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TORSIONAL FATIGUE OF TAPER BUSHINGS

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INTRODUCTION AND OBJECTIVE

MASTERDRIVE has been supplying split tapered bushings for many years. Generally, they are used to secure a sheave to a shaft. Usually the bushings have four holes. Two are clearance for clamping the bushing on to the shaft and two are tapped and are used to force the bushing out of the hub for removal. The hub has two tapped holes for installation. To install the sheave, the holes are lined up and the cap screws are tightened. Currently, this can only be done from one side of the sheave. In order to make installation and removal simpler such that the bushing could be installed from either side, MASTERDRIVE proposed to drill two clearance holes in the hub. The normal cap screws would be inserted in these holes and lined up with the tapped hole in the bushing. The cap screws would then be tightened to pull the bushing into the hub. Since this installation method had not been used before, MASTERDRIVE proposed to evaluate the new arrangement in a simulated severe application. The hubs and bushings were evaluated in a reversing load setup and at torques equal to and greater than the normal maximum rating.

CONCLUSIONS

1. The initial design had a 9/32 inch diameter clearance hole in the hub, and when tested at a reversing load equal to the maximum rated torque of 810 in-lbs the clamping cap screws were found to be failed after 500,000 cycles.

2. The clearance holes were changed to 1/4 inch and the new assembly was tested at twice the rated torque of ±1620 in-lbs and no failures were detected after 500,000 cycles.

3. A competitive Browning bushing was tested at three times the rated torque, the cap screws came out after only 10,599 cycles.

PROCEDURE AND RESULTS

The bushings and hubs were tested in a reversing load torsional fatigue setup. One sheave was rigidly held in place, and another sheave was twisted through a torsional load cell by a hydraulic rotatary actuator. The torque cell was calibrated for this test, and the loading was controlled by a set of MTS 407 electronics. The tests were run in load control such the torsional loading was maintained by the electronics, and if the torsional deflection exceeded a preprogrammed amount the test stopped and the setup was inspected for failures. Two views of the test setup are included as Figures 1 and 2.

The tests were run with a sinusoidal waveform, at a frequency of 3-5 Hz. The electronic limits were adjusted such that if the deflection exceeded about 120 percent of the normal deflection, the test stopped.

FATIGUE TEST RESULTS

For each of the tests, the cap screws were initially tightened to 95 in-lbs with a torque wrench. In the first test, the new and normal arrangement bushings were tested at ±810 in-lbs for 500,000 cycles and no failures were detected. The load was increased to 1,000 in-lbs, and testing continued. After only 3,280 cycles the test had shut down several times as a result of excessive deflection. The test was disassembled and inspected. The cap screws on the new arrangement bushing were bent, and failed during disassembly. It is judged that the cap screws were actually failed in the first test, but failures were not detected. The failed screws are shown in Figure 3.

In the as received hub, a 9/32 inch clearance hole was supplied. It is judged that the clearance for the cap screw in this hole allowed the screw to move back and forth during the reversing loads. This generated a failure. The hub was re-drilled with a 1/4 inch clearance hole, the hubs were re-assembled and re-tested. After 500,000 cycles at ±810 in-lbs, no failures were detected. The torsional loads were increased and run for another 500,000 cycles. The load was increased to 1,000, 1,200 and ±1,620 in-lbs, and at each torque level, the assemblies were run for 500,000 cycles. No failures were detected upon disassembly. A list of the tests run is included as Table 1.

A competitive Browning bushing also was tested with the new concept MASTERDRIVE bushing. They were tested at torques of ±1,200, ±1620 in-lbs, and no failures were detected. The load was increased to ±2,430 in-lbs, and testing was continued. After 10,599 cycles, the test shut down and the cap crews in the Browning bushing were loose and were backing out of the tapped holes, no problems were detected with the MASTERDRIVE bushings.

If you have any questions concerning the contents of this report, please contact me. It should be noted that it is our policy to retain components and sample remnants for 30 days from July 18, 2008, after which time they will be discarded. If you would like to make alternate arrangements for disposition of the material, please let me know. This project shall be governed exclusively by the General Terms and Conditions of Sale and Performance of Testing Services by Stork Technimet, Inc. a Wisconsin business corporation d.d. March 22, 2004. In no event shall Stork Technimet, Inc. be liable for any consequential, special or indirect loss or any damages above the cost of the work.

