iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 5 **Issue:** IX **Month of publication:** September 2017

**DOI:** http://doi.org/10.22214/ijraset.2017.9082

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for ReseaArch in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887*
*Volume 5 Issue IX, September 2017- Available at www.ijraset.com*

# Optimization of Pulp Feeding System Components of Paper Recycling Machine

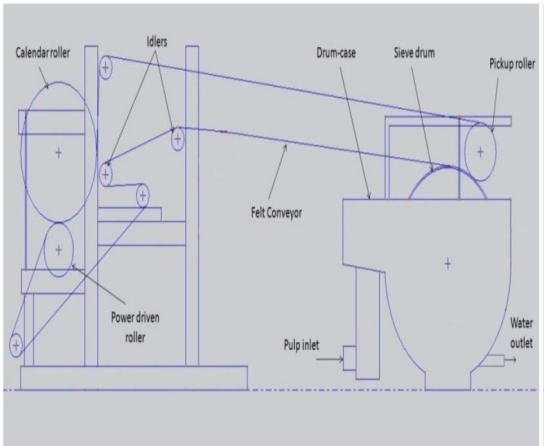
J Narsaiah[1], Basawaraj S Hasu[2], Bollam Naresh[3]
[1]*Assistant Professor, Dept of Mechanical Engineering, AVN Institute of Engineering & Technology, Hyderabad, India*
[2]*Professor & HOD, Dept of Mechanical Engineering, AVN Institute of Engineering & Technology, Hyderabad, India*
[3]*PG Student, Dept of Mechanical Engineering, AVN Institute of Engineering & Technology, Hyderabad, India*

***Abstract:** Paper is one of the most important products ever invented by man. The primary raw material for the paper production is pulped fibers' obtaining by a complicated chemical process from natural materials, mainly from wood. Paper recycling saves the natural wood raw stock, decreases the operation and capital costs to the paper unit, decrease water consumption and last but not least this paper processing gives rise to the environment preservation. The manually operated paper recycling machine unit mainly consists of the following four systems. Pulp feeding system and Pulp transferring system, Calendaring System and driving mechanism. The pulp feeding system mainly consists of the sieve drum, drum case and the pickup roller. Its function is the preparation of pulp slurry and feeding it. In this project, initially, the design of the manually operated paper recycling machine was done from the design calculations and the previous literature survey. From the calculations, a 3D assembly of the manually operated paper recycling machine is created using the NX-CAD software. Structural static analysis is performed on the components of pulp feeding system by applying the evaluated boundary conditions and forces. The stresses and deflections of the components of pulp feeding system obtained from the analysis. Efforts are made to reduce these stresses and deflections by optimizing the design of pulp feeding system components to increase factor of safety.***

## I. INTRODUCTION

Paper is one of the most important products ever invented by man. Widespread use of a written language would not have been possible without some cheap and practical material to write on. The invention of paper means that more people would be educated because more books would be printed and distributed. The industry would grow because all the plans, blueprints, records and formulae it uses would be written down and saved, together with the printing press, paper provided an immensely important way to communicate knowledge. The primary source of raw material for the production of paper is vegetable fibers, obtained mainly from plants. To ensure that the forest is not diminished of these woods, there is need to provide an alternative source of raw materials; this, therefore, leads to the invention of the process of recycling.

Recycling, which is the extraction and recovery of valuable materials from scrap or other discarded materials, is employed to supplement the production of paper. The designing and fabrication of a used paper recycling plant are, therefore, a welcome development as it will ensure that the source of raw material for paper production is multiplied and also waste paper that could have constituted into wastes are recycled for various productive purposes. Designing a manually operated paper recycling plant ensures that a cheap and non-complex method of production of the paper product is guaranteed.




General Layout of Pulp Feeding System.

