

Automatic System for Reducing the Amount of Cobble in Wire Rod Mill

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Abstract: Occurrence of cobble in rolling mill decreases the production. Early action for preventing the rest of the metal in congested rolling stands ultimately saves the down time of the mill. The paper presents a low cost automatic system for sensing the cobbles in narrowly spaced four strands wire rod mill of steel plant which produces 3 km long wire rod from a billet. The sensing of metal in each strand has been carried out by couple of photosensors. At finishing stage the rolling metals are enveloped by the clouds of steam, hence they cannot be sensed through photosensors. Therefore variation in the load currents of rolling stand motors has been taken into account. However variation in load current method for sensing the metal in roughing and intermediate stands is not possible because in these sections, the four strands and two strands rolling are carried out by a single motor. The states of photosensor and load current of rolling motor are continuously scanned in four strand mill by using microprocessor and it is linked with a control circuit of shear for taking immediate action for preventing further accumulation of cobbled metal in narrowly spaced strands. After the introduction of the system, the length of the cobbled metal has been reduced significantly thereafter mill availability is increased and the production has been increased by 2.7 %. The annual benefit of the system is Rs 2.3 crores however the pay back of the system is less than a week.

Key words: Safety, Productivity, Safety, Light emitting diodes cobble display, Microprocessor.

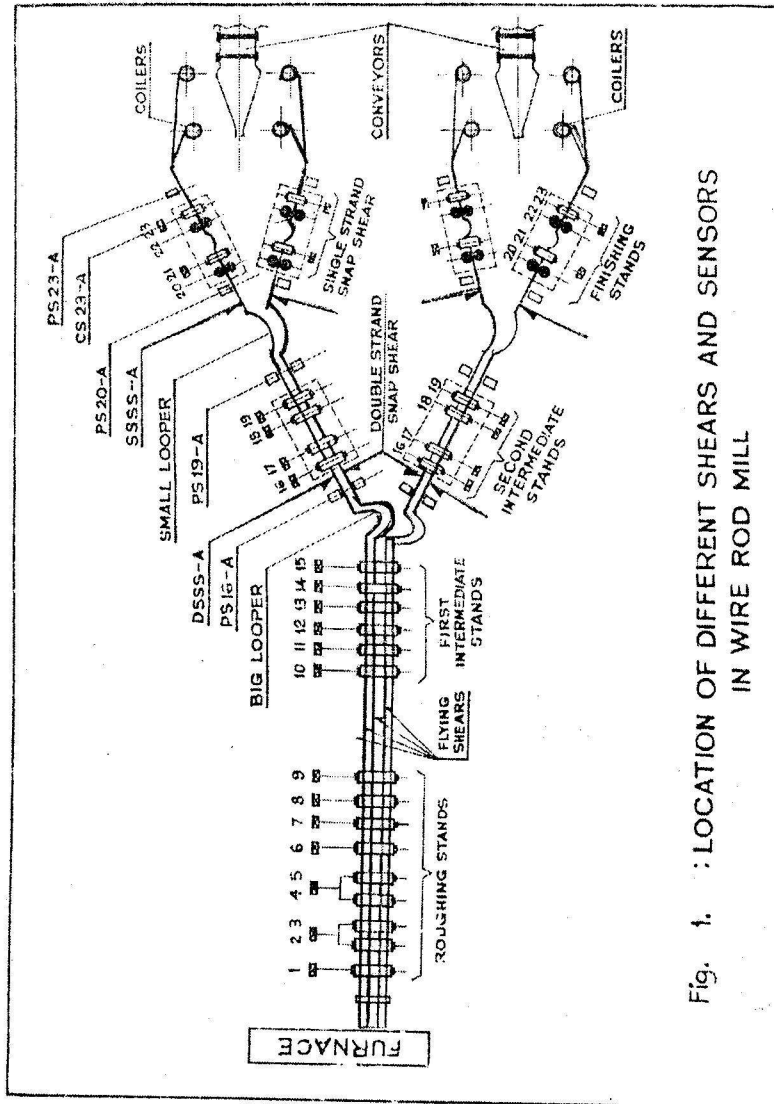
1. Introduction

The Bhilai wire rod mill (India) has been producing 3 Km, 2.3 Km, 1.8 Km long wire rod for 6 mm, 8 mm and 10 mm diameter respectively from 12 m long rectangular billets by rolling them through 23 rolling stands^{1,2}. The mill is divided into four groups and before each group shears are installed: (a) roughing group is comprised of S. No. 1 to 9 rolling stands having flying shear (b) 1st intermediate group is having S.No.10 to 13 rolling stands (c) 2nd intermediate group S. No.14 to 18 rolling stands having double strand snap shear (DSSS) and (d) finishing group consisted of rolling stands S. No. 19 to 23 having single strand snap shear (SSSS). The snap shears work on the principle related to free fall of heavy body on the rolling metal. The pneumatically based snap shears are controlled

through solenoids and their dropping instances are synchronized with the starting of respective flying shears. The flying shear is coupled with DC motors.

