Study and Optimization of Granite Processing Plant
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Abstract— India is one of the countries which is rich in granite reserves and mining of granite in India takes the country to compete in the international market level. In today’s scenario the granite stone become the building block for the construction field. The apartments, hotels, MNCs are got Royalty and attractive looks because of these granite infrastructure. The Granite Industry has received a wider publicity and corporate importance in the last few years. 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 project is to study of the factor which affects 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

I. INTRODUCTION
Over the past century, production of the granite slabs has made a considerable progress in different variety and design, and also the manufacturing plants get automated to produce maximum production in shorter time. India has major resources of marble, granite, sandstone, Kotalhstone, quartzite & slate. Granite resources are largely in South India and Marble deposits are largely in Western India (Rajasthan & Gujarat). India is one of the countries which is rich in mining exports of granite. The factories which are in south India have mission to produce the granite slabs with export quality. Different color and shades of granites are available all over India like in Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Assam, Bihar, Rajasthan, Odessa, Meghalaya and Madhya Pradesh. 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[1]. And also re-use of granite sludge in producing green concrete by Allam M. E., Bakhoum E. S. and Garas G. L. [3][4] 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. The sawing of Granite blocks using multi-blade Gangsaw and an abrasives mixture is one of the most complex operations in the rock transformation industry. The surface quality of the finished slabs is major determinant of the volume of material to be removed in subsequent polishing operation, thus influencing the final cost of the product. To determine this quality, a portable piece of equipment which records the direct measurement of the roughness of the slab surface was developed. “Rogerio pinto Ribeiro, Antenor Braga Paragussu, Jose Eduardo Rodrigues[6] discuss the cusses which result in reaction to knoop hardness, Amsler were, deep abrasion and petrography and concludes that the texture of the rock has the most important influence on the cost of production of polished slabs.

II. STUDY ON 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. 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.

Fig. 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 a Automatic Tensioning system. 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 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 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.

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

Fig. 2: Gang Saw Machine.

Fig. 3: Grinding and Polishing Machine.

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Fig. 4: Resin Line.

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.

Fig. 5: Granite Slab Plant – Process Flow Chart.

III. 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.

IV. OBJECTIVE

The objective of the project is to finding out the problems occurring in the machine which causes the breakdown of the system, failure in control system, breakage of the granite slabs decreasing in production rate etc.

V. METHODOLOGY USED

A. Production Report:
   First is to reporting the current production by observing and note down the ongoing operation and comment on that.
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Table 1: Polishing Machine Weekly Report.

<table>
<thead>
<tr>
<th>Date</th>
<th>Shift</th>
<th>Target Slabs</th>
<th>Achieved Slabs</th>
<th>Slab Size</th>
<th>Polished Slabs</th>
<th>Rejected Slabs</th>
<th>Fatigue Slabs</th>
<th>Defect Slabs</th>
<th>Machine Damage</th>
<th>Breakdown Reason</th>
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<tr>
<td>1 16/11/24</td>
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<td>195</td>
<td>1170</td>
<td>209</td>
<td>564</td>
<td>86</td>
<td>316</td>
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<td>95</td>
<td>570</td>
<td>100</td>
<td>600</td>
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<tr>
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<td>1170</td>
<td>456</td>
<td>23</td>
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<td>150</td>
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<td>0.35</td>
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<tr>
<td>4 19/11/24</td>
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<td>1170</td>
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<td>95</td>
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<tr>
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<td>133</td>
<td>798</td>
<td>62</td>
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<tr>
<td>6 21/11/24</td>
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<tr>
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<td>63</td>
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<td>0.45</td>
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<tr>
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<td>56</td>
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</table>

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

Fig. 6: Number of Slabs Produced.

B. Vibration Analysis:
Vibration analysis is done on the rotating parts of machinery is to identify and predict the failure in the machinery. Usually the vibration analysis done under some standard consideration, like for the shaft of diameter between 200 and 500mm and shaft speed less than 500rpm the Alert will be at 1gE and Danger will be at 2gE. The vibration analysis is weekly or monthly checkup which keep machinery functioning for as long as possible without failure. The vibration analysis done on rotating part of machines, such machinery includes pumps, fans, motors, turbines, gearbox, conveyer roller etc. In this project the vibration analysis did on the each rotating spindle which having polishing heads to find out the faults.

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.

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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.

VI. **RESULT 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.

![Fig. 8: Double Acting Pneumatic Valve](image)

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.

![Fig. 9: Operation of Double Acting Pneumatic Valve](image)

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. The Weekly Report of Polishing Machine after optimization is shown in below table.
The graph is plotted number of days versus number of Targeted Slabs and Achieved Slabs as shown in Figure 8.

Fig. 10: Number Of slabs Produced After Optimization.

The project is successfully conducted and the result can be checked by comparing the graphs which is in figure 6 and figure 10 respectively. Finally conclude that after optimization the production rate of the factory gets improved.

VII. ACKNOWLEDGMENT

I take this opportunity to express my gratitude to my guide and the project coordinator Dr. Ramachandra C G, Professor & Head of the Department of Mechanical Engineering, Srinivas Institute of Technology Mangaluru, India, my Co-Guide Mr. Sudakar, Sr. Mechanical engineer and Anjali Granite Private Ltd. Andra Pradesh for suggesting this project and for the keen interest they have taken throughout the project work.

REFERENCES

[1] Izzet Karakurt, Gokhan Aydin, and Kerim Aydiner “An Experimental Study on the Depth of Cut of Granite in Abrasive Waterjet Cutting” Department of Mining Engineering, Karadeniz Technical University, Trabzon, Turkey.


