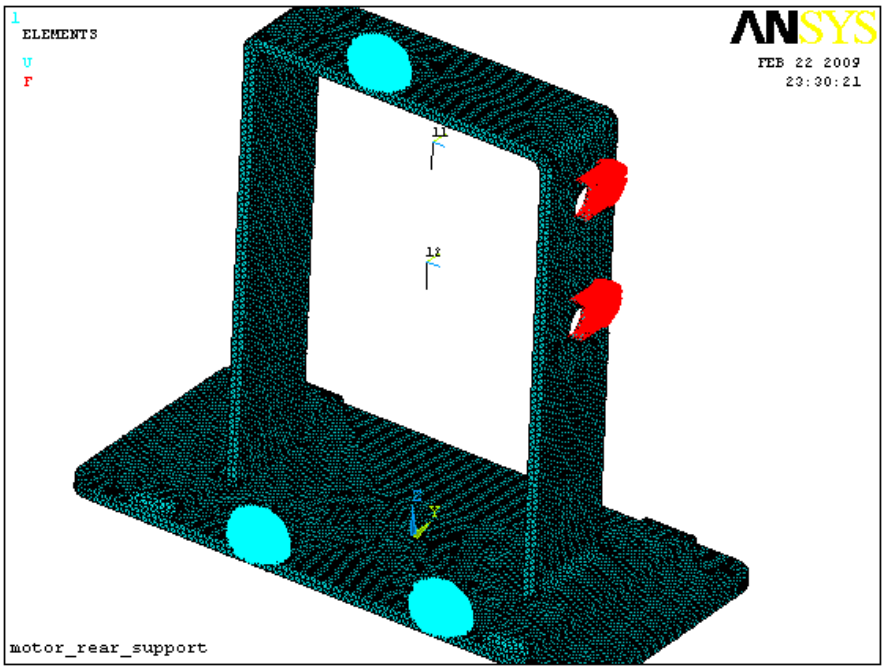



## Boundary Condition

Total no. of elements created = 121580



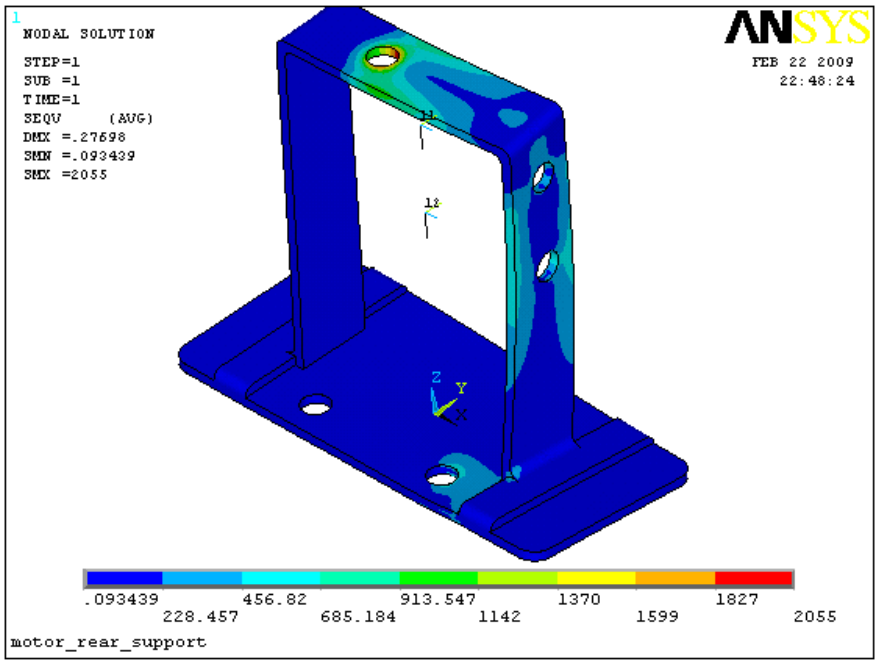

Loading Conditions

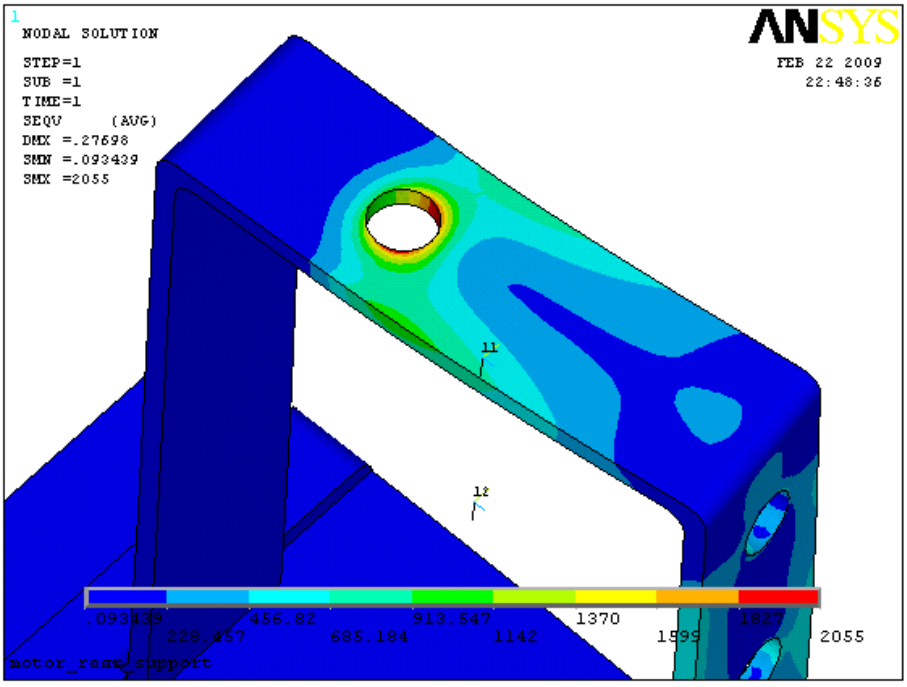


The motor rear support is fixed at bolting locations and force resulted due to torque is applied at the motor mounting locations as shown in above pictures.

