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Research Article

DESIGN AND ANALYSIS OF OVERHEAD MATERIAL HANDLING SYSTEM IN A FOUNDRY

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A R T I C L E I N F O

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A B S T R A C T

New types of automated over head rail system carrying grab bucket able to achieve high throughput are continuously being developed and requires new control policies to take full advantage of the developed system in industry. In this work, an over head mono rail system has been designed and studied, consisting of a Hydraulic cylinder grab bucket, hoist and two rollers sets. This study aims in scheduling the scrap material transport from storage area to vibrocharger present in furnace zone. The objective of this system design is to reduce the cycle time of material transport throughput and to increase the efficiency of material handling system. Automated Grab Bucket picks the scrap, holds it firmly between the jaws, lifts it to required height and travels on over head monorail to the furnace area and dump to vibrocharger. Automated grab bucket system for handling foundry parts is designed using CATIA and analyzed using ANSYS software. Material handling system throughput consists of Picking the scrap Holding the scrap Lifting the scrap to required height Liner travel Lowering the scrap to desired height and dumping it to vibrocharger (open the grab bucket).

INTRODUCTION

As in straightforward way, Material Handling is stacking, moving and emptying of materials. To do in precisely and securely, distinctive sorts of handles, devices and types of gear are utilized, when materials taking care of is alluded to as mechanical treatment of materials. Material Handling is the field concerned with taking care of the down to earth issues including the development, stockpiling in an assembling plant or stockroom, control and security of materials, merchandise and items all through the procedures of cleaning, planning, producing, dispersion, utilization and transfer of every single related material, products and their packaging. The center of investigations of Material Handling course work is on the routines, mechanical hardware, frameworks and related controls used to accomplish these capacities. The material taking care of industry fabricates and conveys the gear and administrations needed to execute material taking care of frameworks, from acquiring, by regional standards handling and shipping crude materials to usage of modern feedstocks in mechanical assembling procedures. Material taking care of frameworks reaches from straightforward bed rack and racking tasks, to complex transport line and Automated Storage and Retrieval Systems (AS/RS); from mining and penetrating gear to custom fabricated grain malt drying rooms in distilleries. Material taking care of can likewise comprise of sorting and picking, and in addition programmed guided vehicles.

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The Material Handling System (MHS) is a crucial piece of an Adaptable assembling framework since it interconnects the distinctive procedures supplying and taking out crude material, work pieces, sub-items, parts and last items. Because of the mechanized way of the entire creation prepare, the MHS must react working together with opportuneness for all prerequisites of the procedures and frameworks.

Since primitive men find the utilization of haggles, they have been moving material mechanically. Any human action including material needs material taking care of. However in the field of designing and innovation, the term material taking care of is utilized with reference to mechanical action. In any little or vast scale industry, including assembling or completed item from purpose of receipt and stockpiling of crude material through creation process and up to completed merchandise stockpiling and dispatch point.

Prerequisites of material taking care of framework:

- Safe development of material
- Time investment funds
- Required least space for putting away
- Lowest expense answer for taking

The MHS is made out of stockrooms, cradles, transports, transportation vehicles or frameworks, part sorters, feeders and controllers.

Requirement Analysis

Equivalent stress

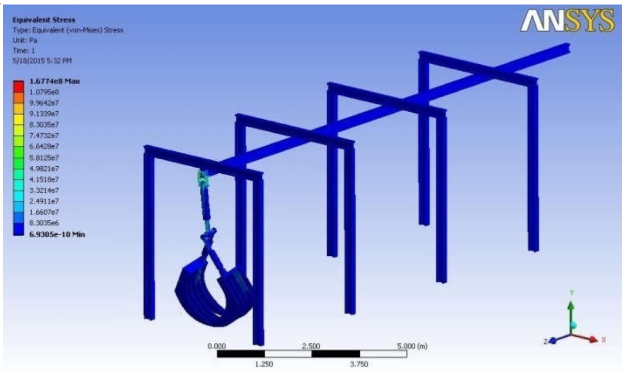

Fig 1 Equivalent stress

The figure 1 shows the result of equivalent stress. A scalar stress value that can be computed from the Cauchy stress tensor. In this case, a material is said to start yielding when its equivalent stress reaches a critical value known as the yield strength.