## II. LITERATURE SURVEY

Vrushabh R. Rathod, Saurabh R. Rathod, Nitin H. Wankhede have published a paper on "Design of Manually Operated Portable Paper Recycling Machine". The abstract of the paper says In any big institution, especially educational institutions like schools or colleges, generation of large quantity of waste papers is quite apparent. And effective use of recycled paper is also possible (craftpapers, registers etc.). So, instead of disposing of off the waste papers into the trash, recycling them makes sense. This not only helps the Institute in cost-saving but will also ensure its contribution towards the protection of the environment. Designing manually operated small-scaled paper recycling plant, which can be used in schools and colleges, ensures that a cheap and non-complex method of production of a paper product is guaranteed. Accordingly, the design of the machine unit has been prepared with all necessary component specifications.Also, 3D modelling and drafting have been done.

M. A. OLUTOYE has published a paper on " Design of a Manually Operated Paper-Recycling Machine". The summary of the paper is A manually operated paper-recycling machine was designed and fabricated. This is done to enable waste paper conversion into a useful product. The fabricated plant consists of six major component units that include the disc refiner, the hydro-pulper, the head box, the belt conveyor, the drivers and the rollers. From the results of the experimental analysis carried out on the study, it was discovered that for every 0.1kg of used paper fed into the refiner, about 7000ml of water is required to fibre it, and about 0.2 kg of starch adhesive is required. The calculated volume of the refiner, hydro-pulper and the head box is 11795.62cm3, 62930.47cm3 and 60979.096cm3 respectively. The fabricated machine is capable of producing 7.6 kg of recycled paper from 10 kg of used paper.

Scott M. Kaufman has published a paper on "Analysis of Technology and Infrastructure of the Paper Recycling Industry in New York City".The objective of this study was to examine the technology and infrastructure of paper recycling in New York City and devise ways for increasing paper recovery. At present, "residential "waste paper is collected as a separate stream by the Department of Sanitation of New York City (DSNY). In 2003, DSNY collected approximately 414,960 tons of paper, i.e. about 35 percent of the estimated paper discarded in the residential stream. The "commercial" paper generated by private businesses and collected by several private charters amounts to approximately8,00,000 tons per year. The NYC commercial paper recycling rate is about 69 percent. The total amount of NYC paper wastes, both residential and commercial, is estimated at 2,360,000 tons every year. Therefore, the overall paper recycling rate is 50.5 percent, slightly little higher than the reported U.S. rate for paper recycling.

## III. DESIGN CALCULATIONS OF DIFFERENT UNITS OF PAPER RECYCLING MACHINE

### *A. Calculations of Drum Case*

Volume of Drum case (V) = Vc+ 0.32 Vc

Where Vc = Volume of sieve drum

Volume of sieve drum $= \frac{\text{mass of the pulp slurry}}{\text{density of pulp slurry}}$

Density of pulp slurry = 1.172 g/ cm3

Mass of pulp slurry = 5.15 * 5 = 25.75 Kg (Scale up factor for whole plant is taken as 5)

Then,

Volume of Sieve Drum $= \frac{25.75*1000}{1.172}$cm3

Volume of Sieve Drum (Vc) = 21970.98 cm3

Volume of Drum case (V) = Vc+ 0.32 Vc

= 21970.98+ 0.32 (21970.98)

= 29001.69 cm3

Volume of Drum case (V) = 29001.69 cm3.

Volume of the Drum Case $V = \pi r^2 h$

Where h = height of the Drum Case = 20 cm

r = radius of Drum Case

Volume of Drum case (V) = 29001.69 cm3

Volume of the Drum Case

29001.69 = 3.14 * r2 * 20

Radius of Drum Case (r) = 21 cm

r = 21 cm

Diameter of Drum Case (D) = 2r = 2*21 = 42 cm

The total surface area of drum case ( A) = $2\pi r(h + r)$

$$A = 2*3.14*21*(20+21)$$
$$= 5407.08\ cm^2$$

The total surface area of drum case (A) = 5407.08 $cm^2$

Circumference of Drum Case ( C ) = $2\pi r$

$$C = 2\pi r = 2*3.14*21 = 131.88\ cm$$

Circumference of Drum Case (C) = 131.88 cm

*B. Calculations of Sieve Drum*

Volume of sieve drum (Vc) = $\frac{mass of the pulp slurry}{density of pulp slurry}$

