Automated Mechanism for Pick and Place of Dead Weight

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Conventional method of manually placing weights[4] on the mould box to suppress the box lift after pouring was employed in the foundry. The method had a number of drawbacks and did not completely serve the purpose of eliminating the box lift. The castings produced in the concerned foundry required placing of heavier weights. Handling of weights, uneven distribution of weight on box, box lift due to insufficient weight, possibilities of accidents were some of the problems encountered in the conventional method.

To overcome these problems, automated mechanism for pick and place of dead weight was proposed. The foundry already had a rectangle-shaped transfer line where activities such as pouring, cooling and breaking of moulds were carried out. This helped in the development of pick and place mechanism.

The paper explains the design and development of pick and place mechanism consisting of weight calculation, design of elements in the mechanism, casting and execution of the proposed work.

Introduction

During the pouring of the liquid metal in the mould, the temperature of the metal is high and the flow velocity of the metal is also high, which causes rise in the pressure inside the mould and this initiates the Box Lift during the pouring process[5]. This box lift causes a large waste of the precious liquid metal which subsequently adds on to the losses and thus depletes the profit of the foundry.

To overcome the box lift during pouring, the foundry used conventional method of manually placing weight over the mould box (Fig.-1). This method causes following problems :

- Uneven distribution of weight.
- Difficulty in manually placing of weight.
- Dedicated labour for weight placing.
- Accident prone activity.

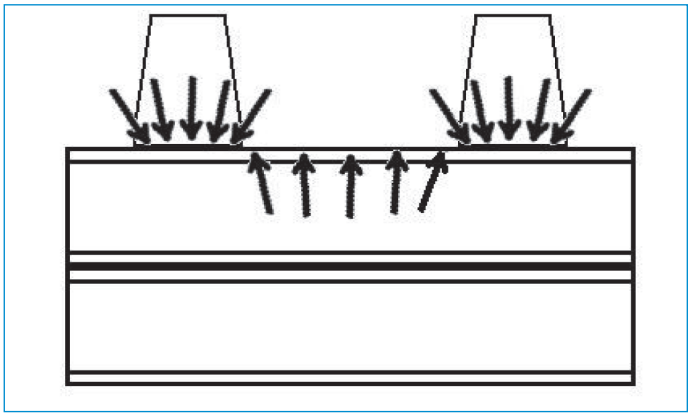

Fig. 1

Fig. 2

The firm initially attempted to reduce the problems of box lift by placing the weight of 100 kg (two No. of 50 kg) over the cope-drag assembly (Fig. 2). The weight was not sufficient to overcome

the box lift. So the firm designed a special weight of 250kg. to be placed on the box[5]. But this added the problem of weight handling as this weight was placed using a hoist, which also required more time to accurately place the weight on the box.

Problem Definition

To design and develop a pick and place mechanism capable of handling a weight of more than 250 kg which would place the weight on the cope and drag assembly immediately after pouring and remove the weight just before it reaches the knockout section.

Details of Existing Layout

Partial layout of the existing facility is as shown in Fig. 3 with location of the project as shown. The layout consisted of conveyor mechanism with pallets housing, the cope and drag assembly. After pouring, the pallets would move in a rectangular layout (Process line – transfer line–Process line) (Fig.7) and reach the knockout section where the knocked sand would be taken to sand reconditioning plant.

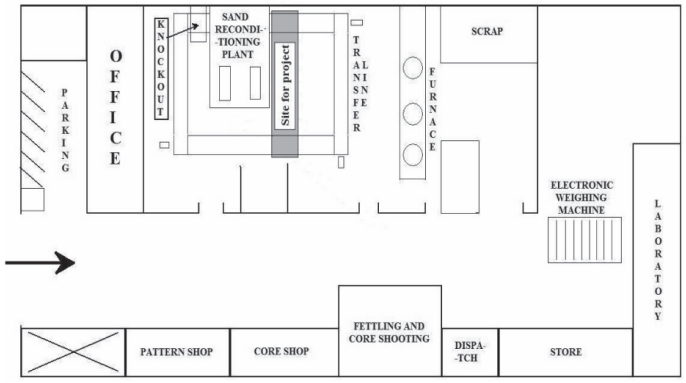

Fig. 3

The time required by the pallet box to reach knockout section after pouring is 90 seconds. The activity to be mechanised consisted of placing the weight on the assembly just before pouring and removing the same after the pallet reaches the knockout section.