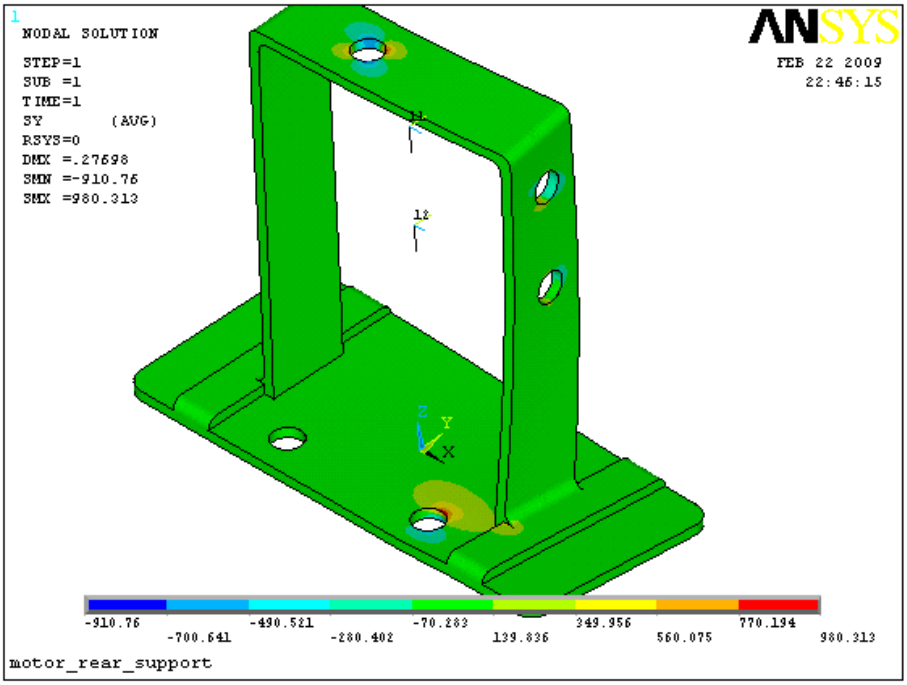
## RESULTS

Von-Misses stresses

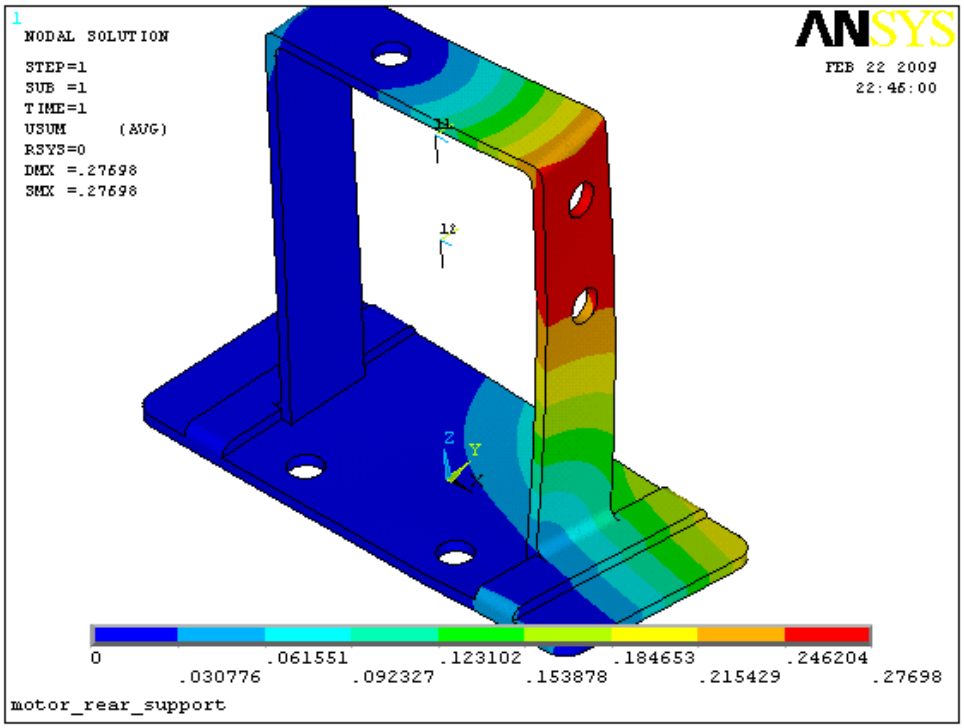



Stresses in Y direction




Displacement Vector Sum



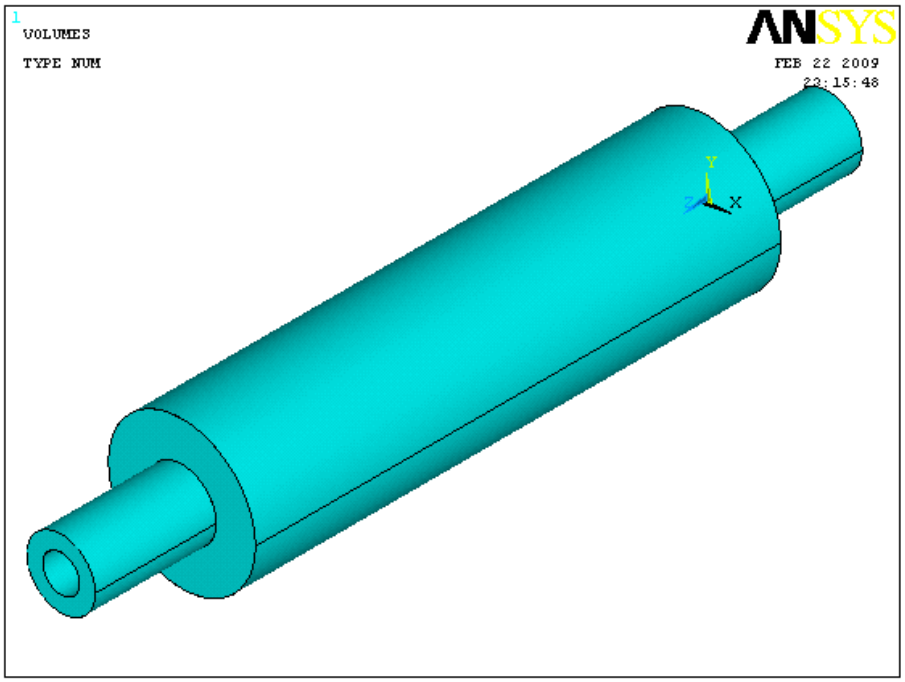

# ROLLER

The rollers are analyzed for the torsion & bending condition.

The torsional condition considered here is the twisting of roller due to gear mounted at one of the end of roller.

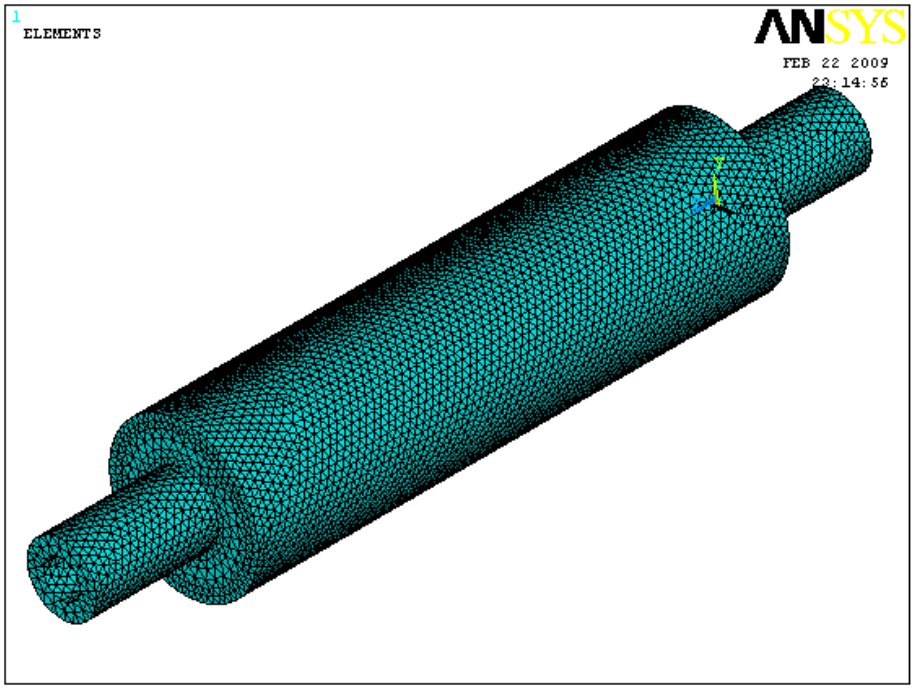
The bending condition considered here is the bending of roller due to spring force at the top of roller.