Boundary condition is nothing but a preprocessor activities in analysis where giving fixed constraints as well as loading points. Fixed constraints will be zero boundary condition. It was taken on I-beam section bottom surface wherever it is resting on the ground. Structural steel is taken as material properties; loading condition is formed at grab bucket teeth's. Solid 45 elements is used for analysis.

Maximum Principle Stress

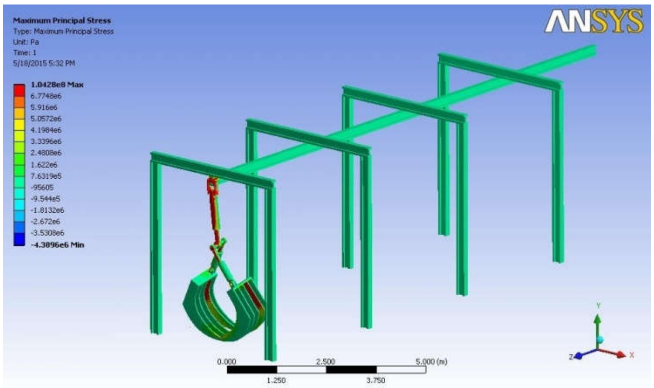

Fig 2 Maximum Principle Stress

The figure 2 shows the result of max principle stress. In the system, when the maximum principle stress reaches the value of elastic limit in a simple tension.

Maximum Shear Stress

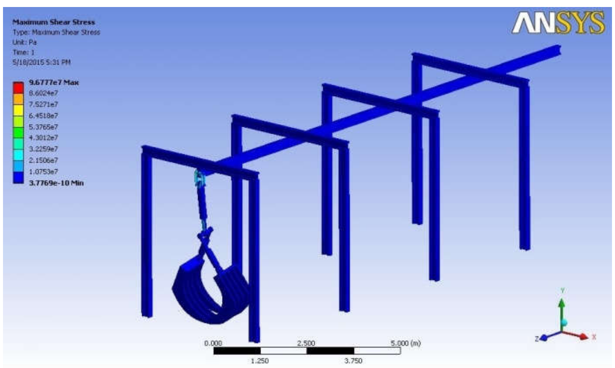

Fig 3 Maximum Shear Stress

The figure 3 shows the result of max shear stress. It is defined as the component of stress coplanar with a material cross section. The vector component arises the Shear stress force parallel to the cross section.

Total Deformation

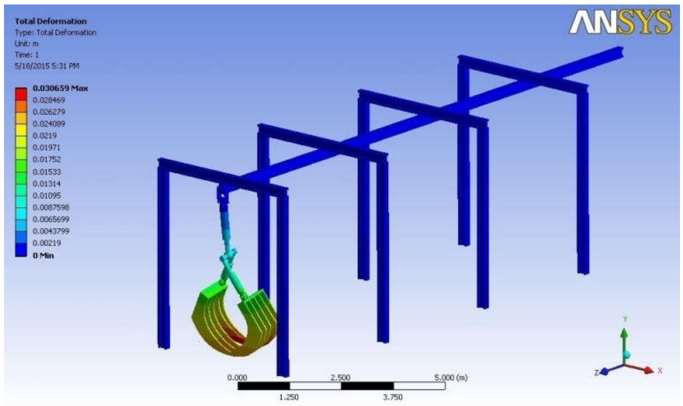

Fig 4 Total Deformation

The Figure 4 shows the result of total deformation on the grab bucket. Total deformation is the vector sum of all directional displacements of the systems.

Load File

Meshing

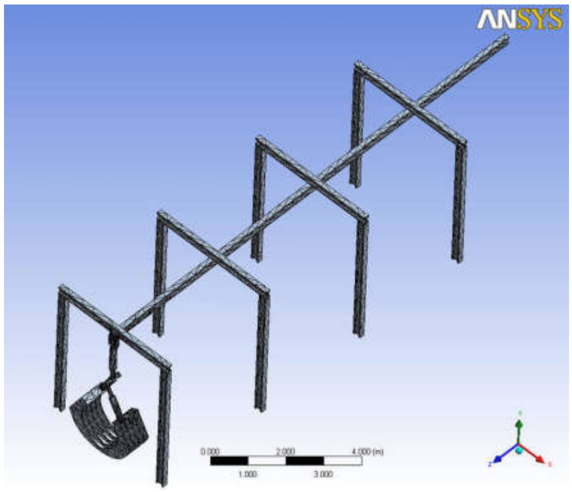

Fig 5 Meshing

Meshing is the act of producing a polygonal or polyhedral lattice that approximates a geometric area. The expression “network era” is regularly utilized conversely. Commonplace uses are for rendering to a computer screen or for physical reenactment, such as finite element analysis. The data model structure can change incredibly however basic sources are CAD, NURBS, B-rep, STL (record arrangement) or a point cloud. The field is very interdisciplinary, with commitments found in arithmetic, software engineering, and designing.

Three-dimensional cross sections made for limited component investigation need to comprise of tetrahedral, pyramids, crystals or hexahedra. Those utilized for the limited volume strategy can comprise of subjective polyhedral. Those utilized for limited distinction strategies typically need to comprise of piecewise organized varieties of hexahedra known as multi-square organized cross sections. A cross section is generally a discretization of an area existing in one, a few measurements.

Pressure

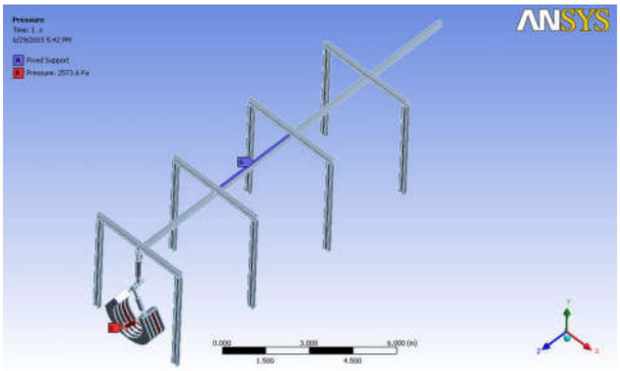

Fig 6 Pressure

Pressure (image: p or P) is the power connected opposite to the surface of an article for each unit zone over which that constrain is circulated. Gage weight (additionally spelled gage pressure)[a][not in reference given] is the weight in respect to the nearby barometrical or surrounding weight.

Different units are utilized to express weight. Some of these get from a unit of power partitioned by a unit of zone; the SI unit of weight, the Pascal (Pa), for instance, is one Newton for every square meter; comparably, the pound-power per square creep (psi) is the conventional unit of weight in the royal and US standard frameworks. Weight might likewise be communicated as far as standard environmental weight; the atmosphere is equivalent to this weight and the torr is characterized as 1⁄760 of this, Manometric units, for example the centimeter of water, millimeter of mercury and inch of mercury are utilized to express weights as far as the tallness of section of a specific liquid in a manometer.

RESULT AND DISCUSSION

Cycle Time Analysis

Computer integrated assembling or manufacturing is the assembling methodology of utilizing computer to control the whole creation process. This integration permits individual procedures to trade data with one another and start activities. Through the integration of computer, assembling can be quicker and less slip inclined, despite the fact that the fundamental favorable position is the capacity to make robotized assembling procedures. Regularly CIM depends on shut circle control procedures, in light of constant info from sensors. It is otherwise called adaptable outline and assembling. The CIM procedure helps reducing in cycle time and increasing in productivity. With the help of computer the number of throughput will increases.

Fig 7 Labors loading scrap material in the pallet

After applying the Automatic material handling system method in Shanthala Foundry the cycle time had been reduced. Before in Shanthala Foundry it takes very much time to complete one cycle. The scrap materials are not able to place in Vibrocharger. The distance between scrap areas to furnace is 15m. The labors are loading the scrap materials in pallet.

While loading the scrap materials in pallet it takes 15min.27 scrap materials can be loaded in pallet if it is in big size. 30 scrap materials can be loaded in pallet if it is in small size. For this process it takes 15min to load scrap materials in the pallet. After that the crane lifts the pallet and moves towards the furnace side for next procedure. The crane takes 5min to reach from scrap area to the furnace. The total capacity of furnace is 2.4 tons. They load 1500 kg of scrap materials in a furnace. They divide scrap materials into 3 steps. In first step they load 500kg of scrap material and second step they load 500kg and third step they load 500kg. So total is 1500kg (500+ 500+ 500). In first step they load 500kg of scrap materials in furnace it takes 15min for melting. During in first step the labor load 10 scrap materials in furnace i.e. (the weight of one scrap material is 50kg so 500/50 is 10 materials). So every step they load 10 scrap materials in furnace. To complete the melting process it takes 45min. In first step it takes 15min second step 15min and last step takes 15min.

Fig 8 Labor loading scrap material in furnace

The labor takes 5min to load the scrap materials in furnace. After the processing of melting the molten metal's poured into the drum. During pouring it takes 1min and after that it poured to several pallets. During pouring to several pallets it takes 4min. At present to complete the one cycle it takes 1hour 15min (75min).

Fig 9 Molten metal's pouring in pallet

After analysis this, it has planned to designed a Grab Bucket Material Handling System. The grab bucket lifts the scrap material and moves from scrap area to vibrocharger. The grab bucket moves in two and fro motion. The total length is 15m from scrap area to vibrocharger. The speed of grab bucket is 0.5m/sec.

The grab bucket takes 30 seconds to reach the vibrocharger. The speed of rollers is 0.5m/s. The grab bucket dumps the scrap material on surface of the vibrocharger. Because of vibration in the vibrocharger the scrap materials move towards furnace for next procedure. The distance between vibrocharger and furnace is 3m.The speed of vibrocharger is 0.08m/s. So it takes 15 seconds to reach furnace and dumping the scrap material in the furnace. By using vibrocharger to dump the scrap material in furnace, the labor is not required. The manpower is completely 0%. Dumping the scrap material to furnace and melting process takes 10min. After that they take 1min to pour the molten metals into the drum. Next step they take 4min to poured several pallets from drum.

Cycle Time Analysis before Implementation of Material Handling System

Time required to load scrap material	**15min**
Time required to move scrap material from stock area to melting area	05min
Time required for labor to dump the scrap materials in furnace	05min
Total cycle time before Implementation	25min.

Cycle Time Analysis after Implementation of Material Handling System

Time required to descending of hydraulic cylinder	**10 seconds**
Time required to carry the scrap materials by grab bucket jaws	1min
Time required to ascending of hydraulic cylinder	10 seconds
Time required to move from scrap area to vibrocharger	30 seconds
Time required to dump scrap materials on surface of vibrocharger	1min
Time required to move vibrocharger to furnace	15 seconds
Time required to load the scrap materials from vibrocharger to furnace	1min
Time required to move from vibrocharger to scrap area	30 seconds
Total cycle time after Implementation	4min 35seconds

To find velocity

Power utilization= 1.5HP Motor
HP in terms of KW= 1.5×0.745= 1.12KW
To find torque:

$$P = \frac{2\pi NT}{60} \text{ KW} \quad \text{.... Eqn 7.1}$$

Where T is torque N-m
N is rpm
P is power in watt

$$T = P \times \frac{60}{2\pi N} \text{ N-m} \quad \text{.... Eqn 7.2}$$

T=1.12×1000×60/2×π×1440
T=7.42N-m
Linear velocity:

$$V = \frac{\pi DN}{60} \text{ m/s} \quad \text{.... Eqn 7.3}$$

Where D is diameter of roller
N is rpm
V is linear velocity
V=π×0.1×100/60
V=0.5m/s.
The velocity of rollers is 0.5m/s.

CONCLUSION

Cycle time for material handling is reduced from 25minutes to 4.5minutes after the implementation of automated material handling system. There is no manual labor required in the newly designed material handling system. 7 to 8 manual labors were required to accomplish the material handling task in the earlier manual system.

In earlier system, there was lot of stress and fatigue on labors due to handling of materials manually. Labors were physically and mentally stress due to target given to them in the production floor. Hence Automation of material handling is done to increase productivity and quality of molten charges. Melting capacity is increase by 45% by switching over to automated material handling system. It is increased to 18 tons per day from 10 tons per day of earlier system.

There were quality hindrances in the earlier system due to delay in supplying the raw material to the furnace at the time of melting. This was overcome by adopting automated material handling system whose cycle time is 4 min 35 seconds. The quality of molten charge is improved and these by reduced in quality.

Cost Estimation

Sl No	Particular	Quantity	COST(Rupees)
1	I Beams	13	2,580/-
2	Rollers	4	900/-
3	Bearings + machining	8	2,000+800/-
4	Hydraulic cylinder	1	2,00,000/-
5	Two small cylinders	2	1,22,000/-
6	Grab Bucket	1	60,000/-
7	Bolt and Nut	48 sets	2,400/-
8	Hydraulic power pack	1	55,300/-
9	Hose pipe and Festoon cable with roller hanger system	2	8960/-

Total estimation cost of the project is Rs.4, 54, 940/-
In words four lacks fifty four thousand nine hundred and forty rupees

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