Respectfully submitted,

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Table 1

Results of Torsional Fatigue Test

Test No.	Bushing Description No 1	Bushing Description No 2	Torque Amplitude (in-lbs)	Cycles Run	Failure Description
1	MASTERDRIVE New As received	MASTERDRIVE Normal	810	500,000	No failures
2	MASTERDRIVE New As received	MASTERDRIVE Normal	1,000	3,280	Cap screws bent and failed
3	MASTERDRIVE New 1/4 inch hole	MASTERDRIVE Normal	810	500,000	No failures detected
4	MASTERDRIVE New 1/4 inch hole	MASTERDRIVE Normal	1,000	500,000	No failures detected
5	MASTERDRIVE New 1/4 inch hole	MASTERDRIVE Normal	1,200	500,000	No failures detected
6	MASTERDRIVE New 1/4 inch hole	MASTERDRIVE Normal	1,620	500,000	No failures detected
7	MASTERDRIVE New 1/4 inch hole	Browing Normal	1,200	500,000	No failures detected
8	MASTERDRIVE New 1/4 inch hole	Browing Normal	1,620	500,000	No failures detected
9	MASTERDRIVE New 1/4 inch hole	Browing Normal	2,430	10,599	Browing cap screws came out - MASTERDRIVE OK

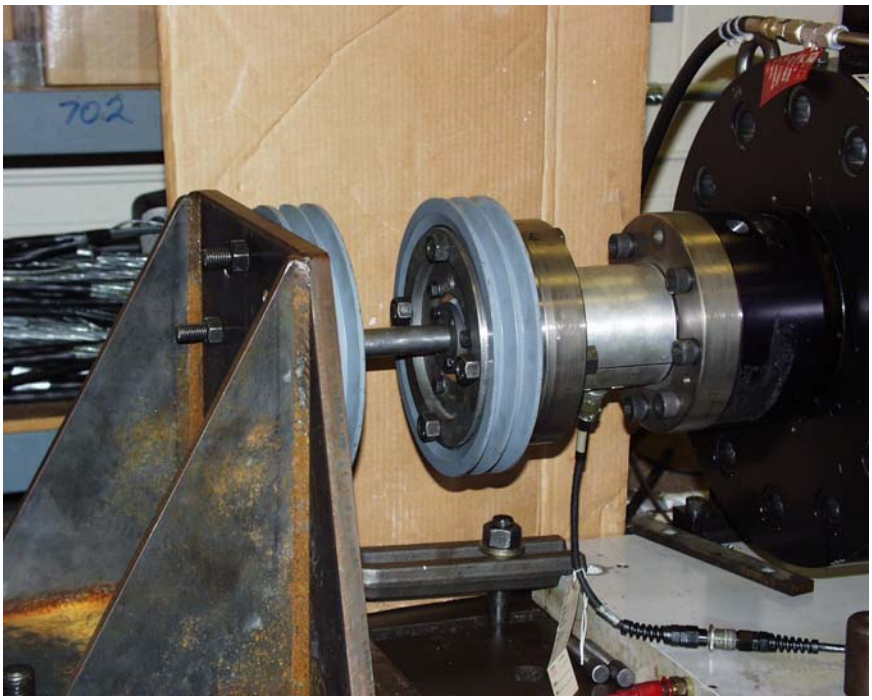

Fig. 1 - Overall view of torsional fatigue test setup.

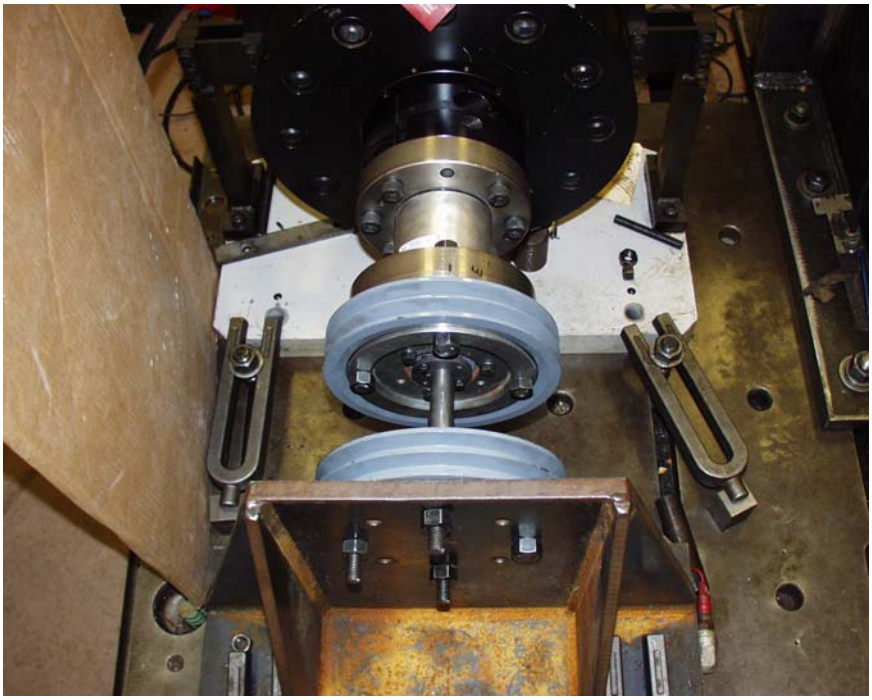

Fig. 2 - Top view of torsional fatigue setup is shown.

Fig. 3 - Overall view of failed cap screws is shown.