# Roller 1 Torsion

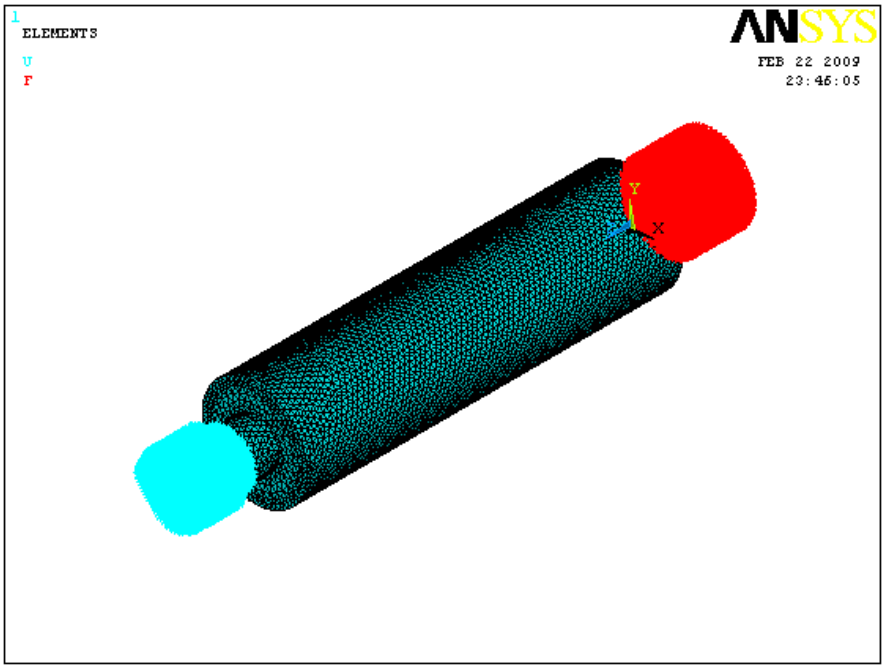



Meshed Roller

No. of Elements - 287714

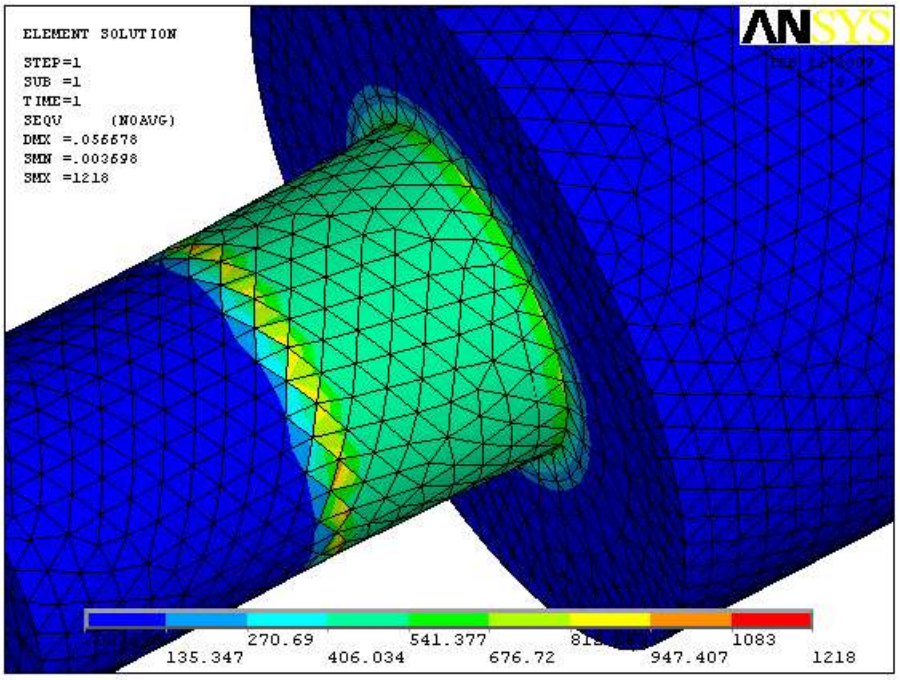



Loading & Boundary Conditions

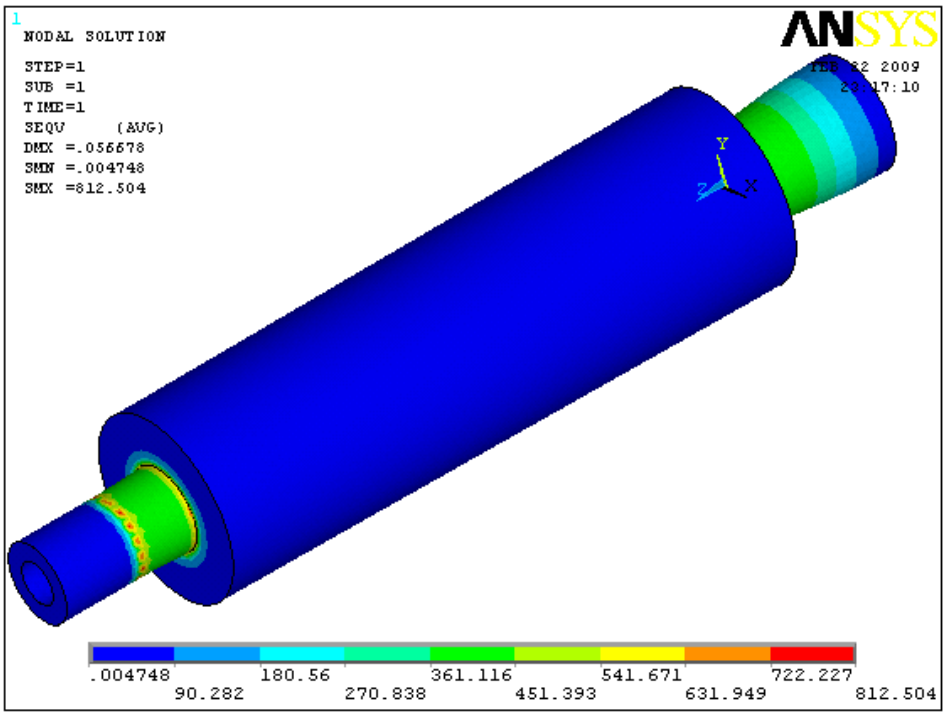


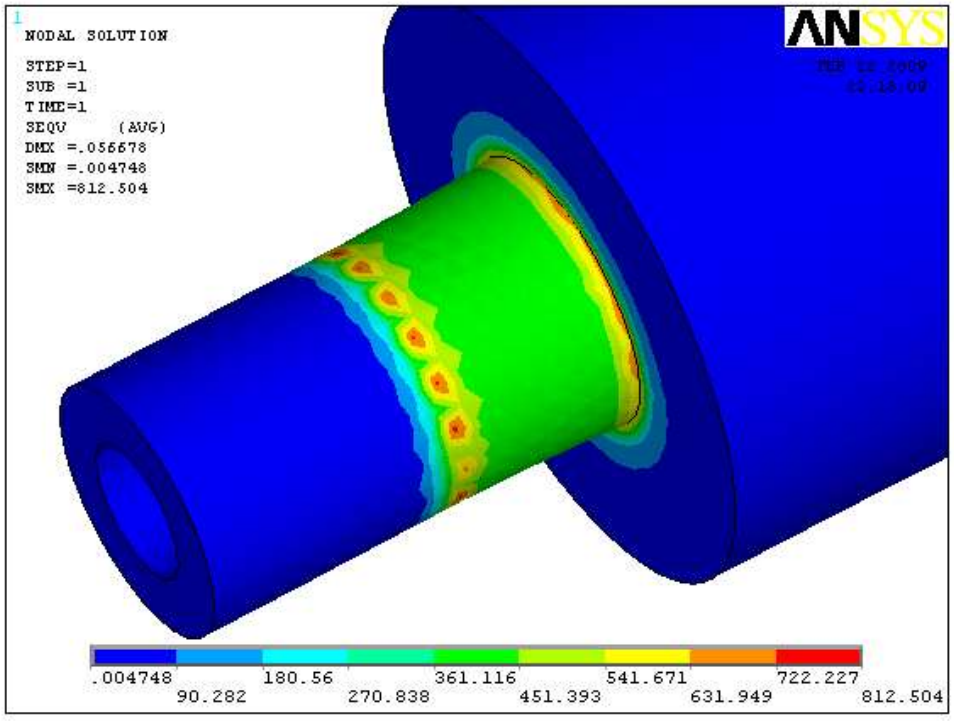

Results

# Elemental Von-Misses Stresses

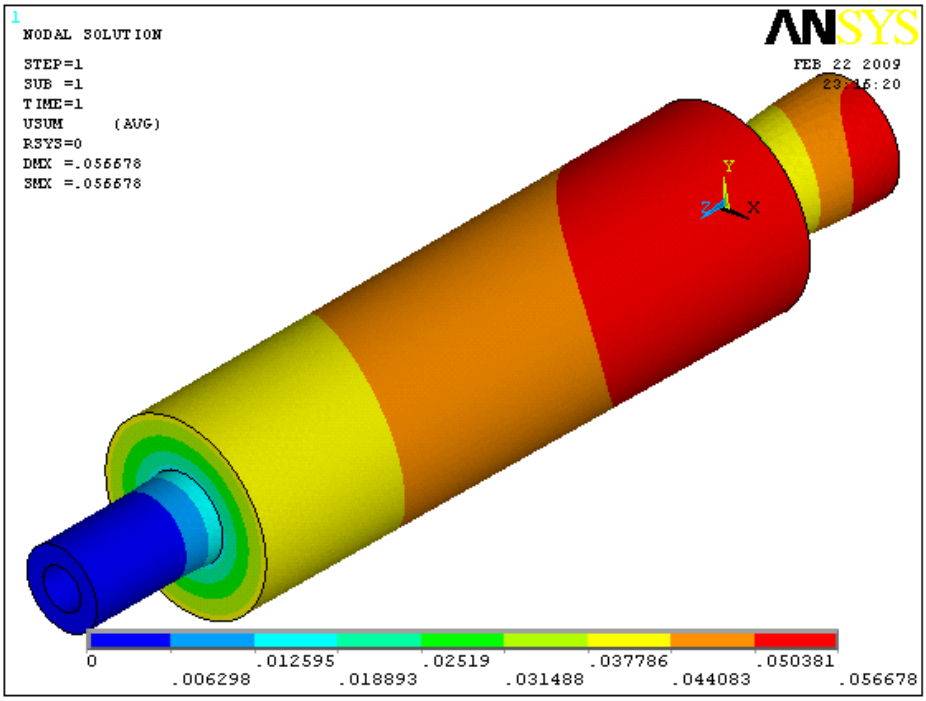



