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# Designing for Static and Dynamic Loading of a Gear Reducer Housing with FEA

by M. Davis, Y.S. Mohammed,  
and A.A. Elmustafa, Old Dominion  
University and P.F. Martin,  
C. Ritinski, Sumitomo Machinery  
Corporation America

# Designing for Static and Dynamic Loading of a Gear Reducer Housing with FEA

**Matt Davis, Yousuf S. Mohammed, and A.A. Elmustafa, Old Dominion University  
and Paul F. Martin, Charles Ritinski, Sumitomo Machinery Corporation America**

[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

## Abstract

A recent trend has been a movement to more user friendly products in the mechanical power transmission industry. One of these more user friendly styles is a high horsepower, right angle shaft mounted drive designed to minimize installation efforts. Commonly referred to as an alignment free type, it allows the drive package mounting to be quicker, more cost effective, and require less expertise during installation. This facilitates the use of the drive in applications, such as in underground mining, where there is little room to maneuver parts. The most common application for the alignment free style drive is for powering bulk material handling belt conveyors.

An alignment free drive is direct coupled to the driven shaft only; it is not firmly attached to a foundation or rigid structure. A connecting link or torque arm connects the drive to a fixed structure, which limits the drive's rotational movement about the driven shaft. The electric motor is supported by the reducer housing through a fabricated steel motor adapter; the coupling connecting the motor shaft and reducer shaft is enclosed by this motor adapter.

Sumitomo Drive Technologies is working on a design of the alignment free system by using Finite Element Analysis (FEA) to help guide the design process. FEA was used to test the cast iron housing to determine any potential problem areas before production begins. Once analyses were completed, the motor adaptor was redesigned to lower stresses using the information from the FEA and comparing it to field test data.

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## Introduction

Gear reducers are key elements for many industrial applications. Alignment free is a common industry term used for a right angle shaft mounted drive designed to be installed with minimal field coupling and electric motor alignments. This particular type of drive system reduces cost and time of field assembly, and minimizes the required skill level of the field assemblers. Sumitomo Drive Technologies goal is to maximize the use of standard products, and to expand this design philosophy to applications beyond underground mining.

Gear reducers allow electric motors producing relatively small torque to create high output torque through a series of gears. [1-4] The weight of both the motor and reducer, plus the movement of the complete drive assembly can create high stresses on the interface between the reducer and the motor or motor adapter. Motor induced vibrations due to gear meshing, etc. also play a significant role in reducer analysis. [5-10] These vibrations are greater at start-up, and can produce large dynamic forces and torques, which increases the risk of gear reducer housing failure at the interface with the motor adapter. A typical practice of stress analysis and design optimization is the use of finite element analysis (FEA) to evaluate high stress and possible problem areas. [11-15] In order to determine if the current reducer design meets the requirements of the proposed alignment free drive systems, the reducer housing was analyzed under both static and dynamic loads using FEA. Pertinent results, structure optimization proposals, and conclusions are introduced in the following sections.

## FEA of gear reducer housing

### FEA modeling

In order to simulate the system effectively the entire system was analyzed as an assembly. Based on an existing and operating prototype design, the alignment free drive was modeled in Autodesk Inventor®. Figure 1 shows the entire assembly.

The drive is connected to the motor adapter, which varies in size depending on what type and model of coupling it houses. The motor is also connected to the motor adapter on the right side by a series of bolts.

The solid model was converted to a step file (.stp) and imported into PTC® Pro/Mechanica.

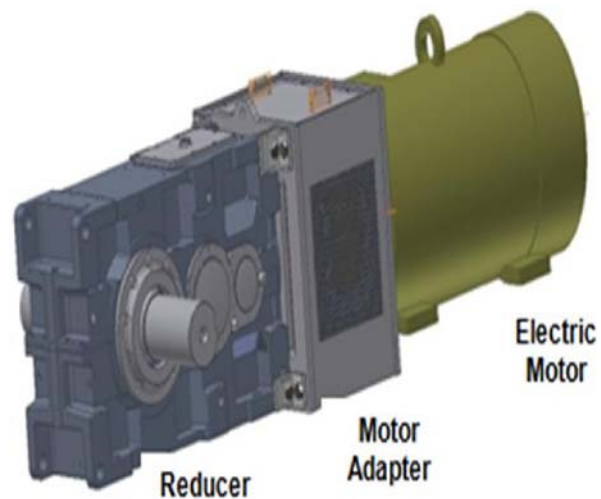


Figure 1. Alignment free drive system

The FEA model was meshed in Pro/Mechanica using p-type elements and simple linear analysis was performed. Bolts were modeled using Pro/Mechanica's fastener application. This method simulates the bolt as a spring element passing through the two fastened parts. The load is completely transferred through the bolt rather than the touching components. The entire assembly mesh is shown in Figure 2. The FEA model had a maximum of 133,812 elements. Although this assembly is very large, it was simplified by removing many structurally insignificant features. Analyzing the entire system (reducer housing, coupling box and motor) as an assembly made it very complicated to simulate. More complexity in the model, in terms of features, means more elements and hence less accuracy. Significant effort was made to simplify the model while maintaining the structural properties of the system.