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Parameter Optimization of Coke Bucket Lifting Device by Using Finite Element Analysis

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Abstract

Our research work is focused on the lifting arm of bucket assembly. We create a 3D model of existing bucket lifting device and apply actual boundary condition with some assumptions on solid works software. Meshing and setup for solution has been carried out by ANSYS software. After the analysis of existing bucket assembly and based on the results of ansys we change the shape and parameters of lifting arm and prepared two more design without compromising the basic functions of lifting arm. Based on the results of FEA of new design it validated with the existing model of bucket assembly and suggest alternative design for existing model.
Key words: FEA (finite element analysis), ISMC (Indian Standard Medium Channel), 3D (three Dimensional)

1. Introduction

The bucket device is efficiently made by pressing, welding, pressing steel framework, and profiling sheet metal. An elevator's structure and sealed enclosure are both made of sheet metal components. One of the main structural components of the entire elevator is the arm. It accommodates the drive and anti-runback back mechanism in addition to supporting the weight of the buckets and gate. Depending on the climate the elevator is used in, corrosion and wear may also impair durability. The gate and lifting device of coke bucket is an important part for our point of view due to our work is based on this topic and overall functions of the bucket is also depended upon the lifting assembly. Excluding the motor and other hardware item there are only two major parts in lifting device first one is gate assembly and other one is lifting assembly. The lifting device is operated by using 30 KW motor by rope way and it lift the bucket in vertical direction. So, the component which is directedly engaged with the gate assembly is lifting arm with eye end. a proper attention is required here while designing of lifting arm. The total capacity of the bucket is around 40 tonnes and it’s one of the big size buckets.

2. basic objective of work

The major purpose of this research is to the analyse the lifting device function and number of stresses generated during the working or acting on load and find out the scope of engineering in gate and lifting device parts of bucket. The total capacity of the bucket is around 40 tone and gate and lifting component take these loads directly so proper attention is required here.

3. Assumptions

All of the assumptions are stated below for the reader's convenience:

- Bucket assembly is in stationary position while analysis.
- Vibration during the working of bucket is negligible.
- Effect of external forces avoided in the bucket assembly.

- Gate and lifting device is properly mounted in the bucket.
- There is two lifting assembly mounted in the bucket, so the overall load is equally distributed on both supports.
- All the parts has been taken of equivalent grade of 0Cr17Mn6Ni5N.
- Mechanical properties of material 0Cr17Mn6Ni5Nis same for substitute materials.

4. FEA Analysis

The lifting device of coke bucket consist of around ten major component which play important role while working of bucket. The lift arm which is directly engaged with the bucket frame is crucial parts for our analysis because it connects lifting device with bucket chassis. The pair of arms is used to lift the bucket and total four arm is used in the assembly.

First of all, we create the separate parts of all lifting device component with reference to the design drawing. After that assembly process is performed to get the required assembled geometry consist of the solid & surface modelling of the parts by using the sketch tools. Once the parts have been prepared, we start assembly of component one by one in proper manner to form the required shape of lifting assembly.

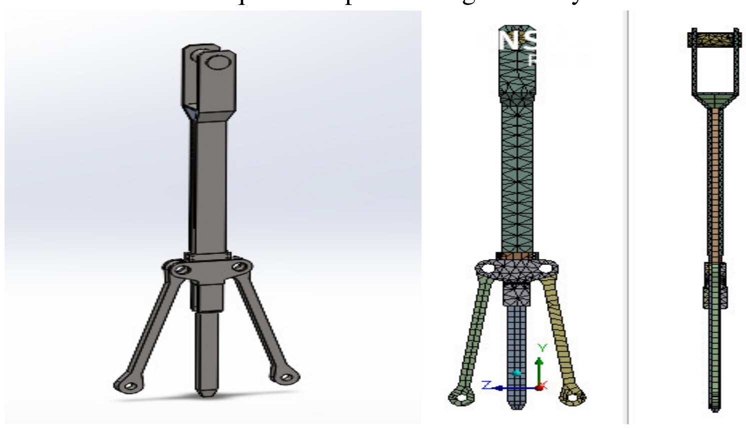

Figure 1 3D cad model and meshing of existing lifting arm

5. Result of existing lifting device

The FEM is a numerical approach for finding an approximation solution to a problem domain's distribution of field variables that is difficult to acquire analytically. It is accomplished by reducing the issue domain into numerous components, then applying the solution to each little element, which has a very basic geometry.