Von-Misses Stresses



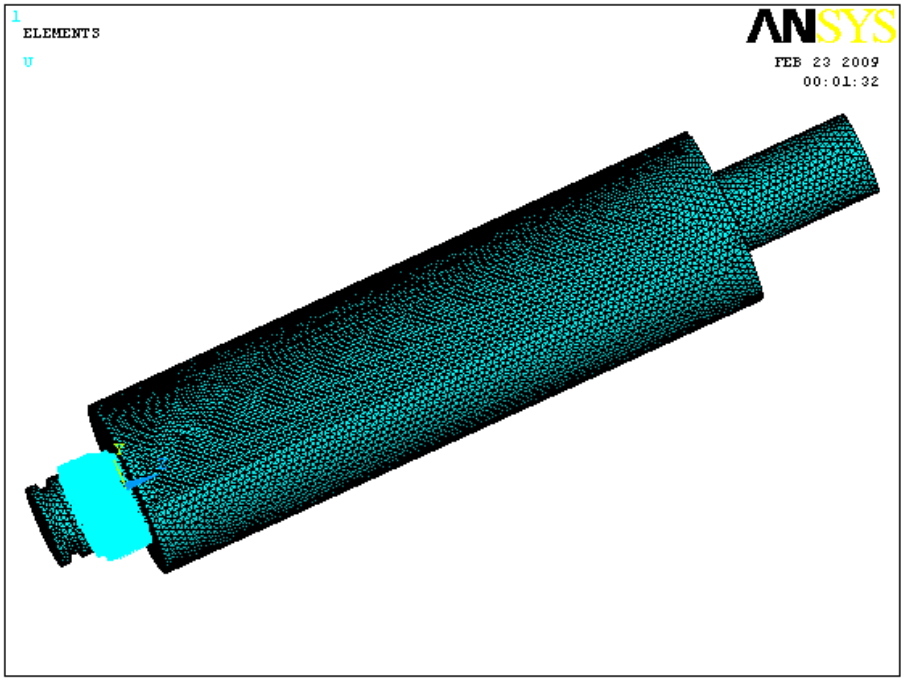



Displacement Vector Sum

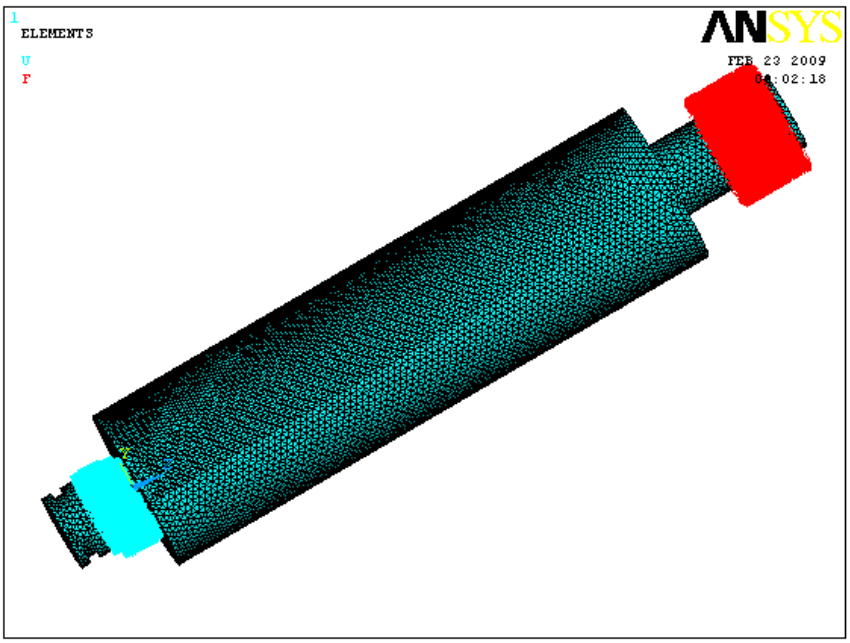


# Roller 2 Torsion

## Boundary Condition

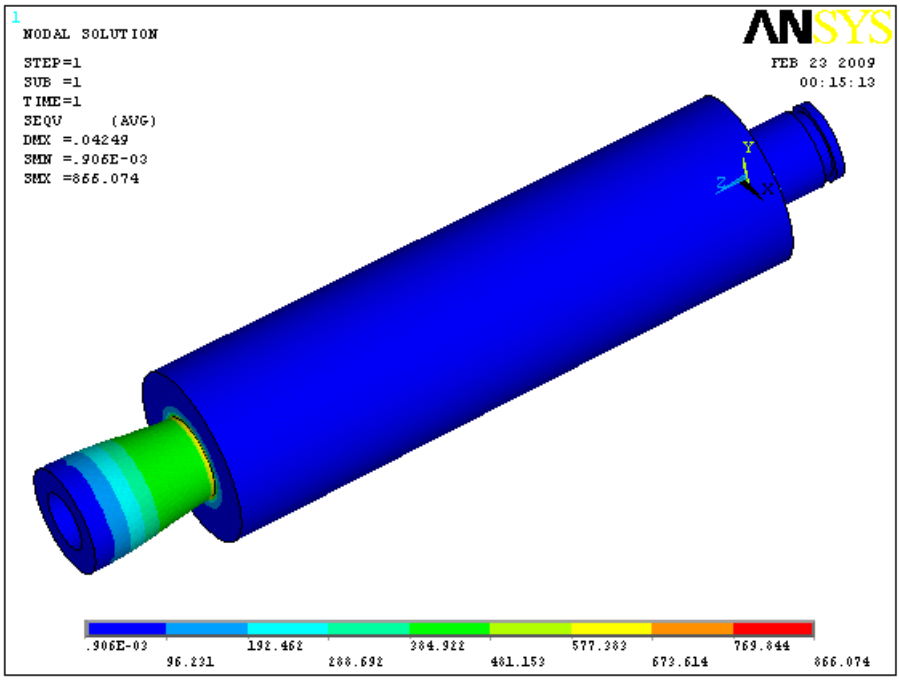


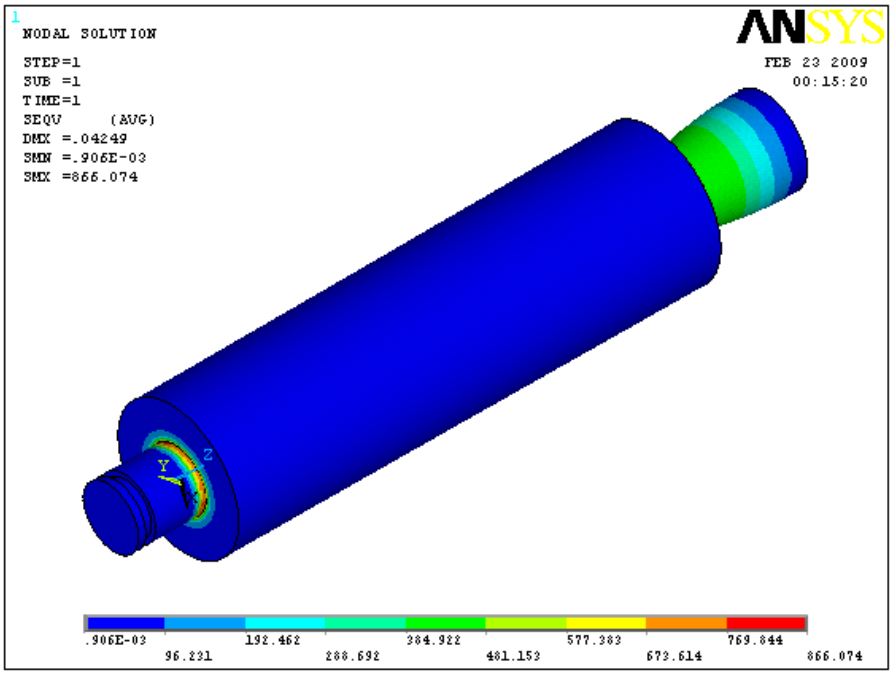

## Loading Condition



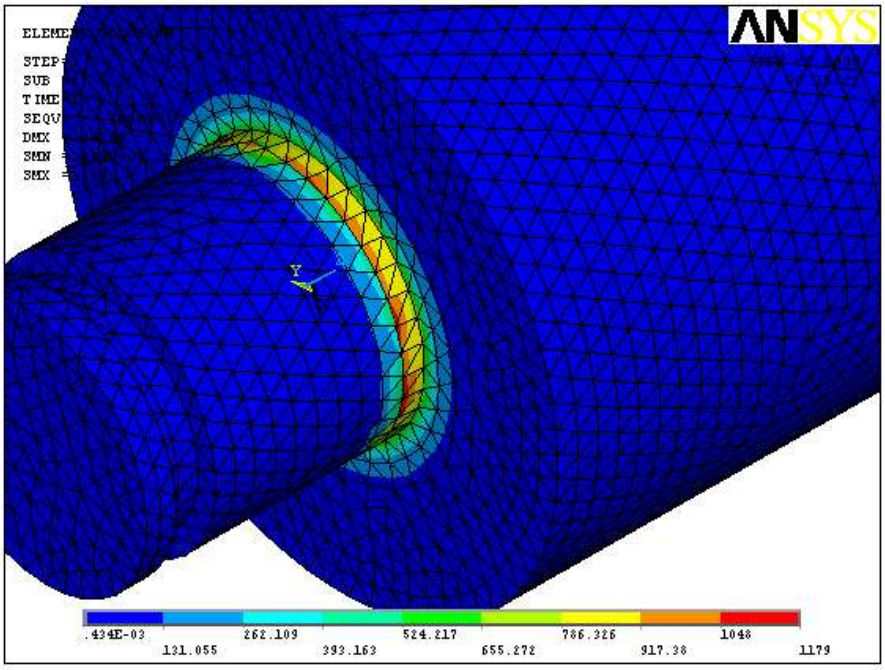
