# OVERTURNING THE OVERTURNING MOMENT ATTRIBUTED TO WATER AND WASTEWATER COLLECTORS

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All collector drives see forces due to the structure attached to the drive output and the reactions to the operating torque. These forces are resolved into thrust and radial loads applied to the drive turntable bearing. It is easy to see how these forces occur and how they effect the spur gear and the turntable bearing.

In some design specifications, an overturning moment is conjured and applied to the drive through the mechanism arms and cage structure. In some cases this assumed overturning moment exceeds the continuous torque output of the gear. The origin of this overturning moment is not as straight forward as the causes of the thrust and radial forces. A structural imbalance, a floor high spot, or an excessive or uneven sludge build up may cause an overturning moment load to be induced.

An imbalance in the mechanism structure would normally be counterbalanced during the design phase and trimmed during installation and start-up of the unit. It is possible that an imbalance might develop over time but this imbalance would not be of the magnitudes that have been specified. As an example, a 500 lb load applied at the tip of one clarifier arm in a typical 120-foot diameter clarifier would generate a moment of 29,750 ft-lb (note the mechanism radius would be 59.5 feet). This is a significant moment but would be offset totally or in part by the mechanism weight. This type of induced moment is taken into account in the turntable bearing calculations when it occurs. In this case, twice the tip load would not cause separation of the bearing, which of course is the reason for concern. This load would be considered in the bearing life ratings if it is applied over a substantial portion of the drive design life.

A floor high spot would normally be corrected during installation and start-up. But for demonstration purposes, rather than the typical 1/2-inch to 1-inch clearance established during installation, suppose the floor was 1-inch high at some point at the mid radius of the basin. This would damage the flights and squeegees or other structure below the arm bottom chords. The arm would be raised 1-inch at this point if the structure did not deform. Assuming no deflection in the mechanism arm, this would lift a 60-inch pitch diameter spur gear 0.04 inches while passing over this spot. The angle of rise would be 0.08 degrees or 4.75 minutes. This would unload the bearing balls in line with the high spot during the passage over the high spot. Once passed the high point, the bearing load would again be distributed over the entire complement of bearing balls.

Neither of the above examples would generate the large moment loads occasionally specified. Where can such large overturning moments originate? The answer is found in the original design of four point Gothic-Arch bearings. Kaydon did the original analysis of the load arrangement that these bearings resist during operation. This analysis studied bearings applied to large radar antennae units. Additional applications for the four point Gothic-Arch bearing are crane turntable bearings and tank turret ring gear bearings. These systems see large constant or intermittent moment loads in normal operation. Kaydon also found that the method of rating the life of the four point Gothic-Arch bearing did not follow the methods established for rating normal rolling element bearing $L_{10}$ Life. The loading must be assumed and if the direction of the answer vector is in agreement with the original assumption, then that load configuration is used. The problem arises in that there are three separate load configurations that must be considered and only one is correct. See Feasibility Study of Large Diameter Anti-friction Bearings for Radar Antenna Applications, prepared for Massachusetts Institute of Technology, by Kaydon Engineering Corp., April 30, 1960, this is the basis for all current life rating equations for four point contact Gothic-Arch type bearings.

A commercially available four point Gothic-Arch bearing can be manufactured with an integral internal or external spur gear. The torque rating of the gear is generally small compared to the bearing capacity due to the heavy thrust and high moment loads normally found in crane, radar turntable, and other such applications. This high thrust and moment load capability compared to gear tangential load capability results in enormous bearing capability when the integral bearing and gear unit is sized to handle the torque loads found in water and wastewater clarifiers or thickeners.

Why then is this design chosen over one in which the gear strength and durability as well as the bearing capacity match the load spectrum of the application? At least in part the answer is that the large diameters of the bearing and gear leave few sources for those who lack the capability to design and manufacture a collector drive. Slewing rings thus become the alternative.

One way to deflect attention from the lack of design and manufacturing capacity is to create a demand for the item that can be obtained readily. In this case the ability to handle large moment loads, which are in fact absent, has been changed from a disadvantage to a sales tool.

In those special applications in which moment loading is actually or potentially occurs, Walker Process Equipment collector drives incorporate anti-lift devices. This overcomes the problem of overturning moment loads and retains the ability to service the drive without removing bridges or platforms, which is necessary with solid ring bearings.