The result obtained from the solution is represented in the graphical form to find out the output parameter in the form of the stress, deflection and strain which is shown in the figure below

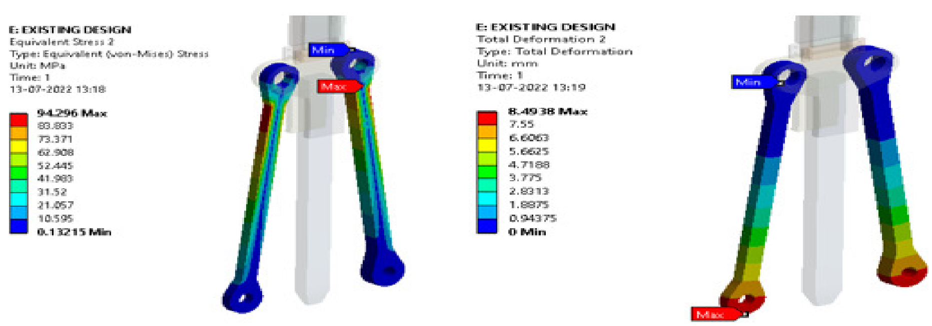

Figure2 3D Result of FEA analysis

6.FEA Result of Optional Design I

Here we convert two support plate into one machine parts and also change the parameter of lifting arm to reduce the amount of stresses in the corner edges of the component as mentioned in figure below. This process lead us to optimize the overall weight and minimization of stresses of the complete assembly.

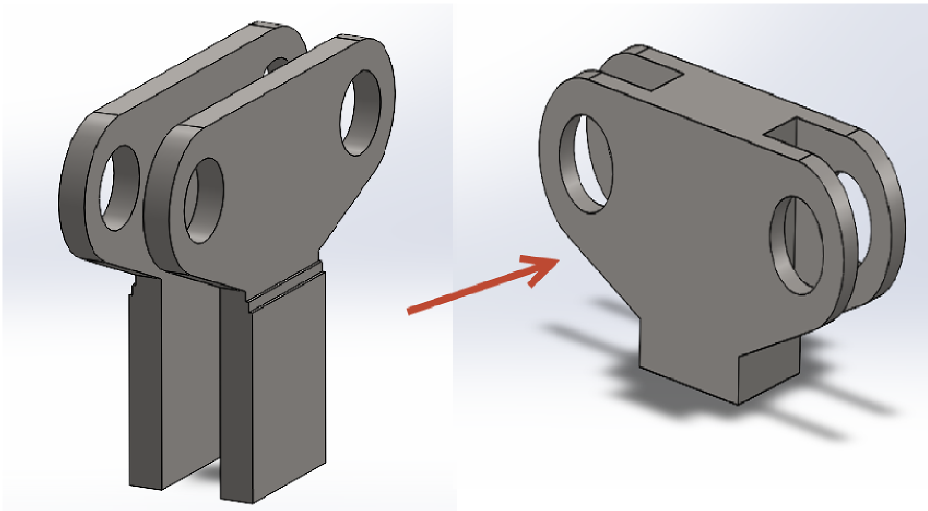

Figure 3 support plate converted into block

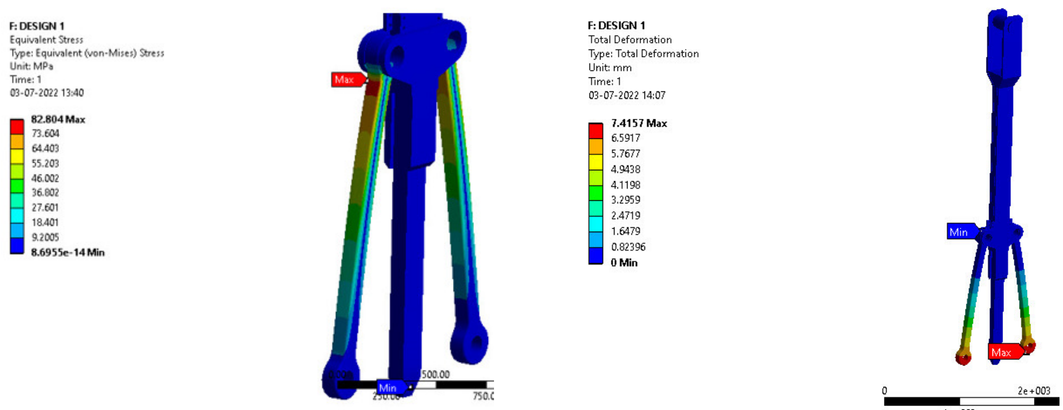

Figure 4 Stress and deflection of design option I

7.FEA Result of Optional Design II

The design option I shows good result as compared to the existing design but still there have some more scope to optimization by controlling the parameters of the parts. Now we focus only on the lifting arm to reach the optimum design parameters, with reference to the existing design of arm it consist of simple shape and eye end with tangent line to join the arm with eye end. these profile is simply and easy to manufactured with laser cutting machine. But it tends to high stress concentration. So in this section we change the arm eye end by using circular profile and join the eye end with arm by using fillet tools. The cross section is gradually change with change in length at the eye end. the stress is higher near to the eye end so proper filling of material is required at this zone to avoid the stress concentration.

