OPTIMIZATION OF AUTOMATED GRANITE PROCESSING PLANT

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ABSTRACT

India is one of the leading country in mining of granite and rich in granite reserves. Indian stone become the most sought after and extendedly used stone materials in building construction and massive structural works throughout the world and it is well known in international market not only for its elegance and aesthetic quality but also for its durability. Because of huge demand for granite many granite processing industries are developed all over India in last few years. This includes the highly programmed automated equipment and machineries. So the granite industry has received a wider publicity and corporate importance in the last few years and India is one of the leading nations in the production. As the demand for the granite is more the factories are aim to produce maximum production out of the machinery but the problem which some of the granite factories are facing is they lagging in production, they not able to produce the estimated production out of the machine. This work is carried out mainly to study the factors which affect the production rate and taking the corrective action in order to produce estimated production. The optimization is done by general inspection method and vibration analysis.

Keywords: Granite Plant; Optimization; Automation; General Inspection; Vibration Analysis:

INTRODUCTION

India has major resources of marble [02], granite, sandstone, Kotahstone, quartzite & slate. Granite resources are largely in South India and Marble deposits are largely in Western India (Rajasthan & Gujarat). India is one among the leading countries in mining and export of granite and is rich in granite reserves. Geologically, the southern and eastern belts of the Nation are abundant in granite deposits. Different shades of granites are available in abundance in Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Assam, Bihar, Rajasthan, Odessa, Meghalaya and Madhya Pradesh. Indian Granite Stone has become the most sought-after and extensively used stone material in building construction and massive structural works throughout the world, and it is well known in the International market, not only for its elegance and aesthetic quality, but also for its durability.

The Granite Industry has received a wider publicity and corporate importance in the last few years. The industry is emerging now as a thrust-export-area with several corporate houses, supported by expert professionals trained in all aspects, entering the sector with sophisticated world-class machinery and making it an organized one. Many overseas buyers, including the Japanese, are the regular importers of the Jet Black Material, which is considered to be the world's best variety and is found in abundance in Tamil Nadu, Andhra Pradesh and Karnataka. Bu they have, of late, lost confidence in the supply of materials owing to its interrupted schedule. This was because of inconsistent policies of the Governments towards the industry, together with political interference in mining lease and other procedures.

Many granite processing industries are developed all over India in last few years. Most of the factories are aimed to maintain the quality of the granite slabs as they are exporting. Lots of study has made on the quality cutting of granite, that the effect of both the process parameters and textural properties on the cutting performance in terms of the depth of cut of the granite in addition to the quality of cut surfaces by Izzet Karakurt, Gokhan Aydin, and Kerim Aydiner [01]. And also re-use of granite sludge in producing green concrete by Allam M. E., Bakhoum E. S. and Garas G. L [03][04] which will use of marble and granite dust as sand replacement has more significant effect on the mechanical properties of concrete compared with using it as cement replacement.

GRANITE PROCESSING PLANT

The Rough Blocks that are received from Granite Quarries are unloaded from the trucks that transport in the Block Yard using a Gantry Crane [05]. The Blocks are inspected by qualified inspectors for defects. Blocks with major defects are stored separately or sent back to the quarry. Blocks that pass the inspection are then checked and a planned for a squaring operation using a Stationery Wire Saw machine. Normally, the Blocks are dressed on the Top surface and bottom surface using a wire saw. Sometimes if the Blocks are too wide or too uneven then the sides also are dressed using the same Stationery Wire Saw machine. The dressed Blocks from the Wire Saw machine are stored separately. These blocks are then loaded on to a Gang Saw Block Trolley using the Gantry Crane. The loading of the Blocks for sawing are dependent on the production program issued by the management.

Figure 1. Gantry Crane.

The blocks that are loaded on to the Gang Saw are set by means of cement after providing ample/suitable packing below to make the Block stable and balanced. The Block Trolley is moved under the Gang Saw Frame by means of the Transfer Trolley winch and pulleys. The Blade Frame of the Gang saw is loaded with suitable number of Blades depending on the size of the Block. The Blades are tensioned by means of an Automatic Tensioning system

Figure 2. Gang Saw Machine.