# Results

## Von-Misses stresses (Note – The pictures are magnified views)

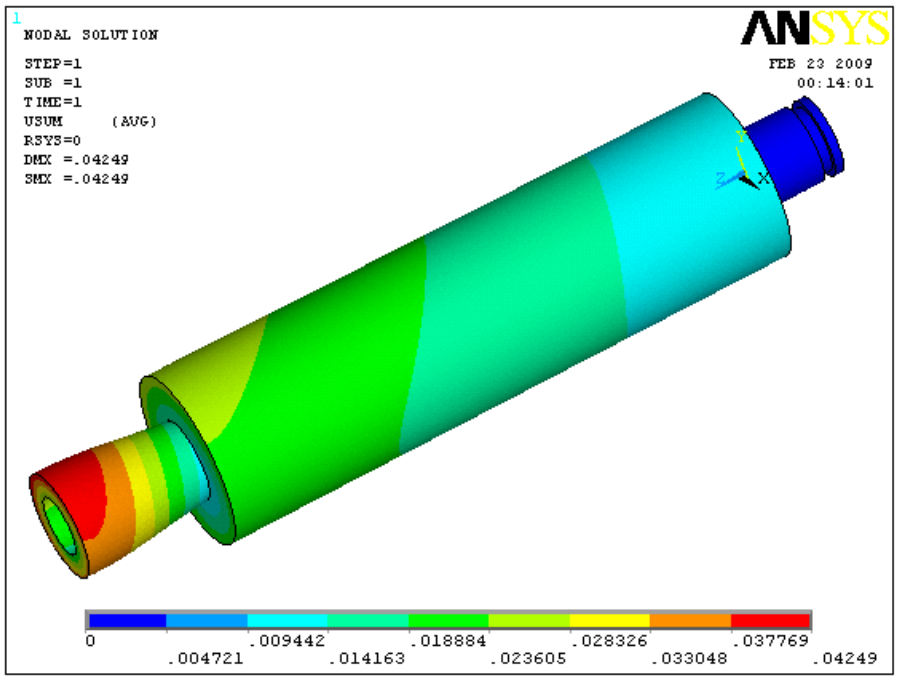


## Elemental Von-Misses Stresses

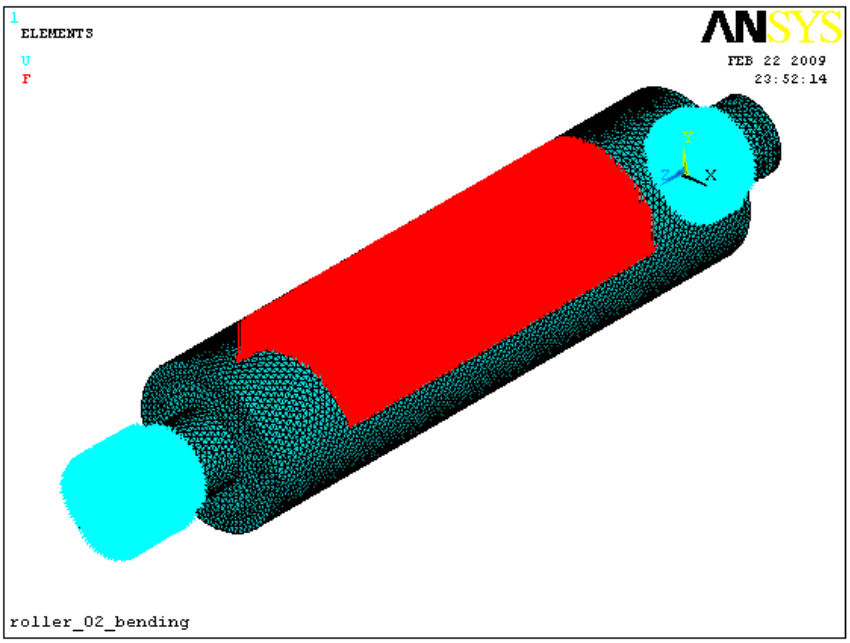



## Displacement Vector Sum



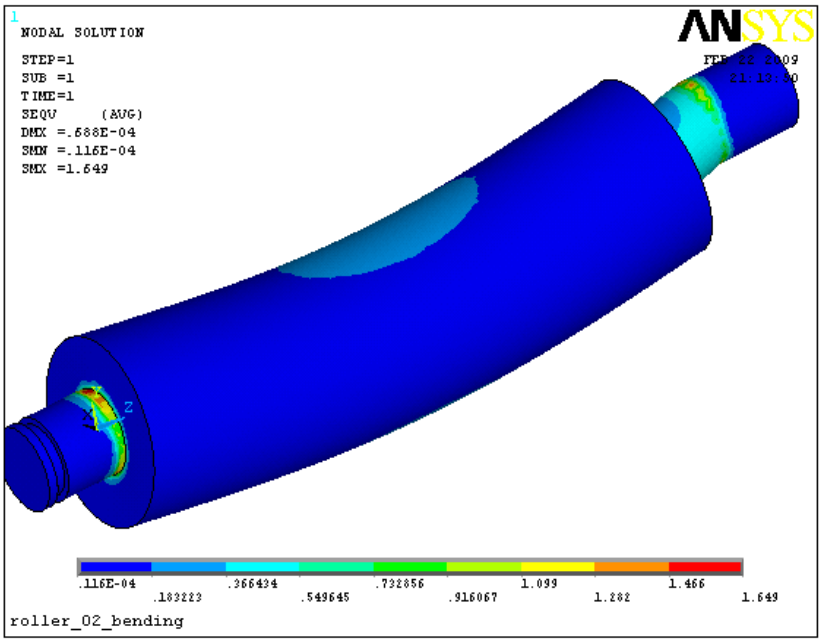
# Bending of Roller against spring force of 8N