The distance covered by the mechanism during one cycle is two times the distance between the process line i.e. 2 x 4.2 m = 8.4 m, the time required for pouring of molten metal into mould box is 30 seconds. The activities to be carried out in the time span of 60 seconds are :

- To move to the other end (Knockout section)
- Pick already placed weight from the cooled mould box.
- Move back to original position.
- Place the lifted weight correctly on the mould box.

Alternatives Proposed

To eliminate the problem different solutions were discussed, one of them was use of mechanism of one of the following types :

- Polar Configured mechanism[2] with conveyor in between.
- Jointed arm configured mechanism[2] with conveyor in between.
- Cartesian coordinate mechanism[1].

Polar Configured Mechanism with Conveyor in Between

Two robots are needed on either side of conveyor line as shown in Fig. 4. The robot will pick the weight over the box at the knockout line and place on the conveyor. The conveyor transfers the weight to the process line side, which will be picked up by the second robot and place it on the cope and drag assembly.

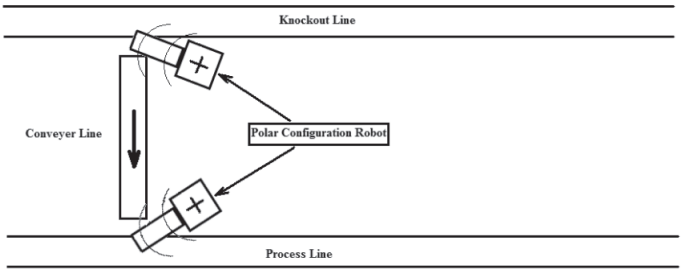

Fig. 4

Jointed Arm Configured Mechanism with Conveyor in Between

In this system, jointed arm robot will replace the polar coordinate robot and do the same activity as discussed above.

Cartesian Coordinate Mechanism

Cartesian coordinate mechanism as shown in Fig. 5 consists of movements in the X, Y, and Z axis. This is the most suitable for the current problem, due to its simple construction and easily fitted in the existing area. Also it did not require the additional conveyor system as in first two cases. The weight lifted by the lifting mechanism shall be transported to the other end.

Cartesian Robot

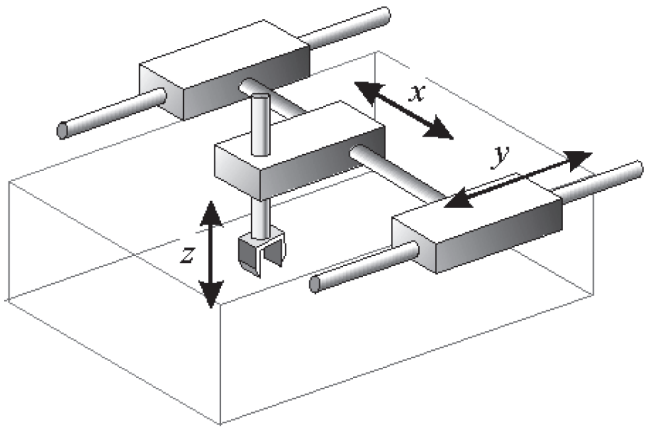

Fig. 5

Grippers

Handling of weights required use of appropriate grippers. Following types of grippers as end effectors were considered.

i) Magnetic ii) Fixed Jaws iii) Eye bolt with chain slings (Fig.6) iv) Positive gripping.