2. Problems

Different types of problems are involved for finding the occurrence of cobble in different groups of the mill. They are summarized as below.



In finishing stands: The high speed flying cobbles hit the surrounding area therefore the finishing stands are covered by the metallic cage. The high power de-scaling pumps increase the noise level thereby operators are unable to listen the sound generated

during to occurrence of cobble from outside the cage and in this way quantity of cobble goes on increasing till entire billet is converted into cobble.

In intermediate stand: Two metals are rolled very closely only 15 mm apart in intermediate stands. In case of occurrence of cobble, operator cannot identify the particular strand in which actual cobble takes place. Many a times he commits mistakes by operating neighboring shear thereby healthy metal is destroyed completely. Secondly it is impossible to scan the metal continuously over 30 m long area in order to sense the occurrence of cobble.

In small looper area: Whenever cobble occurs in small looper^{3,4} area, the operator cannot see it clearly as he stands in the main control pulpit which is 35 meter away. Due to poor visibility, he simply operates the DSSS instead of SSSS so that the incoming healthy metal falls in the bigger looper pit which increases the further burden for removing the metal because two strands are spaced very closely and not isolated with each other and affects rolling of neighboring stands. While in small looper area their spacing increases gradually up to 2 m. The remaining metals which are under tension in the small loopers as well as in the big loopers area accumulated in the second and the first intermediate groups respectively and leads to stoppage of mill at least for 15 minutes.

3. Control Strategy for Reducing the Amount of Cobble

In the finishing stands: The flow of metal before and after finishing stands is sensed by two photosensors⁵ as shown in Fig-1. The photosensor which is photodiode converts the electrons which are generated due to bombardment of photons on its base to emitter junction and it produces detectable electronics signal. The dark current of phototransistor is given by

$$(3.1) \quad I_d = AI_j e^{((qV_j)/KT)-1},$$

where K is Boltzmann's constant, q is the electronic charge, T is absolute temperature, V_j is junction voltage and A is amplification factor. If the front of metal does not come out from finishing stands in predetermined time, then SSSS is operated. The predetermined time is given as follows:

$$(3.2) \quad T = f_n(d_n, D, N, l_n, s),$$

where d_n are the different diameters of metal before entering into respective stands, D_n are the different diameters of rolls related to different rolling stands in mm, N_n are speeds of different rolls in rpm, l_n is distance between different rolling stand with respect to first rolling stand of the particular group, s is the slip between metal and roll and it varies by 4-4.5%⁶.

As soon as the front end of metal crosses last stand i.e. 23rd stand, the descaling pump starts and entire rolling region is enveloped by the clouds of steam and at the same time rolling stands also discharge the scale water, therefore the light / heat radiation of metal is unable to reach respective photosensors. With this background metal status at 23rd stand has been detected by variation in the load current of separately excited armature controlled D C motor. Speed response of armature controlled motor is faster than field controlled motor⁷. The current is tapped by inserting current transformer around incoming bus bar of thyristor drive⁸.

status of PS-19 is sensed. If the status is sensed after the predetermined time and metal does not reach before PS-19 i.e. the resultant of accumulator goes to minus then processor gives output voltage correspond to drive particular shear otherwise processor senses the next rolling strand. The complete scanning process and controlling the different shear are shown in Fig 3.