Finite element model with Loading & Boundary Condition

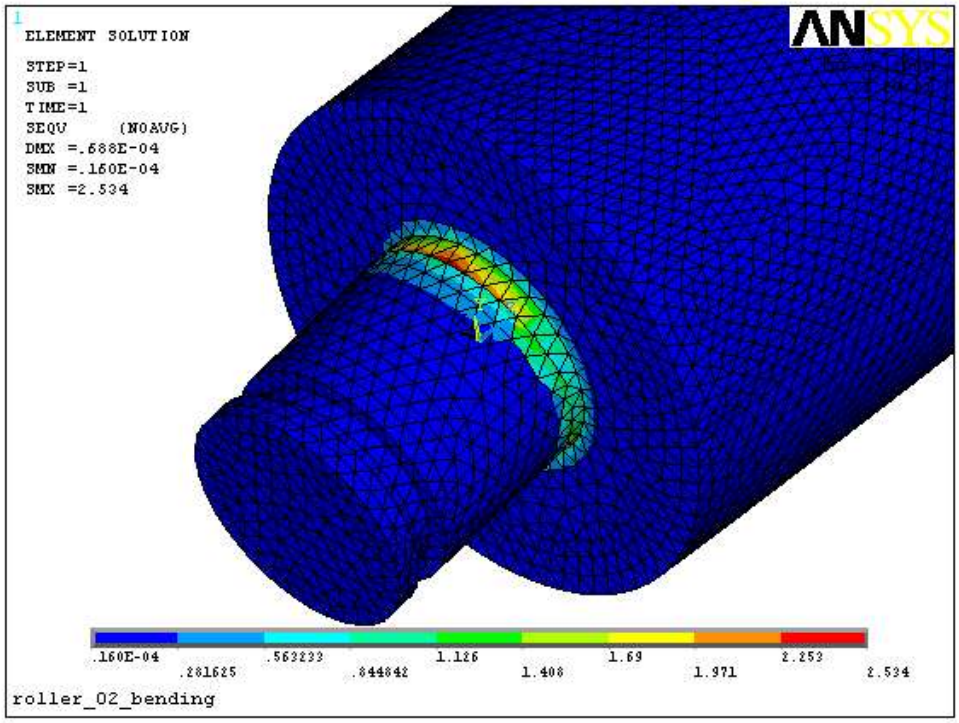



# Results

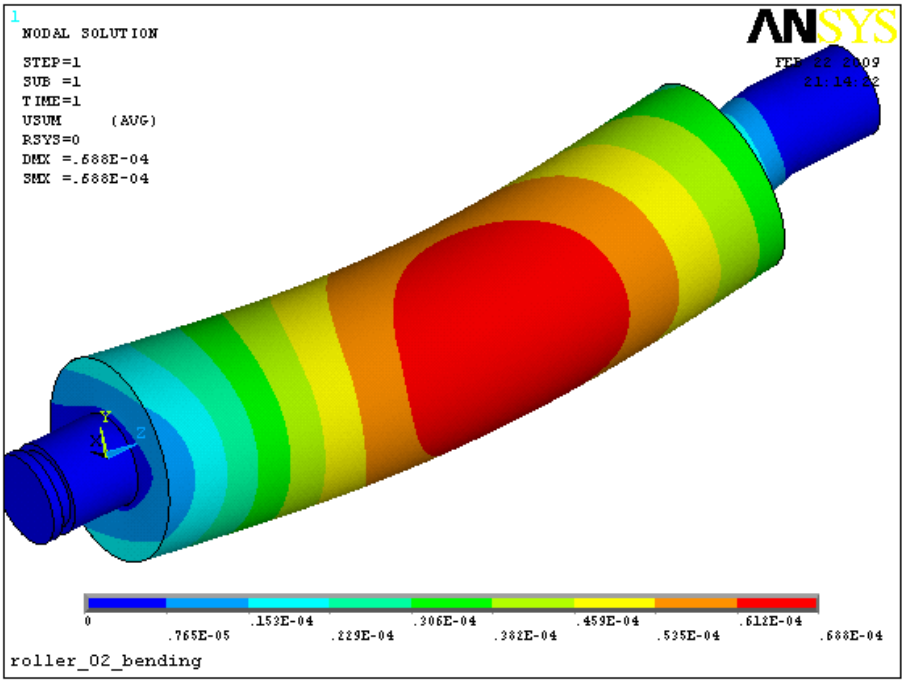
Von-misses stresses




Elemental Von-Misses stresses

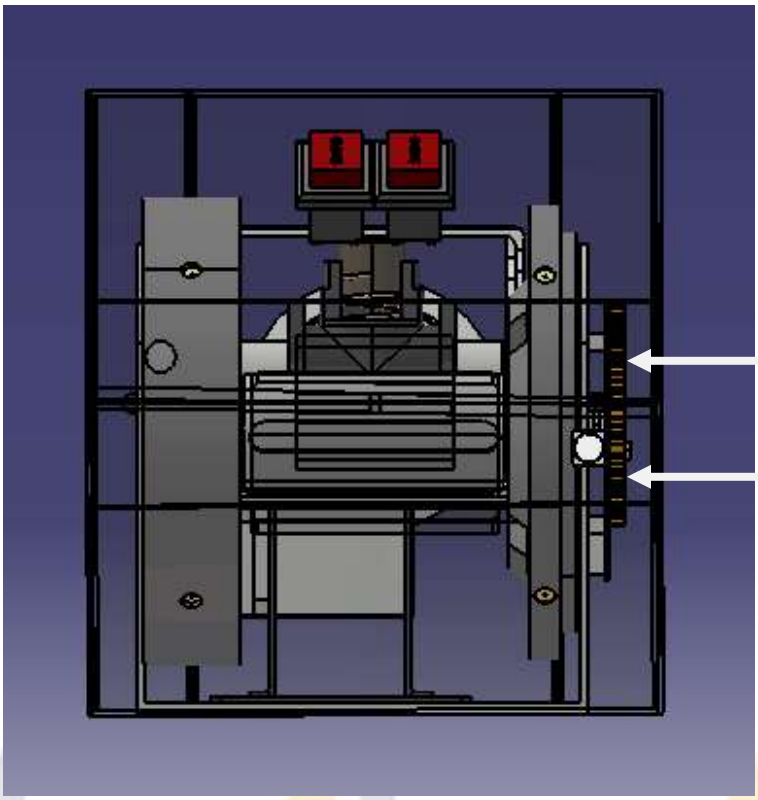


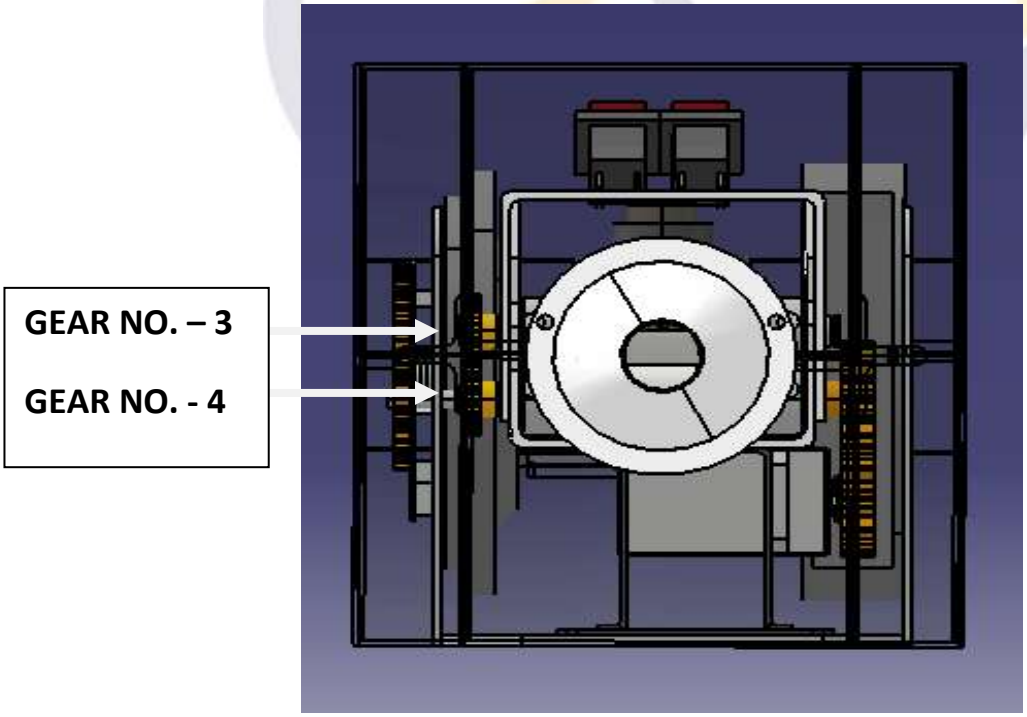

Displacement Vector Sum

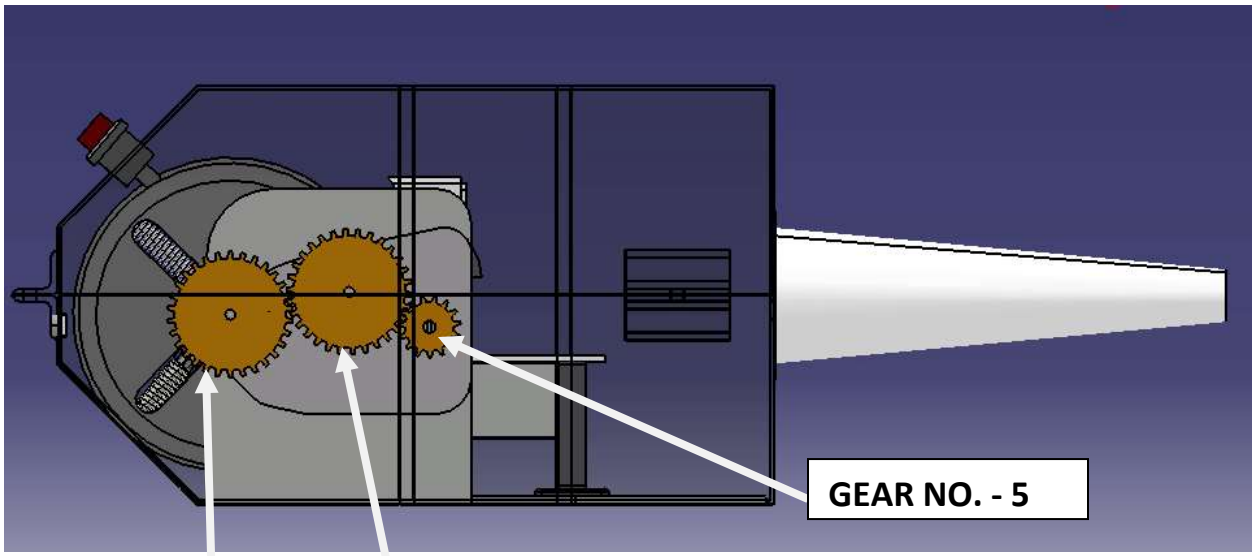



# SATELLITE BOOM DEPLOYMENT MECHANISM

## GEAR NUMBERING SYSTEM





# GEAR ANALYSIS

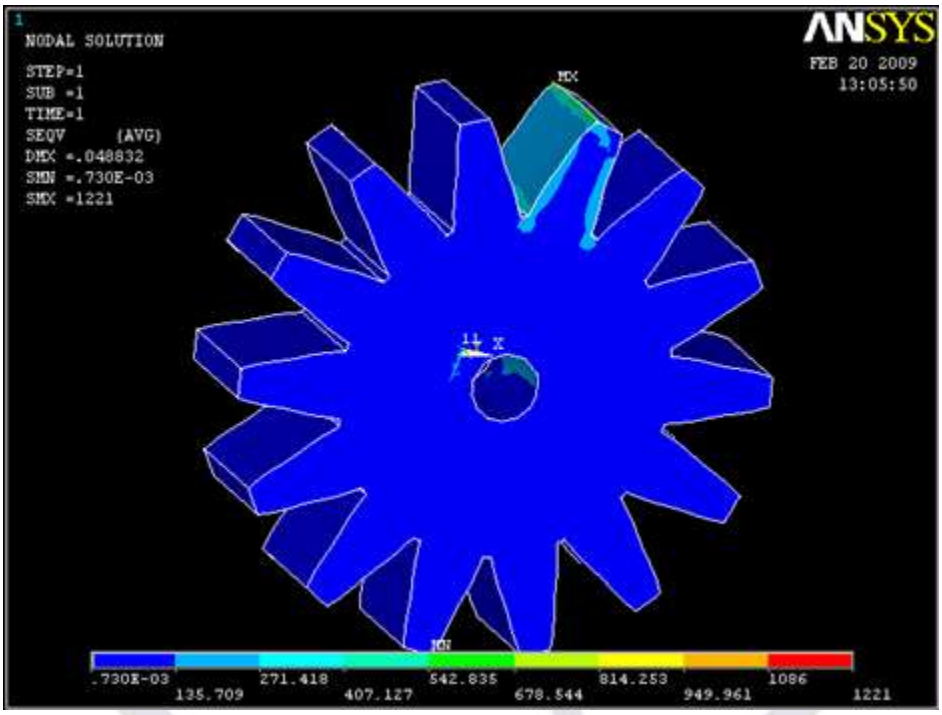
The analysis of gears is done on the basis of bending of gear tooth at the maximum tangential tooth load. So it is assumed that the in case of stalling of gear the maximum tangential tooth load comes at the tip of the tooth. The stress concentration occurred due to the sharp edges and in actual model the sharp edges are removed already and the model considered here for analysis is not covering the details of models as in actual.