Once the Blade Frame is ready with Tensioned Blades and the Mixture Pit is ready with the Sawing Mixture, the gang saw is started and the cutting operation starts. The cutting is performed by the Steel Grit which acts like teeth to the Steel Blades. The steel grit disintegrates due to the cutting action. There is Steel Grit Reclamation Unit which separates the good/useable steel grit from the bad un-useable steel grit, which is taken out of the system.

Depending on the hardness of the material, quality of the blades [06] and steel grit the gang saw is able to complete the sawing in between 45 – 90 hours of cutting in each

operation/trolley. The washing, unloading and greasing time is about 5-8 hours. Simultaneously, the blade setting for the next sawing programmed is completed. Hence the total cycle time for one trolley is between 53 – 98 hours on an average. Once the sawing is completed till the bottom of the block, the Block Trolley is carefully removed from under the Blade Frame and out of the Gang Saw or out of the wire saw. The Block Trolley and the slabs are thoroughly washed to remove any residue of the steel grit or the sawing mixture. The Cleaned Slabs are transferred into the polishing workshop. Here the clean slabs are loaded automatically onto the Grinding Line which has a certain number of heads fitted with Grinding and Polishing Abrasives/ Tools.

Figure 3. Grinding and Polishing Machine.

The Automatic Grinding and Polishing machine first Grinds the Slabs automatically and prepares the surface for resin Treatment in the Resin Line.

Figure 4. Resin Line.

The Honed slabs are first dried in the Drying section of the Resin Line for at least 60 minutes at a temperature of 45 – 50 o Centigrade to remove all humidity. These dried slabs are then applied with a thin coating of Epoxy Resin [07]. The slabs thus treated are sent to the drying chamber / catalysis chamber to harden the Epoxy Resin. The catalyzed slabs are unloaded from the resin Line and stored. Such slabs stored for 24 hours will be ready for Polishing. The resined and cured slabs are then automatically loaded on the Polishing Machine with suitable series of abrasives and polished. The Slabs which come out of the Polishing

machine are inspected and stored for packing and export / further process. Some of the slabs which have been polished will need to be cut to size depending on the order from customers. This is done with the help of the Bridge/Edge Cutting machine. The granite slabs or tiles thus manufactured are ready for packing and dispatch/export.

