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An Application-Tailored Rock Breaker Tower for Aggregate Processing

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Introduction

Occasionally, the manufacturer of aggregate processing plants may encounter unique structural challenges such as when a structure must support a piece of machinery producing dynamic loads. Machines such as rock breakers and crushers can generate a variety of loads to a structure including static and dynamic loads such as shock and vibration. In the following study, we look at the design of a tower used to support and elevate a rock breaker several stories above grade.

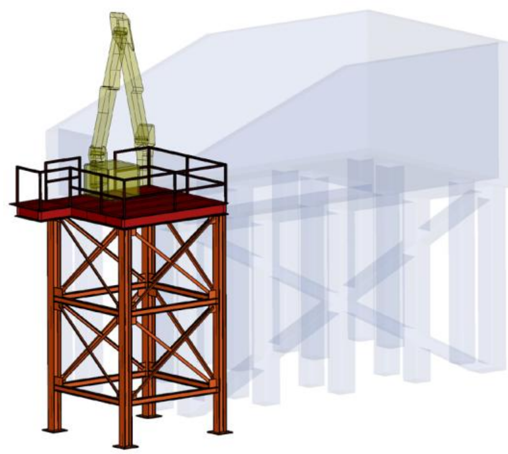

Figure 1: Design of a tower to support an elevated rock breaker

A Cost-Effective Approach

Assuming that the rock breaker has been appropriately sized based on the size and hardness of the aggregate, the next step is typically packaging the machine and tower in its environment. 3D CAD software may be used to ensure that space requirements are met and the machine tool is able to access all areas without interference. At this stage, a rough model of the structure may be designed based on past experience or hand calculations.

The next step is to fine-tune the design, ensuring that it is able to withstand load requirements. In many cases, the manufacturer of the equipment specifies loads that are transmitted from the tool/chisel to the pedestal (base) as shown in figure 2. Various load conditions exist, including forces, overturning moments, and torques produced from both the hammering process and motion of the tool which imparts inertial loads. In earthquake prone regions, seismic loading may also be considered, especially when the supported machine is exceptionally heavy and the structure is slender.

Engineering Data: Loads and Moments

Imperial

Static Overturning Moments: ft-lb (+/-)	Loads: lbs. (+/-)	Dynamic Overturning Moments: ft-lb (+/-)
MH*: 115,759 / 0	FS*: 9,363 / 9,363	MH: 231,518 / 0
MV: 29,377 / 29,377	FV: 0 / 13,421	MV: 58,754 / 58,754
MS*: 115,759 / 115,759	FH*: 9,363 / 9,363	MS: 231,518 / 231,518

Swing Torque: 29,377 ft-lb

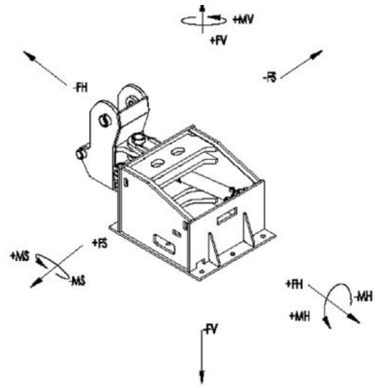

Figure 2: Example of rock breaker pedestal loads supplied by manufacturer

One effective method for analyzing the structure to building code AISC 360-10 is to use the Allowable Stress Design method (ASD) in conjunction with finite element analysis software. Much software exists for this purpose, but those specializing in structural design are well-suited for these applications. This type of software allows the user to create simple beam models of the design resembling stick figures (fig. 3).

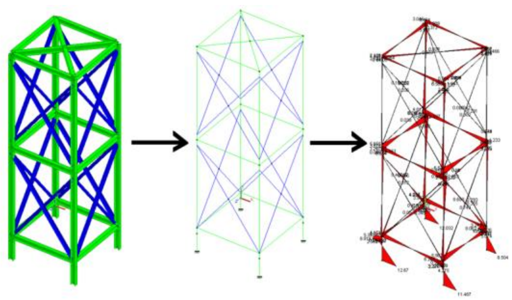

Figure 3: Example of a structural modeling process

Once the beam model is drawn, constraints and loads are applied. The analysis is then initiated and results are produced by checking the individual structural members to code. Many results can be investigated, including beam stresses, bending moments, and member efficiencies. If a member is over stressed, it can be resized or altogether replaced with a different type of steel member. Quickly, the analysis can be re-run and results re-analyzed. Ultimately, the structure is optimized for weight and overall size while simultaneously adhering to building code standards.

Following the FEA analysis, the 3D CAD model may be updated, reflecting the findings from the analysis work. 3D CAD software may then be used to produce a drawing package specifying individual structural members and also any assemblies.

Conclusion

The included method for analyzing and designing a custom, structural tower for dynamic machinery is an improvement over hand calculations in terms of speed and accuracy. While not as exhaustive as a full, detailed FE analysis, in many cases the methodology is adequate to produce a design that is robust and safe. This methodology is not specific to the above example, but may apply to a variety of custom structures that must support machinery that generate various static and/or dynamic loads.