Ameridrives

Bauer Gear Motor

Bibby Turboflex

Boston Gear

Delroyd Worm Gear

Formsprag Clutch

Guardian Couplings

Huco

Industrial Clutch

Inertia Dynamics

Kilian

Lamiflex Couplings

Marland Clutch

Matrix

Nuttall Gear

Stieber

Stromag

Svendborg Brakes

TB Wood's

Twiflex

Warner Electric

Warner Linear

Wichita Clutch

Vibration Reduction in a 5 Stand Cold Mill

Ameridrives®
Altra Industrial Motion

Vibration Reduction in a 5 Stand Cold Mill

D. Horn, Department Manager, AK Steel Corporation
B.C. Newkirk, Senior Staff Maintenance Engineer, AK Steel Corporation
G.E. Maupin, Process Engineer, AK Steel Corporation

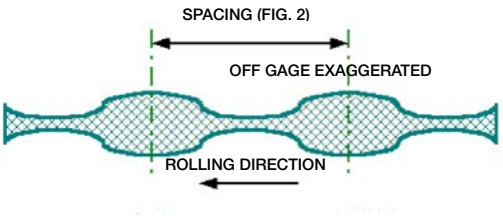

Fig. 1. Third Octave Vibration Pattern

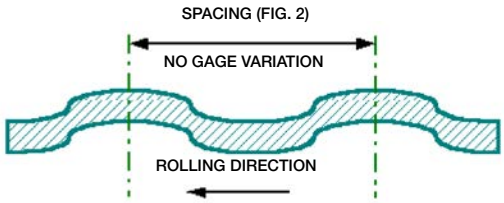

Fig. 3. Fifth Octave Vibration Pattern

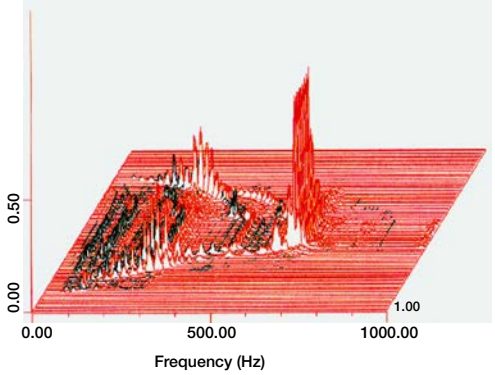

Fig. 4. Waterfall Diagram of Stand #5 kiss pass

Abstract

In 1994, we began a planned program to improve production, quality and safety at AK Steel's Middletown Plant, No. 1 Cold Mill (Table 1). Vibration reduction was a part of this plan for both productivity and quality.

Table 1. Middletown No. 1 Cold Mill Specifications.

Facility Constructed	1970
Last Major Upgrade	June 1995
Design	5 - 4 High Stands 2 Stands Hydraulic AGC
Horsepower	38.000
Top Speed	5,500 FPM
Capacity	270,000 TPM
Productivity	400 TPH
Gage Range	0.015-0.120
Width Range	25" – 76"
Average Gage	0/35
Average Width	52"

Vibration Types

The complex nature of a five stand cold mill prevents the discussion of all steps performed to date to improve performance. We will discuss three basic types we encountered as we began to increase mill speeds: Rumble, Third Octave and Fifth Octave:

Rumble

Vibration occurring near 100 Hz was encountered during acceleration and would require stopping the mill to correct. The vibration is severe and is characterized by noticeable shaking of the building structure and adjacent equipment. The mill stops resulted in excessive coil off gage and loss of production.

Third Octave

Vibration occurring between 128 and 256 Hz is encountered at any operating level and is associated with the backup roll natural frequency being excited by some mechanical defect or component. This vibration is detectable only with monitoring equipment and is characterized by

repeating gage variations (**Fig. 1**) perpendicular to the rolling direction spaced relative to the ratio of mill speed and frequency (**Fig. 2**).

FPM = Feet per minute in stand
Hz = Vibration frequency in cycles per second
Sp = Spacing in inches

$$Sp = \frac{FPM}{Hz * 5}$$

Fig. 2. Spacing Calculation

Fifth Octave

Vibration occurring between 512 and 1024 Hz, is encountered at any operating level and is associated with the work roll natural frequency being excited by some mechanical defect or component. This vibration is detectable visually and with monitoring equipment and is characterized by repeating parallel light and dark bars perpendicular to the rolling direction (**Fig. 3**) spaced relative to the ratio of mill speed and frequency (**Fig. 2**).

The following improvements were implemented to eliminate or minimize these vibrations:

Date	Improvement Description	Vibration Type	Result
1/92	Install SDRC Vibration Monitoring System	ALL	Provided ability to analyze vibration
2/94	Install Hydraliners – Stands 2 – 5 (Asko)	Rumble	Eliminated
3/94	Changed to Cationic Rolling Oil (Stuart)	3rd & 5th	Reduced
7/95	Replaced Gearing All Stands (Horsburgh & Scott)	3rd & 5th	Reduced
6/96	Upgraded vibration monitoring equipment (Fig. 4) (Zonic Corporation)	ALL	Improved Analysis
1/97	Began daily mill vibration level reporting (Fig. 5)	ALL	Improved Condition Monitoring
11/97	Install Universal Joints (Ameridrives)	ALL	Reduction in Mill Vibration

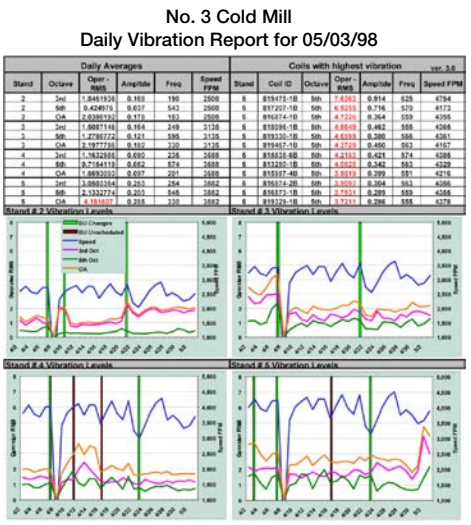

Fig. 5. Daily Vibration Report

Vibration Improvement

Figure 6 indicates the results of these improvements on the overall mill vibration.

