CASE STUDY : FEA OF BALL-MILL

INTRODUCTION

Ball-Mills are the structures used in cement industries. This structures are mainly subjected to Mechanical static, Dynamic & Fatigue loads depending on their service subject. FEA gives better understanding of actual behavior of assembly due to various static, dynamic & fatigue loadings. Girth gear, shell, welds, crusher, foundation are critical components of Ball-Mill which are subjected to higher stresses because of various loadings. Due to asymmetric nature of static & dynamic loadings, structure may result in higher localized stresses; while fatigue loading is dangerous than other loadings as the structure will experience sudden failure without any prior indication. Hence fatigue calculations needs to be part of design of a Ball-Mill.

Process equipment manufacturer from India & Abroad approached *ANALYZER* to seek assistance in evaluating the design of their newly developed Ball-Mill to multiple Static & fatigue loadings using simulation techniques & provide the solution in case of any observed fatigue failure. FEA also plays an important role in thickness optimizations.

FEA WORKFLOW

- Design parameters & material properties extraction for Complete Ball-Mill.
- Determining the various loading conditions affecting strength of the Ball-Mill.
- Preparing FEA Model for Ball-Mill with complete structured Hexahedral Mesh.
- Solving the FEA Model & Result extraction
  - For fatigue analysis, Performing the Fatigue calculations as per ASME Sec. VIII Div. 2 Part 5 & Annexure 3.F
  - For Static analyses (Thickness optimization), comparing stresses with allowable stress limits
- Preparing an easy to understand report for the performed FEA.

CHALLENGES

- Preparing structured hexahedral mesh for complete Ball-Mill structure without losing critical areas like fillets & weld chamfers.
- FEA modeling of Bearing & Roller Supports.
- SN Curve Selection for material of construction of different parts.
- Fatigue calculations for multiple fatigue loadings during complete life of vessel & areas of evaluation.
- Identifying the critical locations for static analysis & carrying out stress linearization at those locations.

THE SOLUTION

➢ Fatigue Analysis:

The Ball-Mill was analyzed using Finite Element Method to determine the induced stresses due to various cyclic loadings. In order to assess fatigue strength for the ball-mill, guidelines from *ASME Section VIII Div. 2 part 5 & Annexure 3.F* were utilized. The fatigue calculations were performed & fatigue damage factor is found much below unit value. Hence, the structure's design was predicted to behave safe during operation without premature failure.

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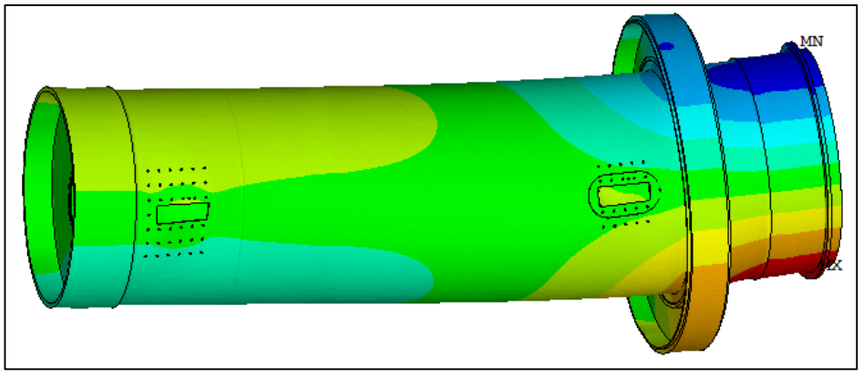
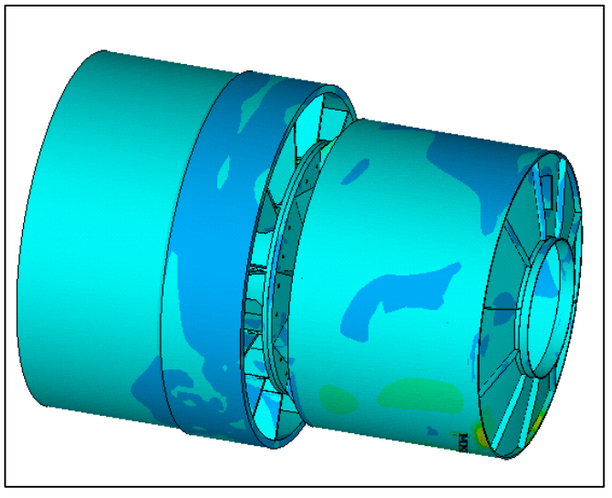
➢ Static & Dynamic Analysis:

The Ball-Mill was analyzed using Finite Element Method to determine the induced stresses due to various loading conditions. In order to assess strength of complete ball-mill, guidelines from ASME Section VIII Div. 2 Ed. 2013 was utilized. Stress Linearization has been carried out at various locations. The results showed that the induced stresses were well within the acceptable limits as per guidelines even for optimized thickness. Hence, the structure's design was predicted to behave safe during operation without premature failure.



Thickness Optimization of Ball Mill



Fatigue Evaluation of Ball mill to Drier Connection

BENEFITS

- Better insights on design modifications for alternate applications
- Optimized design with reduced material cost
- Reduced manufacturing time

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