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Rod Mill No. 256

Maurice Knott

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MORGAN CONSTRUCTION CO.
ROLLING MILL DEPT. MEMORANDUM

TO: Steve Ordog
FROM: Maurice Knott
DATE: 18 October 1965

ROD MILL No. 256
Bethlehem Steel Company, Sparrows Point
All the Gears for the No-Twist Finishing Mills

DISCUSSION

1. General

The gears for the STELCO and the J. & L. No-Twist Finishing Mills were the same. The four largest driven bevel gears on J. & L. were not integral with their shafts, as on STELCO, but the gear teeth were unchanged.

For Bethlehem there are changes. The new gears are shown in red on Figure 1. In sizing these gears the STELCO (Darle Dudley) rating formulas were used. In (2) the wear formula is compared with Morgan's wear formula.

2. Rating Formulas

The gears are sized for wear (pitting), and a pitch is then selected to make the teeth strong enough (beam strength). For this reason only the wear formulas are compared.

**Morgan's Wear Formula**

\[ W_t = K_1 \ C_v \ d \ F \left( \frac{mg}{mg + 1} \right) \]

For the medium hard drive helicals, which we plan to cut on a Maag machine, Morgan uses \( K_1 = 360 \) and \( C_v = 78/78 + \sqrt{V} \). For Bethlehem's single stage increaser -

Allowable \( K_1 \ C_v = 360 \times 46 = 166 \)

**Darle Dudley's Wear Formula** (Similar to AGMA)

\[ W_t = K_2 \ C_v \ d \ F \left( \frac{mg}{mg + 1} \right) \frac{1}{C_o \ C_s \ C_m \ C_r} \]

continued...
On the drive helicals D. Dudley wrote the following in his STELCO recommendations - "Well designed helical gears made with good accuracy can carry up to 100 K-factor quite reasonably even when there are shock conditions in the system that may introduce momentary overloads of two to three times this amount."

\[
\text{Allowable } K_2 C_v \times \frac{1}{C_0 C_s C_m C_f} \quad \text{(same as our } K_1 C_v) = 100
\]

Full depth teeth are being used on STELCO. When we take into consideration that, "it has been demonstrated on many kinds of high-speed, high-accuracy gearing that the full depth teeth will handle 20 to 25 percent more power successfully than the stub teeth", the allowable "K_1 C_v" for high speed gears is being de-rated beyond our standards by a factor of about 2.

The PLV’s shown on Figure 1 are high. It was mentioned several times in our STELCO discussions that at these speeds we will not get corrective gear tooth wear. The speeds are sufficient to create oil films between the loaded gear teeth. Because of this the misalignment (C_m factor) must be evaluated. This probably partly explains the above difference in rating.

We should get expected spacing and profile error data from our shop, and make some dynamic load calculations. Our C_v factor is for moderate dynamic load. What is our situation?

3. **Single Stage Increaser - Figure 1**

These gears were designed to carry 2680 HP at a motor speed of 875 RPM. This is the maximum torque job, rolling 1/4" rod at 8800 FPM.

- 105 T. Driving 58 T.
- 3 N. D. P. - STELCO Tooth Proportions
- 9" Face
- 14° Helix Angle (overlap ~ 2.08)
- Tip Relief (J & L Cutters)

See memo on Armco, Kansas City, No-Twist Gears, before designing this box.
4. **Three-High Speed Increaser**

The J. & L. - STELCO three-high unit can be used for Bethlehem. The upper and lower line shaft torques, with the added stands, increase only 16%. Another way of explaining why the three-high calculates to be adequate is to note that the 23, 5" p. d., 90 T., middle three-high gear carries on 2 x 5-1/2 = 11" of face slightly less load than the 9" of face does on the 19, 9" p. d., 58 T. output gear of the single stage increaser.

5. **Bevels for New 8" Stands**

The desired bevel gear ratios for the two 8" stands are .391 for Stand No. 14 and .401 for Stand No. 15. The two pairs shown in Figure 1 have been sent to Gleason for review and for summary sheets.

6. **Driving Pinions and Roll Shaft Pinions for the New 8" Stands.**

**Research Sketch No. 880**

The driving pinions have 31 T., and 4 and 4-3/16" face widths. They are identical with the STELCO driving pinions except for the face width. The roll shaft pinions are completely new. The face width is 4-3/8" and the number of teeth is 35. The increased face width was needed to make the gear teeth equal to the shear pin coupling torque.

The amount of the helix modification for the 35 T. roll shaft pinions is yet to be calculated.

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**SUMMARY**

The gears for Bethlehem's No-Twist Finishing Mills are discussed in this report.

The gears for Armco, K. C., are covered in the separate memo.

Maurice Knott

MK/cac