Density of pulp slurry = 1.172 g/ $cm^3$

Mass of pulp slurry = 5.15 * 5 = 25.75 Kg

(Scale up factor for whole plant is taken as 5)

Then,

Volume of Sieve Drum = $\frac{25.75*1000}{1.172}$ $cm^3$

Volume of Sieve Drum (Vc) = 21970.98 $cm^3$

*C. Calculations of Calendar rolls*

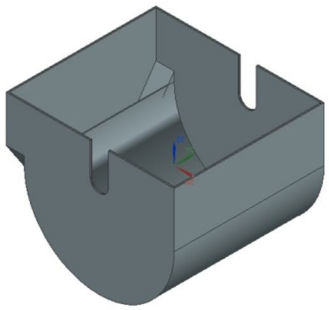
Calendar rolls have two rollers. One roller is attached to the motor, and another roller is attached to other rollers and sieve drum. One roller has a bigger diameter, and other has a smaller diameter.

a.Diameter of Bigger roller = 12 cm

b.Diameter of Smaller roller = 8 cm

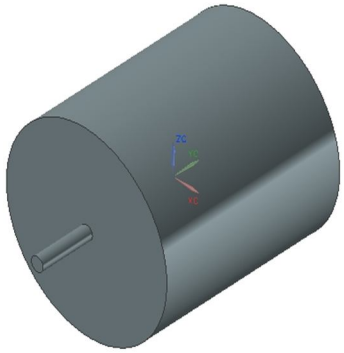
## IV. 3D MODELING OF PAPER RECYCLING MACHINE

3d model of different components of paper recycling machine is modelled based on design calculations. All components of paper recycling machine are modelled in NX-CAD software.



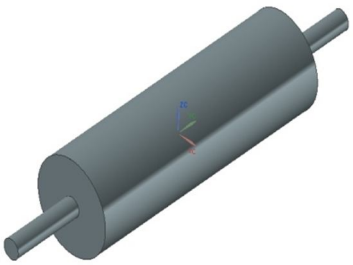
Isometric view of Sieve drums case

*A. Isometric view of Sieve drum*



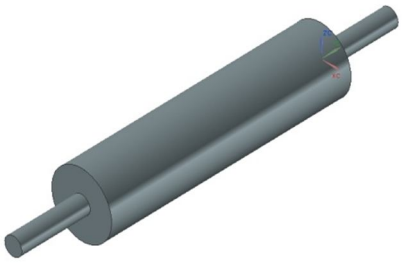
Isometric view of Sieve drums.

*B. Isometric view of calendar roller-1*



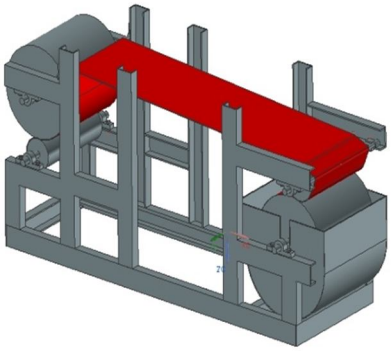
Isometric view of calendar roller-1.

*C. Isometric view of calendar roller-2*



Isometric view of calendar roller-2.

*D. Assembly of paper recycling machine*



3d model of assembly of paper recycling machine.

## V. FINITE ELEMENT ANALYSIS OF PAPER RECYCLING MACHINE

*A. Static analysis of sieve drums case*

Static analysis can include steady inertia loads and time varying loads that can be approximated as static equivalent loads. The 3d model of the sieve drum case is created in NX-CAD and converted into Para solid. The Para solid file is imported into ANSYS, and finite element analysis is carried out using ANSYS software.