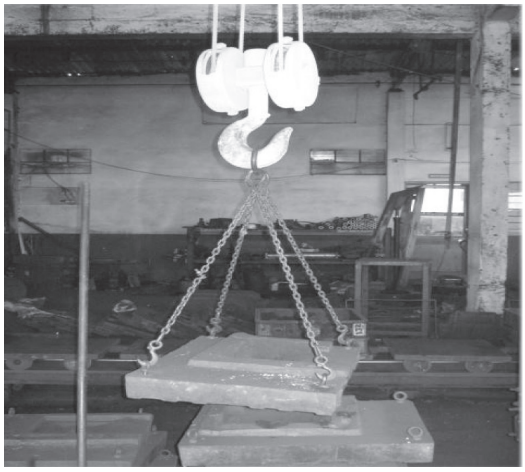

Fig. 6

Problem Solution

The final alternative proposed as the solution to the problem consisted of a pick and place Cartesian coordinate mechanism (Fig. 7) that will lift the weight from cooled cope and drag assembly near knockout section and transfer the weight to the other process line and place the weight on the cope and drag assembly before pouring. Following activities were carried out

- Design of lifting and weight transfer mechanism.
- Design of framework for above mechanism.
- Manufacturing of the above mechanisms and framework.
- Trials using a single worker.

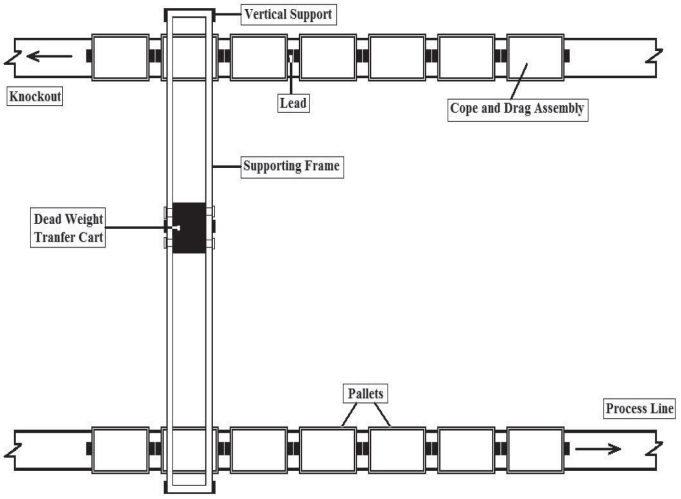

Fig. 7

Design of Lifting and Transfer Mechanism

The mechanism required to do activities like

- Lifting, holding and release of weight.
- Moving of weight from one end to another.

The total assembly (Fig.8) consisted of cart mounted on the framework, plate suspended from the cart with jaw attachment for holding/release of weight, motor with chain wheel drive for movement of the entire assembly from one end to other.

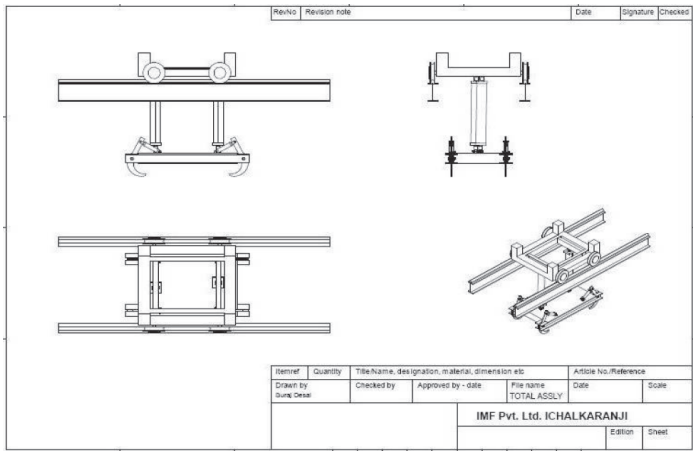

Fig. 8

Design of Framework

Framework consisted of two I beams on which the cart would move, which was supported by four columns at either end. The height was so selected that weight is lifted through a sufficient distance and is not at a large height which could cause damage to property/ human being in case of accident or failure of pneumatic mechanism.