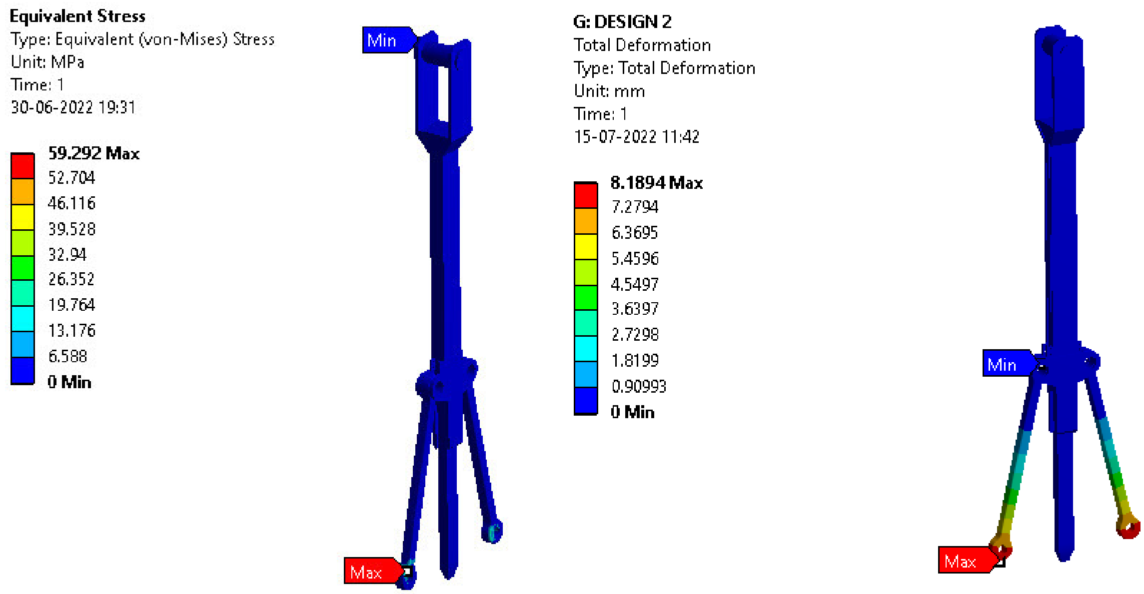

Figure 5 Stress and deflection of design option I

8.Conclusion

Based on the data furnished in result section we concluded that the nature of graph for all cases is almost similar and marginal variation is found in case design I and II. The amount of stress is minimum in design II but the deflection is little higher as compare to the design I. but the design option I shows great flexibility in manufacturing point of view , this profile can be achieved by using only laser cutting but in case of design II we need other process to form the partition line at mid plan which will increase the cost of manufacturing, so design I of lifting device is most suitable option for existing design.

References

[1] Henry Panganiban, In-Gyu Ahn, Tae-Jin Chung, (2012) "Multi-phase Design Optimization of a Long-Range Aerial Lift Boom Structure". Proceedings of the World Congress on Engineering 2012 Vol III WCE 2012, July 4 - 6, 2012, London, U.K.

[2] Bilal Pirmahamad Shaikh & Abid M. Mulla, (2015) "Analysis of Bucket Teeth of Backhoe Excavator Loader and its Weight Optimization", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol. 4 Issue 05, May-2015.

[3] Slobodan Garić et al, (2016) "Modelling and Finite Element Analysis of Elevator Buckets", researchgate.net/publication/313702902 , January 2016.

[4] Urbi Pal &PrabhashGokarn, (2021), "Study of Frequent Failures of the Pressure Roller at Sinter Plant "hthps://www.researchgate.net/publication/350322764.

[5] Zoran Marinković, Goran Petrović , FACTA UNIVERSITATIS Series: Mechanical Engineering Vol. 2, No 1, 2004, pp. 109 – 124.

[6] Jakub Gottvald&ZdeněkKala (2012), "sensitivity analysis of tangential digging forces of the bucket wheel excavator schrs 1320 for different terraces", journal of civil engineering and management, ISSN 1392-3730 print/ISSN 1822-3605.

[7] Sumarhadi, et al, "Designing of modified forklift with double hydraulic bucket system for coal transporting in the coal mine" International Journal of Research Science & Management, ISSN: 2349-5197.

[8] K. Saikrishna et al, (1990), "Design, Fabrication and Testing of Linear Motion Bucket Wheel Reclaimer – A Prototype", IJSRSET | Volume 3 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN: 2394-4099.

[9] Abhijeet Chavan et al, (2018) "Design and Analysis of Bucket Lift", JETIR May 2018, Volume 5, Issue 5.

[10] Wenbin Ma et al., (2017) Continuous Line Bucket Lifting Versus Pipe Lifting", Journal of Offshore Mechanics and Arctic Engineering · March 2017.

[11] Aravinda. P. A&S.Kumarappa, (2014), Computational Fluid Dynamics Analysis of Double flue Technology in Coke Dry Quenching", Volume III, Issue X, October 2014 IJLTEMAS ISSN 2278 – 2540.

[12] Bhaveshkumar P. PATEL & Jagdish M. PRAJAPATI (2017), "evaluation of bucket capacity, digging force calculations and static force analysis of mini hydraulic backhoe excavator", machine design, Vol.4 (2012) No.1, ISSN 1821-1259 pp. 59-66. U. V. Patel College of Engineering.