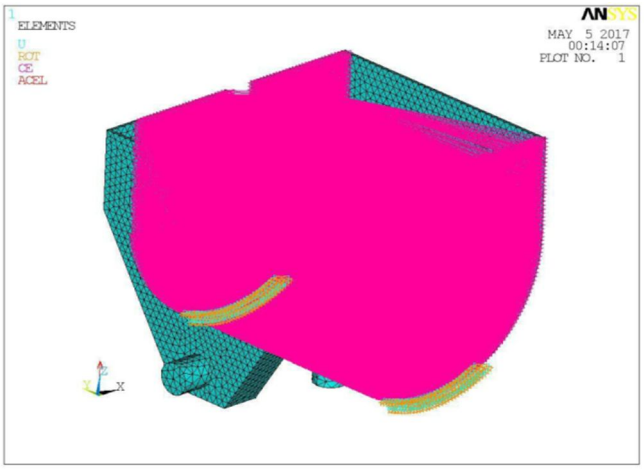
*1) Material Properties:* The material used for Sieve drum case is steel

Young's Modulus: 200GPa
Poisson's Ratio: 0.3
Density: 7850 Kg/m3
Yield strength: 240MPa

*2) Boundary conditions*

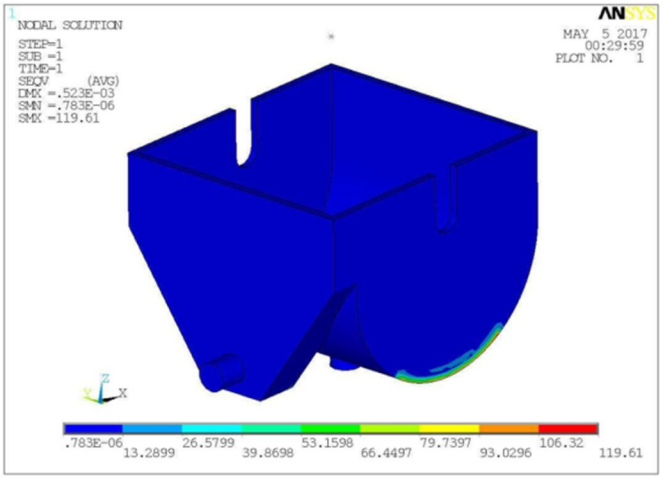
*a)* The bottoms of the sieve drum case are constrained in all Dof.

*b)* A weight of 25.75 kg load is applied inner side of the drum case.




The applied boundary conditions of Sieve drum case

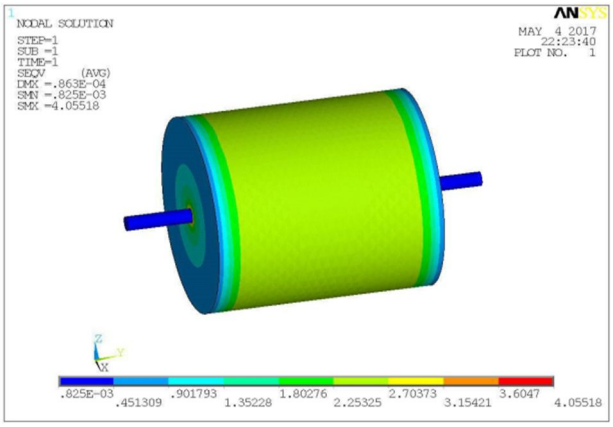
The Von Mises Stress observed is 119.61MPa on modified Sieve drum case.




The Von Mises stress of modified Sieve drum case.

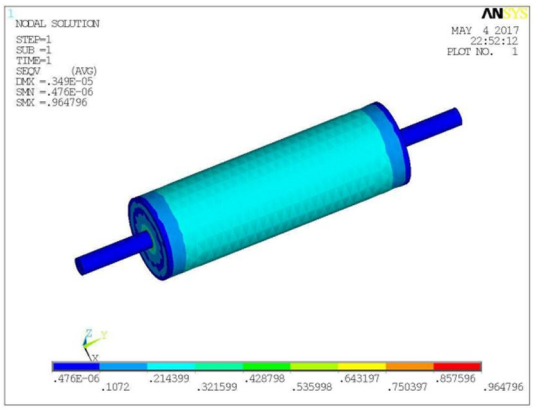
*B. Static analysis of sieve drum*

The Von Mises Stress observed is 4.05MPa on Sieve drum.




Von Mises stress of Sieve drum.