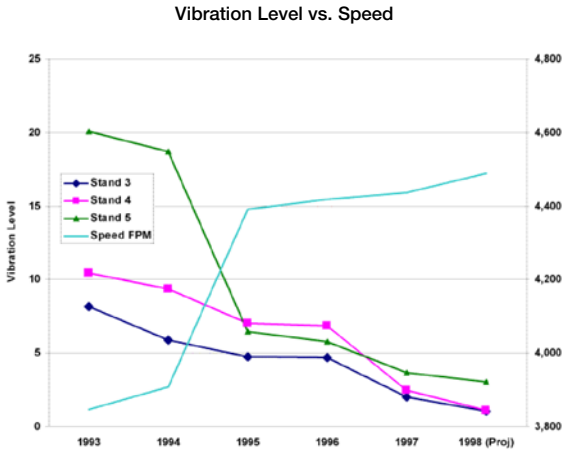

Fig. 6. Yearly Vibration Level vs. Mill Speed

Productivity improvements were as follows:

Category	1993	1997	Figure
Tons per Year	2,066,592	3,133,126	7
Lineal Feet per Year	627,490,650	945,399,615	8
Tons per Hour - Year	265	393	9

Quality

To date, there have been no downstream AK Steel department or AK Steel customer rejections due to Cold Mill vibration.

Summary

During this four-year program we have continuously reduced mill vibration by installing “Hydraliners,” upgrading the pinion stands, and replacing gear spindles with universal joints. This reduced vibration has resulted in improved quality and productivity. While vibration reduction is not the only factor in these improvements, it is a significant one. We continue to reduce vibration in all phases of the operation and to investigate all vibrational factors related to rolling.

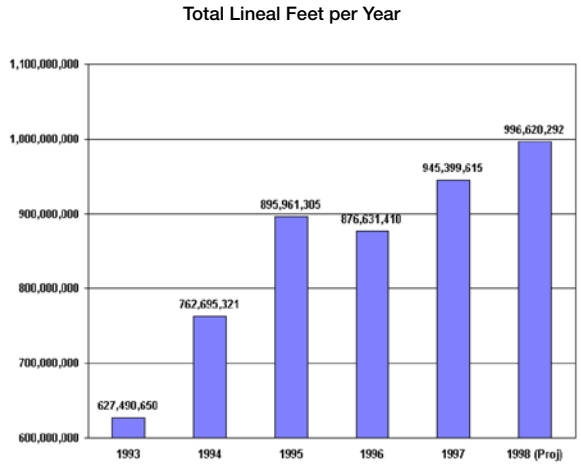

Fig. 8. Lineal Feet per Year

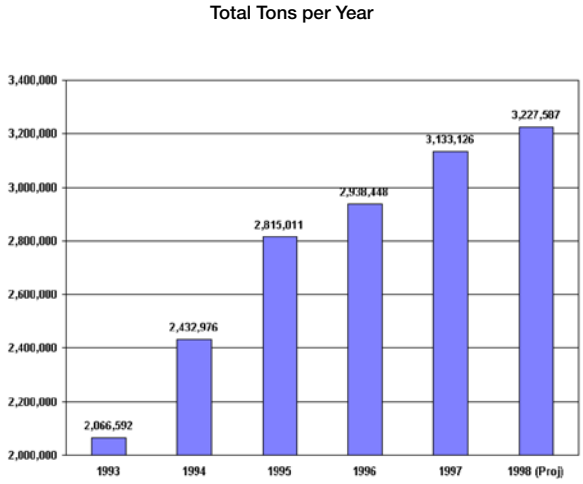

Fig. 7. Tons per Year

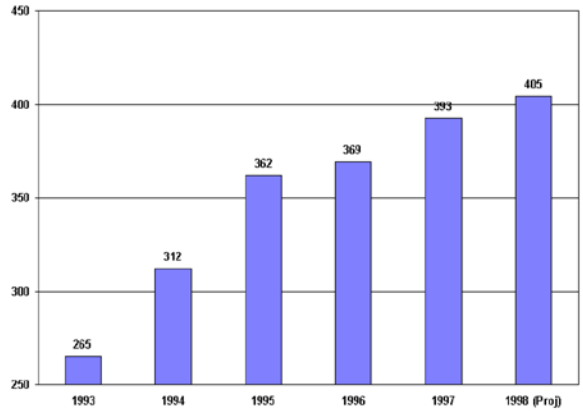

Fig. 9. Tons per Hour - Year

Ameridrives®
Altra Industrial Motion

US (Customer Service)
1-814-480-5000 (Universal Joints, Driveshafts)
1-888-449-9439 (Small Industrial Driveshafts)
1-219-874-5248 (Irrigation Universal Driveshafts)
www.ameridrives.com

For a complete list of our global sales offices visit:
altramotion.com/contactus

P-7568-AC 4/18