Table 1

S.No.	Strand	Sensor	Chip 8155/-	Port/Bit
1	A	PS 16	0	A0
2	A	PS 19	0	A1
3	A	PS 20	0	A2
4	A	PS 23	0	A3
5	A	CS23	0	A4
6	B	PS 16	0	A5
7	B	PS 19	0	A6
8	B	PS 20	0	A7
9	B	PS 23	0	C0
10	B	CS23	0	C1
11	C	PS 16	0	C2
12	C	PS 19	0	C3
13	C	PS 20	0	C4
14	C	PS 23	0	C5
15	C	CS23	1	A0
16	D	PS 16	1	A1
17	D	PS 19	1	A2
18	D	PS 20	1	A3
19	D	PS 23	1	A4
20	D	CS23	1	A5
21	A	DSSS	0	B0
22	A	FLYING SHEAR	0	B1
23	A	SSSS	0	B2
24	B	DSSS	0	B3
25	B	FLYING SHEAR	0	B4
26	B	SSSS	0	B5
27	C	DSSS	0	B6
28	C	FLYING SHEAR	0	B7
29	C	SSSS	1	B0
30	D	DSSS	1	B1
31	D	FLYING SHEAR	1	B2
32	D	SSSS	1	B3

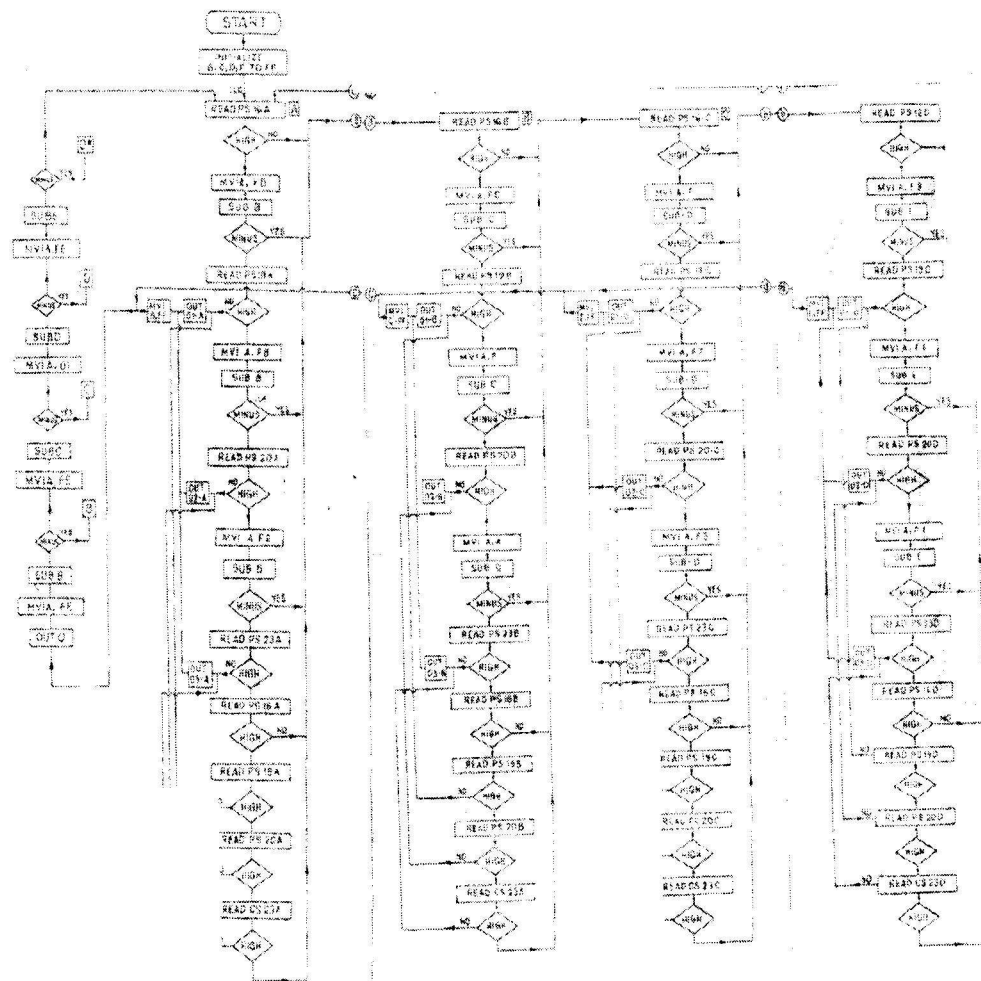


Fig. 3: Flow chart of complete cobble sensing and shear operating process

Conclusion: The length of cobbled metal has been reduced significantly. The down time of the mill is also reduced and productivity has been increased with a monetary gain of Rs 2.3 crores. The system was tried with microprocessor later on it was replaced by programmable logic controller RH84. Due to modernization of mill, existing discrete rolling stands are being replaced by rolling block though this system will continue to boom to wire rod mill till completion of modernization of mill in different phases.

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