The Von Mises Stress observed is 0.964MPa on bigger calendar roller.




Von Mises stress of bigger calendar roller

The Von Mises Stress observed is 0.26MPa on smaller calendar roller.

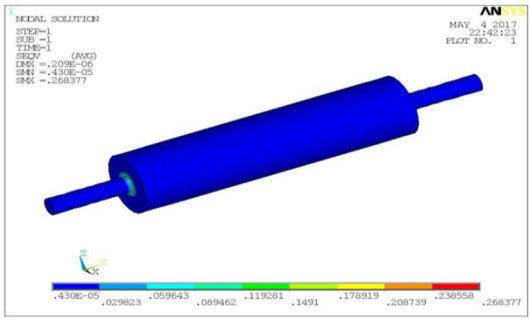



Fig: shows the Von Mises stress of smaller calendar roller.

## VI. RESULTS AND CONCLUSION

Assembly of Paper recycling machine parts was done in NX-CAD software. Static analysis was on following parts of Paper recycling machine.

*A. Sieve drum case*
*B. Sieve drum*
*C. Bigger Calendar roller*
*D. Smaller Calendar roller*

*1) Static analysis of sieve drum case:* From the above analysis, the Max Deflection and the Von Mises Stress observed on the Sieve drum case is 0.0004mm and 243.9MPa respectively and the Yield strength of the material steel is 240MPa.According to the Maximum Yield Stress Theory, the Von Mises stress is greater than the yield strength of the material.

*2) Static analysis of modified Sieve drum case:* From the above analysis, the Max Deflection and the Von Mises Stress observed on the modified Sieve drum case is 0.0005mm and 119.6MPa respectively and the Yield strength of the material steel is 240MPa.Hence according to the Maximum Yield Stress Theory, the Von Mises stress is less than the yield strength of the material.

*3) Static analysis of sieve drum:* From the above analysis, the Max Deflection and the Von Mises Stress observed on the Sieve drum is 0.0008mm and 4.05MPa respectively and the Yield strength of the material steel is 240MPa.Hence according to the Maximum Yield Stress Theory, the Von Mises stress is less than the yield strength of the material.

*4) Static analysis of bigger calendar roller:* From the above analysis, the Max Deflection and the Von Mises Stress observed on the bigger calendar roller is 0.3E-5mm and 0.96MPa respectively and the Yield strength of the material steel is 240MPa. Hence according to the Maximum Yield Stress Theory, the Von Mises stress is less than the yield strength of the material.