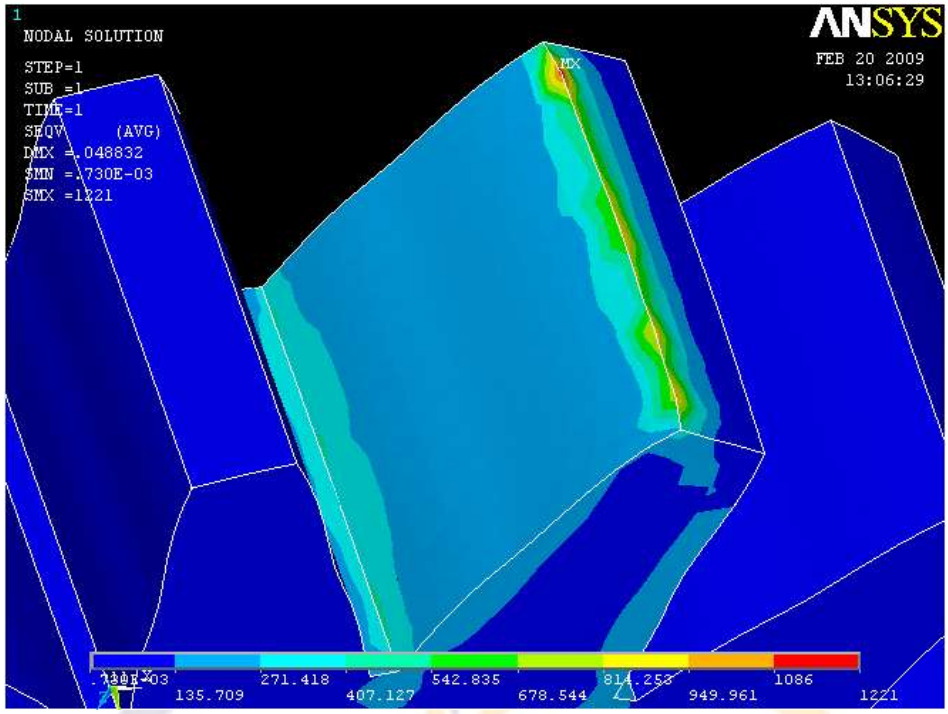
The running torque of 12 Nm is considered for calculation.

# Analysis of Gears

## Gear No. 2 (Above motor Gear)

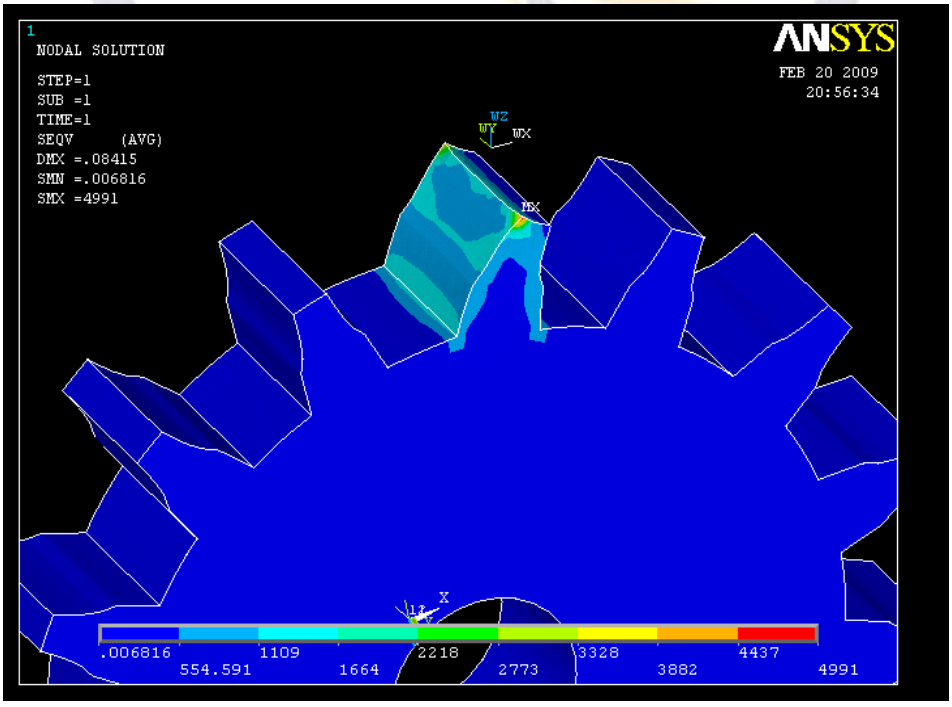
## Von-misses stresses





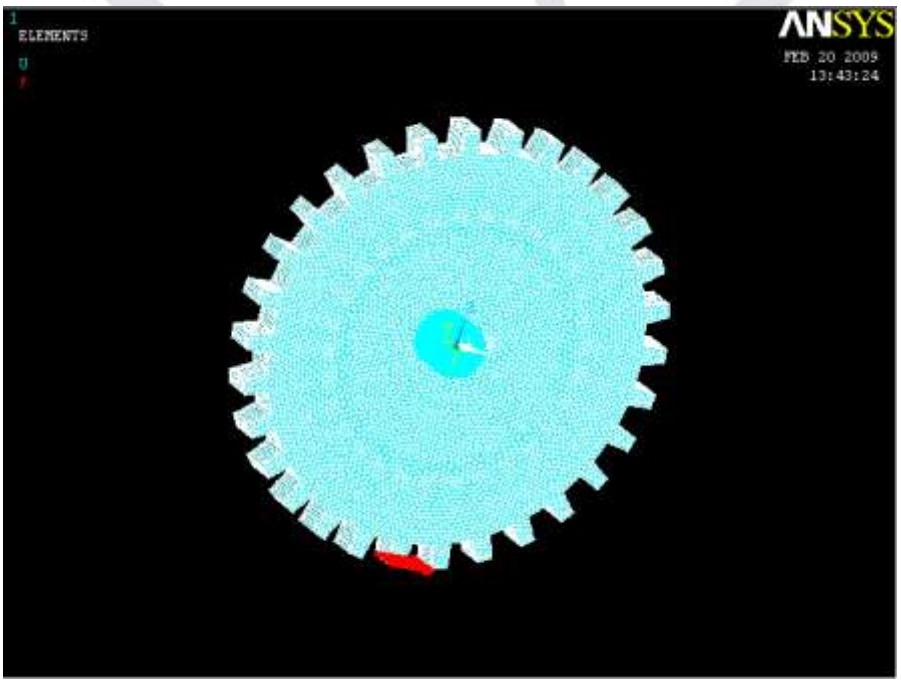

Gear No. 5 (Smaller gear next to roller gear)

## Von-Misses gear

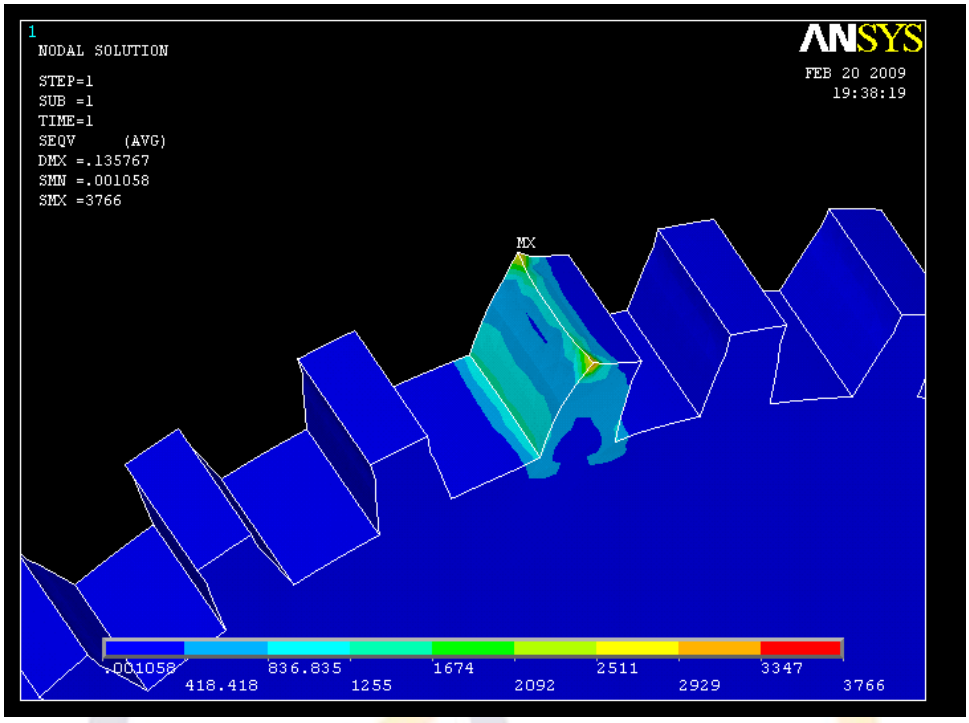


## Gear no 6 (Larger gear driven by smaller gear)

## Loading & Boundary Condition



# Von-Misses Stresses




# Displacement Vector Sum