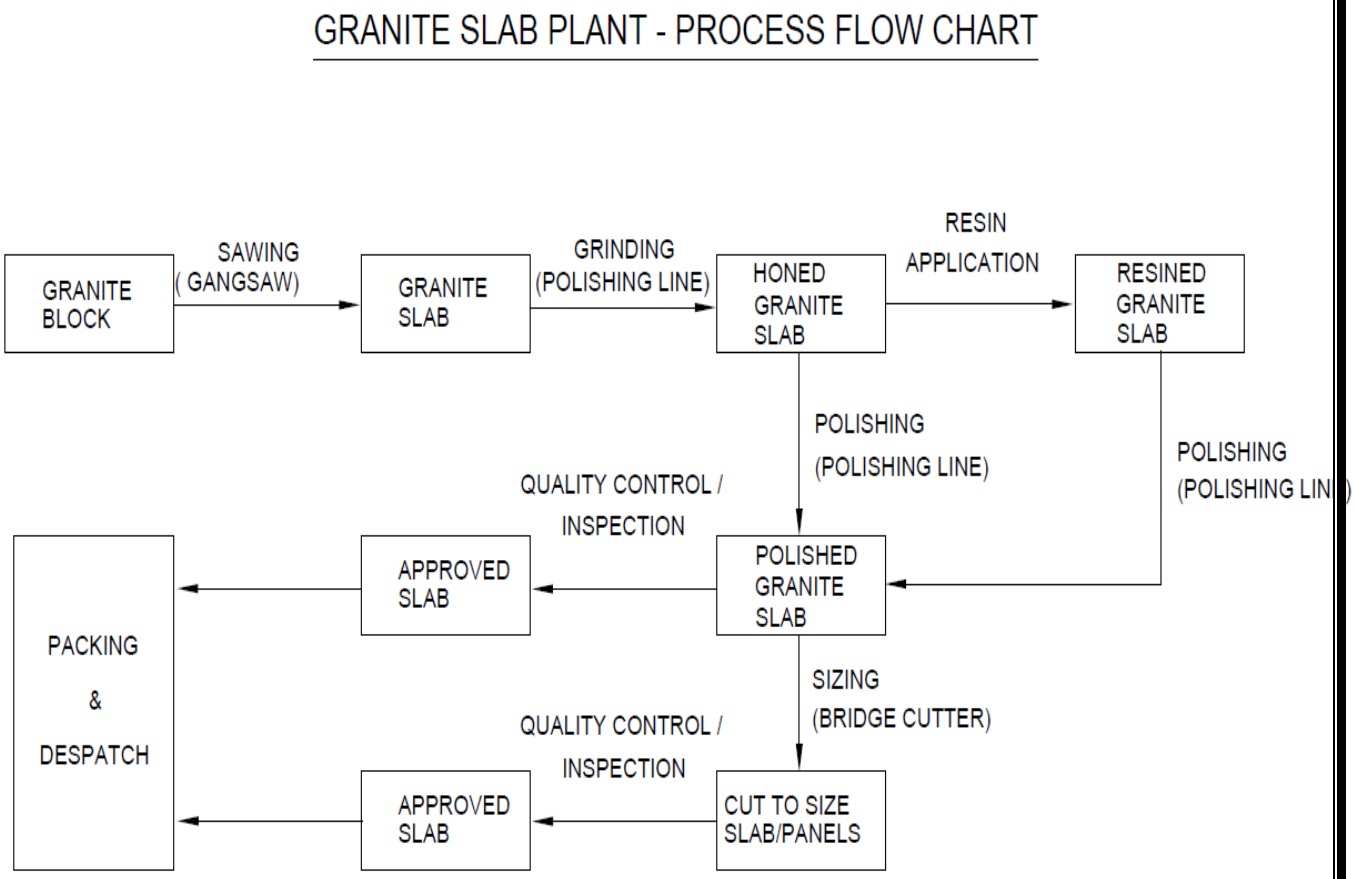

Figure 5. Granite Slab Plant – Process Flow Chart.

PROBLEM DEFINITION

As the demand for the granite slabs are increasing day by day, the factory is trying to produce maximum production out of the machinery. The problem is that the production in the factory is lagging, i.e. the company people are not able to achieve the estimated production from the machinery. And the tools which are used for the process are get worn-out early and this will leads damages in the granite slabs. By general inspection come to know that the production is lagging in the polishing section of granite slab, So optimization is necessary in polishing section of the granite factory.

METHODOLOGY USED

*A. **Production report**:*

First is to reporting the current production by observing and note down the ongoing operation and comment on that.

Table I. Polishing Machine Weekly Report.

POLISHING MACHINE WEEKLY REPORT

Machne model no: PGM 2200/20 Year:2007

Sl.No	Date	No.of shift	Targated slabs	Targated sq.m	Achived slabs	Achived sq.m	short slabs	short sq.m	Repolished slabs	No of batch size production	power in hrs	Mech in hrs	Elec in hrs	Lunch Brk in hrs	No load in hrs	Water	Other	Belt gap Hrs	Running hrs	Quality in %(Glasso meter)	break down reason
1	16/12/14	3	195	1170	109	654	86	516	2	4	0	4	3.45	1	1	0	0	2.4	12.15	92%	BRIDGE MOTOR INVERTER PROBLEM,CRANE PROBLEM
2	17/12/14	3	195	1170	95	570	100	600	5	5	0.4	1	3	1	2.15	0	0	3	13.85	90%	ALL HEAD UP AND DOWN PROBL M ,HEAD NO 5 FELL DOWN.
3	18/12/14	3	195	1170	119	714	76	456	23	0	0.35	1.5	0.15	1	1.5	0	1	0	18.85	85%	HEAD NO. 5,7,8,17 WATER PIPE CLEANING, HEAD NO. 8 &11 FALI NG DOWN.
4	19/12/14	3	195	1170	129	774	66	396	10	2	0	0	0	1	0.4	0	0.4	1.2	21	85%	
5	20/12/14	3	195	1170	133	798	62	372	0	2	0.35	0	0	1	0.4	0	4.45	1.2	16.95	88%	RECYCLING WATER PROBLEM,HE D UP AND DOWN LIMIT PROBLEM.
6	21/12/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	WEEKLY OFF
7	22/12/14	2	130	780	96	576	34	204	0	1	0	1	0.45	0.5	0.45	0	1.1	0.4	12.1	85%	BRIDGE MOVEMENT PROBLEM
8	23/12/14	3	195	1170	139	834	56	336	13	1	1	0	4	1	0	0	0.2	0.4	17.4	89%	HEAD NO. 9 WATER PIPE VALVE FIXING&RECYCALING

The graph is plotted number of days versus number of Targeted Slabs and Achieved Slabs as shown in Figure 6.

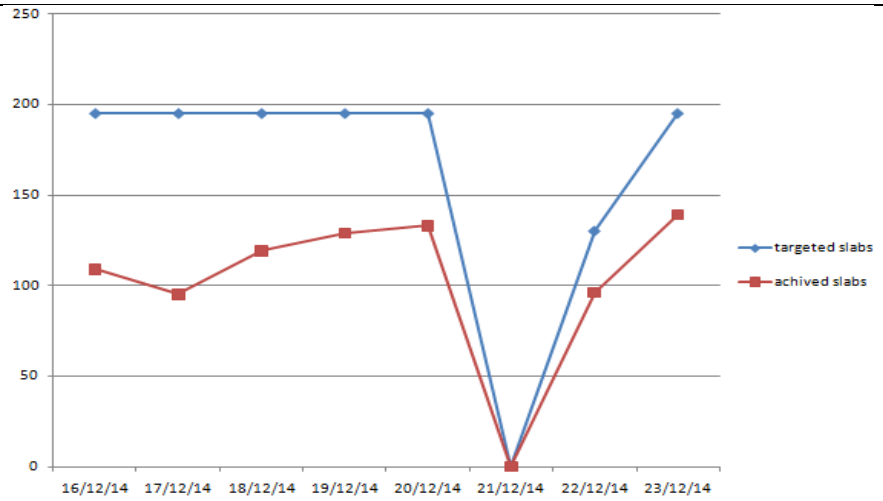

Figure 6. Number of Slabs Produced.

B. *Vibration analysis*

Table II. Polishing Machine Heads Chuck List.

POLISHING MACHINE HEADS CHECK LIST																					
MACHINE MODEL NO: PGM 2200/20											SERIAL NO: 91-095						YEAR: 2007				
	Water Line				Penumatic system						Spindel			Motor					Heads			Remarks
Heaads no.	Valve	Flexible Pipe	Pipes	Fittings	Fittings	Leakage	DC Valve	Break Valve	Pin Cylinder	Potentiometer	Top Housing	Bearings	Bottom Bearings	Sound	Fan Cover	Cleaning	Pully	Belts	Sound	Lubrication	Abbressive wearout	
1	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	LN	OK	OK	D	N	OK	1D	N	N	N	Head obling spindle bearing noise
2	N	Ok	Ok	Y	LF	N	N	N	OK	N	OK	NOI	LN	OK	D	N	OK	OK	LN	N	N	Up and down jerk sound head obling
3	N	Ok	Ok	N	LF	N	N	N	OK	N	D	LN	OK	OK	D	N	OK	OK	LN	N	N	no cover for spindle
4	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	LN	LN	OK	D	N	OK	OK	N	N	OK	Spindle noise head vibration
5	N	Ok	N	N	LF	N	N	N	OK	N	OK	NOI	OK	OK	D	N	OK	OK	OK	N	OK	Top spindle heat head vibration
6	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	OK	N	N	N	Normal
7	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	OK	N	N	N	Head noise
8	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	NOI	OK	OK	D	N	OK	2T	LN	N	OK	Top spindle heat head vibration
9	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	OK	OK	N	N	Spindle noise head vibration
10	N	Ok	N	N	LF	N	N	N	OK	N	OK	NOI	OK	OK	D	N	OK	3D	N	N	N	Spindle noise head vibration
11	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	LN	OK	OK	D	N	OK	OK	LN	N	N	Top light noise head vibration
12	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	OK	N	N	N	Spindle noise head vibration
13	N	Ok	Ok	Y	LF	N	N	N	OK	N	OK	NOI	OK	OK	D	N	OK	OK	OK	N	N	Normal
14	N	Ok	Ok	N	LF	N	N	N	OK	N	D	LD	LN	OK	D	N	OK	OK	OK	N	OK	Middle bearing light noise
15	N	Ok	Ok	N	LF	N	N	N	LD	N	OK	OK	OK	OK	D	N	OK	OK	LN	N	N	Normal
16	N	Ok	N	N	LF	N	N	N	OK	N	D	NOI	OK	OK	D	N	OK	OK	LN	N	N	spindle top loose sound
17	N	N	N	N	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	OK	OK	N	N	Spindle problem Heads on Break dow
18	N	Ok	Ok	N	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	7T	N	N	N	Head oblind
19	N	Ok	Ok	Y	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	OK	OK	N	N	Normal
20	N	Ok	Ok	Y	LF	N	N	N	OK	N	OK	OK	OK	OK	D	N	OK	OK	OK	N	N	Normal

DATE OF INSPECTION : 05/1/2015

OK: NORMAL CONDITION **LF :LOOSE FINNTING** **1D: 1 BELT DAMAGED** **N: NOT OK/ NOT PRSENT** **NOI: NOISE**

2T: 2 BELT TWISTED **D: DAMAGED LN LIGHT NOISE**

Industrial vibration analysis is a measurement tool used to identify, predict, and prevent failures in rotating machinery [8]. Implementing vibration analysis on the machines will improve the reliability of the machines and lead to better machine efficiency and reduced down time eliminating mechanical or electrical failures. Vibration analysis programs are used throughout industry worldwide to identify faults in machinery, plan machinery repairs, and keeps machinery functioning for as long as possible without failure. The rotating elements of these machines generate vibrations at specific frequencies that identify the rotating elements. The amplitude of the vibration indicates the performance or quality of machine. An increase in the vibration amplitude is a direct result of failing rotational elements such as bearings or gears. Based on the machine speed, the rotational frequencies can be calculated and compared to the measurements to identify the failure mode.

C. Inspection of Machine Parts

1. Controlling system:

- Operator is not able to polish/ grind the edges of slabs properly in moderate or high conveyor speed. The heads are not getting down as per the setting on the operator panel. There is delay when heads are moving down in front edge of the slabs and lifting up from the back ends of slabs. Then the operator is compelled run machine with lower belt speeds (less than 50cm/minute).
- The pre-approach function of the machine is not working.
- The bottom and top ends of slabs are not covered properly by the heads.
- The Bridge encoder (on the bridge motor) is kept in deactivation mode.
- Abrasive monitoring / control not activated.
- Water sensor is deactivated and not used.
- Cleaning brush is not working.

2. Machine condition:

- The pneumatic valves for Heads up/down movement are working with single acting actuator instead of double acting actuator.
- The linear potentiometers and signal cables of entire heads are damaged.
- Rack and pinion for bridge movement at slab entry side is damaged.
- Rack and pinion and rollers inside the bridge side supports are also damaged.
- Lubrication oil is leaking from slab entry side bridge support.
- Noise is developed from bridge support rollers.
- The heads number 1, 3, 5, 9, 13, 14, 15 and 18 are having abnormal vibrations.
- Lubricating grease is leaking from the Heads number s 11, 17, 18 and 20.
- Protection Bush and labyrinth Bush are damaged in upper part of head spindle units.
- Water sealing glands on the spindle units are damaged.
- Belt supporting rollers under the bed are damaged.
- Belt washing tube is not proper.
- Scale is formed on the belt roller drum at slab entry side and Belt tensioning bolts are corroded.
- Moisture is present in Pneumatic valves and cylinders.

RESULTS AND DISCUSSIONS

As in current condition of polishing machine is works with a single acting pneumatic valves, because of this the pre approaching of the polishing heads is not working, and also there is no control over the polishing head. So for this single acting pneumatic valve is replaced by double acting pneumatic valve in order to get the pre approaching and also the controlled movement of the polishing head.