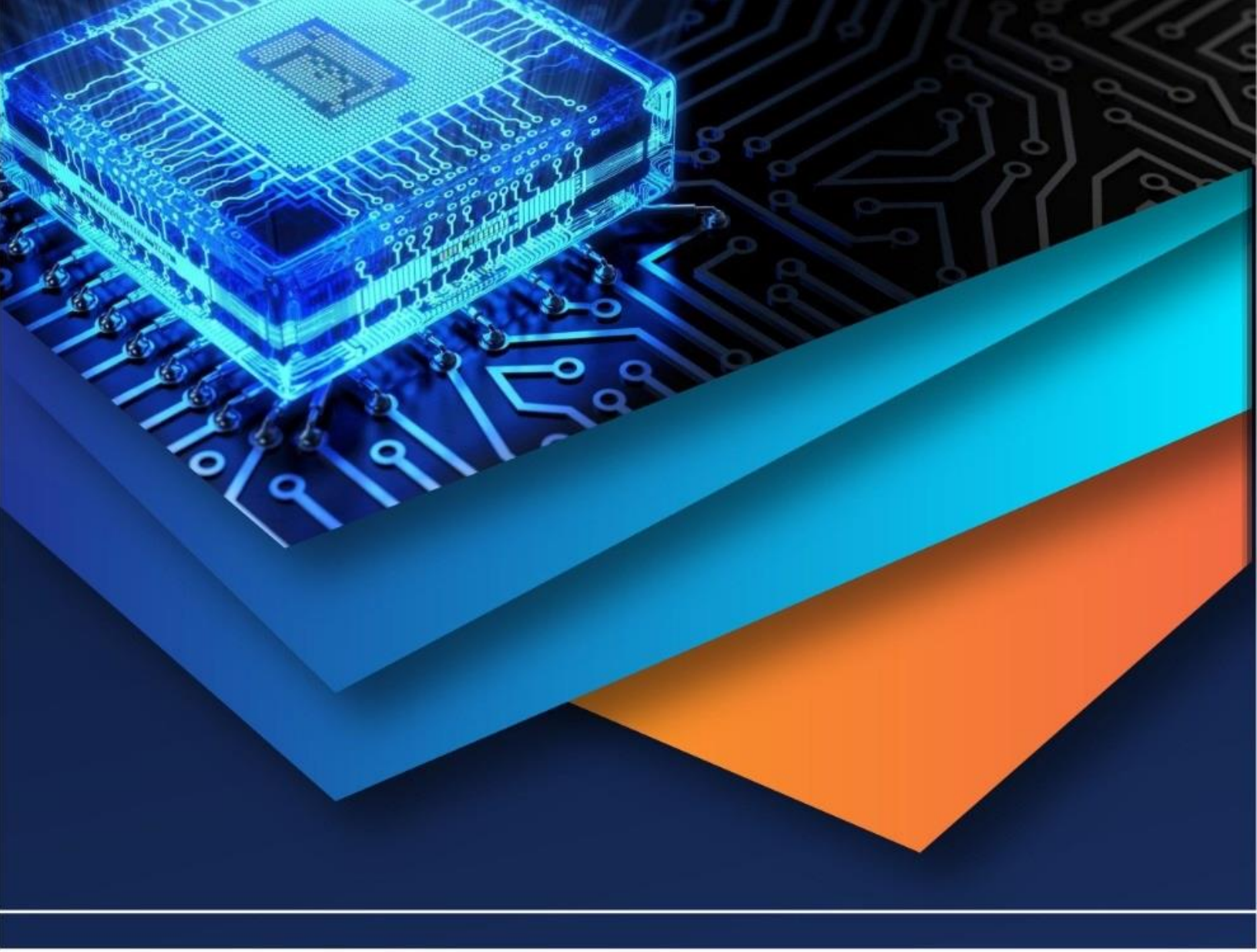
*5) Static analysis of smaller calendar roller:* From the above analysis, the Max Deflection and the Von Mises Stress observed on the smaller calendar roller is 0.2E-6mm and 0.26MPa respectively and the Yield strength of the material steel is 240MPa.Hence according to the Maximum Yield Stress Theory, the Von Mises stress is less than the yield strength of the material.

## VII. CONCLUSION

In this project, at first design calculations were done.3d model assembly of paper recycling machine was modelled in NX-CAD software. Static analysis was done paper recycling machine parts (i.e. Sieve drum case, Sieve drum, Calendar rollers).From results of the static analysis, both Sieve drum and Calendar rollers have stress values within limits. But in case of Sieve drum case, the Von Misses stress, not within limits of the yield strength of the material used. So, modifications were done the 3d model of Sieve drum case. From results, the modified sieve drum case has Von mises stress within limits of the yield strength of the material used. So, finally, it was concluded that model of modified Sieve drum case was better in comparison to the model of Sieve drum case.

## REFERENCES

[1] M. A. OLUTOYE "Design of a Manually Operated Paper-Recycling Machine" ISSN 1583-1078, Issue7,July-December2005p.49-54.
[2] Vrushabh R. Rathod, Saurabh R. Rathod, Nitin H. Wankhede "Design of Manually Operated Portable Paper Recycling Machine " ISSN: 2321-8169, Volume: 3 Issue: 2 050– 054.
[3] Prof.Kusekar S.K, Morajkar C.E, Kashid S.N, Hipparkar K.S, Deshpande V.S " Design & Development of Plastic Recycling Machine by Using FEA" e-ISSN: 2395-0056 Volume: 02 Issue: 02, May-2015.
[4] Scott M. Kaufman "Analysis of Technology and Infrastructure of the Paper Recycling Industry in New York City ".



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY