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Enclosed Gear Reducers for Movable Bridges - Specification Considerations

Author: Steve Szychowski - Sr. Applications Engineer
Nuttall Gear

RENAISSANCE ORLANDO AT SEAWORLD
ORLANDO, FLORIDA

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Abstract

As a manufacturer of engineered enclosed gear reducers, we are accustomed to variances in specification requirements depending on the industry and the function of the gearbox. Dating back to 2010, we have seen variances in specification requirements imposed by engineering design firms or specifying authorities such as the DOTs, US Army DOD, the railroad, and mass transit. The engineering and design requirements vary by type of bridge, configuration constraints, environment, and other factors.
Reducer manufacturers are provided design specifications and plan drawings for either new or rehabilitation movable bridge project. Many times, the design specifications are extracted from old legacy files which may not be consistent with current day design standards as set forth by the American Gear Manufacturers Association (or AGMA) as an example. Another common area overlooked is testing requirements imposed by the authority which can result in a design with a much higher service factor that is inconsistent with AGMA. This oversight can also result in a larger reducer which sometimes could violate plan configuration constraints.
The goal of any manufacturer is to supply and assure a reliable and durable product which meets or exceeds the design or performance specifications. Situations will occur where mutually agreed upon specification variances are in the best interest of the owner, specifying authority, and manufacturer.
We will address some of these specifications and the variances which appear to have the most significant impact from a design standpoint and the overall impact whether it is performance or cost related. Examples will be provided where inconsistencies in specifications ultimately lead to changes in the specification requirements.

Introduction

We need to preface and say, there are no such thing as a perfect specification. Various contributions by any number of individuals with different backgrounds create project plans and design scopes for the requirements specific to the bridge application and bridge owner's expectations. Specifically, enclosed reducer manufacturers are many times asked to vary from a standard cataloged reducer and provide a value engineered reducer having some restrictions which could have potential cost effects.

This paper will address the areas of potential impact on the overall design a reducer which sometimes results in variances that might have been otherwise avoided and are listed below:

- Material Considerations
- Testing Considerations

Material Considerations

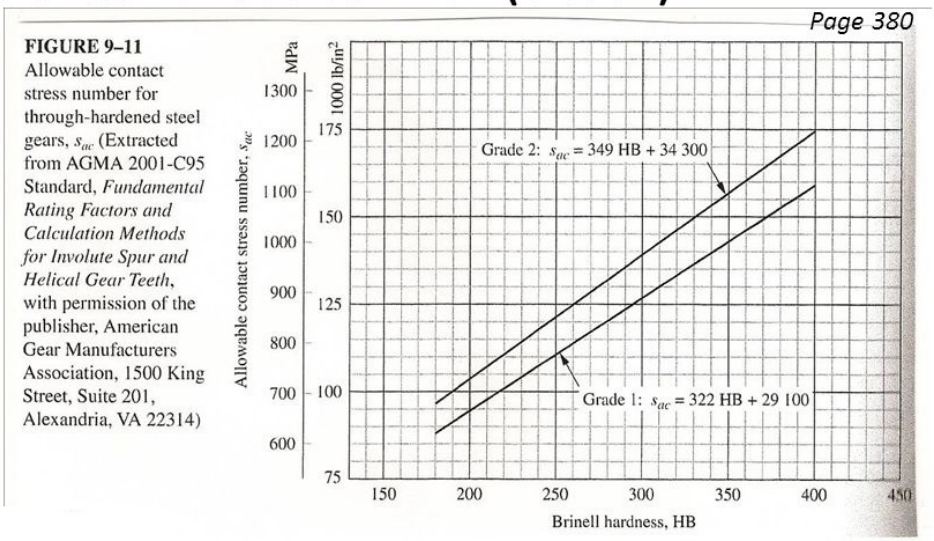
As a minimum, an enclosed reducer manufacturer will require the following project information:

- Input Speed and Power
- Output Speed
- Output Torque
- Service Factor
- External Loads
- Testing Requirements
- Configuration Requirements
- Environment
- Performance, features, and testing

The above information can be provided in plan drawings and/or special provisions. As almost always noted in the special provisions, experienced reducer manufacturers understand the reducers shall have an AGMA durability rating equal to or greater than the full load-rated horsepower of the driving motor at full load motor torque and speed with an understood service factor of 1.5 where no components shall

exceed 75 percent of its yield strength. The relative hardness of gears and driving pinions are designed to meet such loading requirements of these specifications. Here in lays an issue where some special provisions especially of the original legacy dated documentation will have a noted material with conformance to ANSI/AGMA 2001 Grade 1 material. As seen in the below graph, an AGMA Grade 1 material presents itself as a conservative grade than the reducer manufacturer preferred AGMA Grade 2 material. Grade 1 material will impact the size of the rotating components of most secondary reducers and any connecting ancillary components (example: shaft couplings). Conformance calculations with the stated AGMA 2 Grade 2 material are almost always submitted for review and approval prior to any detail manufacturing drawings and start of manufacturing. An experienced enclosed reducer manufacturer understands the importance of the scope of the project and demonstrate with the utmost respect to the quality and reliability required for given application.

Hardness Numbers CONTACT (Grade 1)



Testing Considerations

Much like the above-mentioned material considerations, shop testing considerations of enclosed reducers are an important aspect of the project. For most of the time, it can be considered the design validation of the upfront conformance calculations as submitted for review and approval specific to the individual enclosed reducers only and not the entire bridge. Specifying load testing at either 200% or 300% above the rated motor horsepower, creates a different design scenario than the service factor and will now dictate the size of the enclosed reducer and add to the expense of the reducer plus the added expense for any ancillary components mounted to the reducer. Special provisions will almost always specify shop testing with first a no-load spin test followed by a load applied test. During spin testing of enclosed reducers, observations of unusual vibration, noise levels, oil leaks, and shaft temperatures ranges can be witnessed, and data can be collected. Normal specified no-load tests are in the duration of 2 hours or 1 hour in each direction. Some special provisions could require additional time, but this will also mean additional costs. After successful completion of a no-load test, the enclosed reducers are normally subjected to load tested.

A dynameter is generally the loaded applying device during shop testing but it can vary from manufacturer to manufacturer. An excellent load test duration is usually a total of 1 hour or 30 minutes in each direction with an applied load of 150% above the rated motor horsepower. Generally, this load duration will far exceed the actual bridge's individual single service operating cycle. After load testing, the proper load distribution on the gear teeth can be witnessed and documented for future reference.

Summary/Conclusions

Enclosed reducers especially with retrofits where space requirements could be at a premium are no-where near standard manufacturers catalog dimensions. An early project consultation with an experienced enclosed reducer manufacturer is the best approach/best practice and will almost always provide the best solution without comprising quality and reliability. Careful review of old legacy documents is generally considered a good starting point reference but might be obsolete with the written content.