Figure 7: single acting pneumatic valve

Figure 8: Double Acting Pneumatic Valve

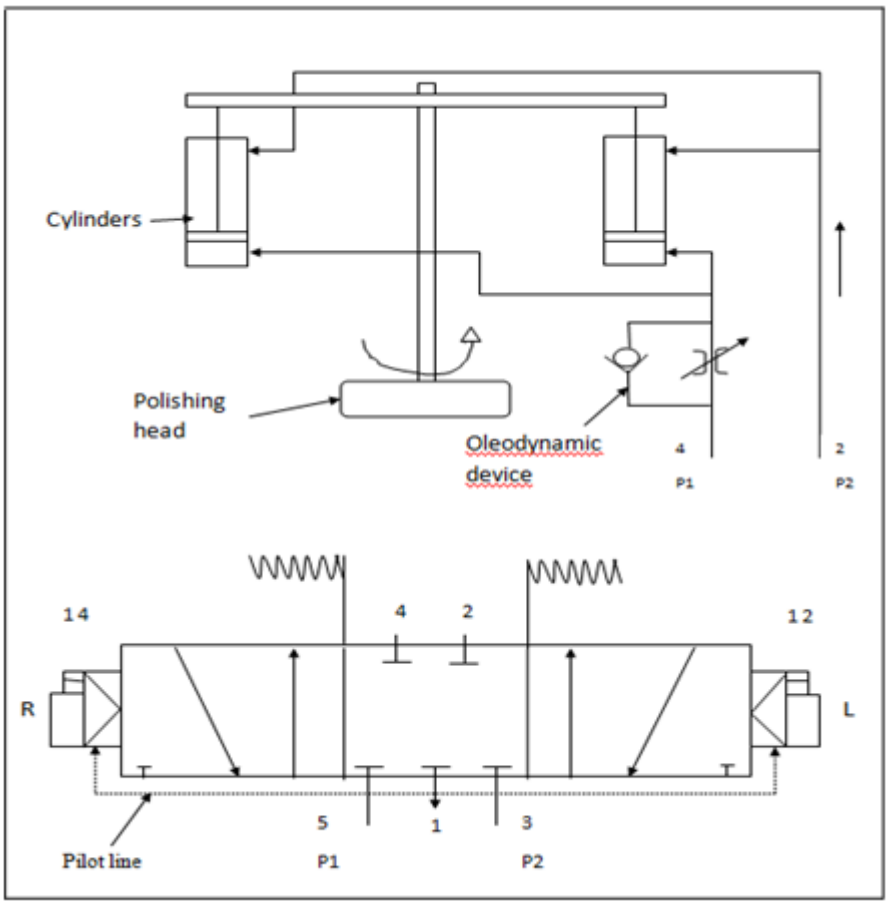

Figure 9: Operation Of Double Acting Pneumatic Valve

This double acting pneumatic valve is having two inlets where controlled pressured air is supplied in one inlet, i.e. P2 and the direct pressure air is supplied in other, i.e. P1. Hear the

actuating switches are of electro-magnetic solenoid, which will actuate the spool whenever electric supply is given to it. One extra pilot line is given in these valves which will helps to actuate the spool more effectively. The operation is when the right side spool is actuated the direct pressured air is flows through P1 which will rapidly pushes the polishing heads to upwards and air is ventilated through 1. When the left side spool gets actuated the controlled pressure air is flows through P2 which will moves the polishing heads in controlled manner. A spatial oleodynamic device is used which is able to rigidly lock the polishing heads in the selected position under the impulse of a control in the working program. After the replacement of the pneumatic valve and some service/repair of the machine the polishing heads are worked in the controlled manner, and this project is successful conducted and the brakeage of the slabs due to sudden falling of the polishing head has been minimized, which in turn increases the production rate of the factory.

CONCLUSIONS

This work is carried out to study the factors which affect the production rate, the study reveals that the production speed of machine can be improved by replacing the single acting electro pneumatic valves with double acting electro pneumatic valves, and also by providing new potentiometers and its signal cables for all head spindle units. The optimization is done by general inspection method and vibration analysis. Some of the corrective actions required in order to produce estimated production are

- The machine and all heads are required to service / repair with necessary spares to avoid frequent break downs and uneven abrasive consumption.
- New lubrication line installation.
- Installation inverter set to the belt and roller conveyer combination

The service / repair can be carried out as two phases. The first phase of action focuses to improve the speed of production of machine and the second phase focuses to increase the consistency of machine.

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