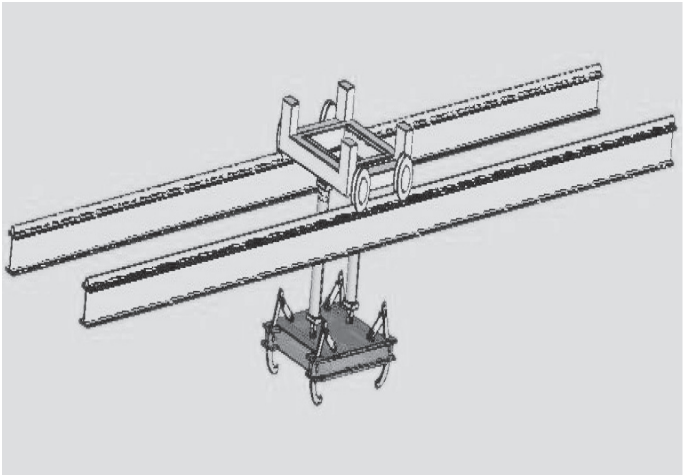

Fig. 9

Manufacturing

The total material and manufacturing cost was Rs.1,03,480. This excludes the cost of the weight.

Working of the Mechanism

The mechanism starts with lifting of the weight from the pallet at the knockout section by using the jaw attachment. The jaws slide into the slots prepared on the four corners of the weight. The lifting mechanism then lifts the weight and the cart starts moving and transfers the weight to the other process line (Pouring section). Once it reaches its destination, the weight is lowered and the jaws are disengaged from the weight. The cart again moves to the knockout section to lift the next weight and the working continues.

Features

The features of the solution proposed are as below.

Weight

A special weight was designed which would satisfy a number of requirements of the foundry.

- It has a rectangular shape (640x560x90)mm which would ensure uniform distribution of load over the box (Fig. b).
- It has a rectangular cavity in the central portion for pouring. This facilitates placing of the weight on the assembly even before pouring. As pouring can be done through this cavity. The location and dimension are such that it can accommodate all possible changes in location of sprue. Slope is provided around the cavity to allow easy pouring of metal (Fig. a, Fig. b, Fig. d).
- The weight has a number of pads below which helps the weight to rest on the pads and maintaining cavity between bottom portion of weight and box, thus ensuring easy passage of flue gases to the atmosphere (Fig. a, Fig. c).
- Four slots of 50mm height on the two opposite side walls for holding the weight (Fig. c).

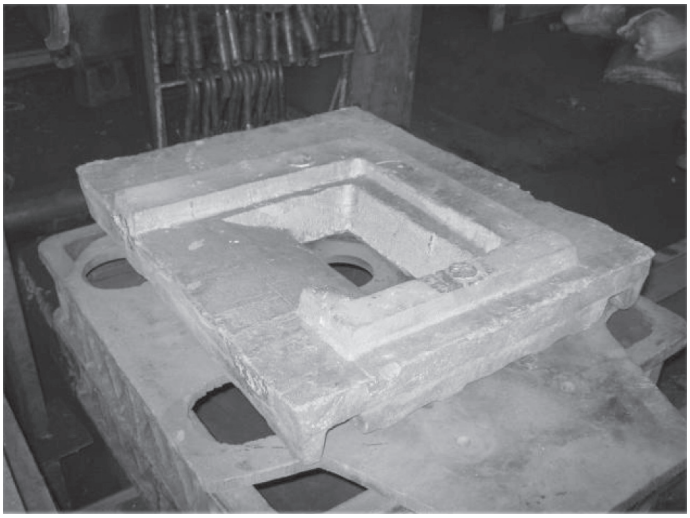

Fig. b (IsoMetric View)

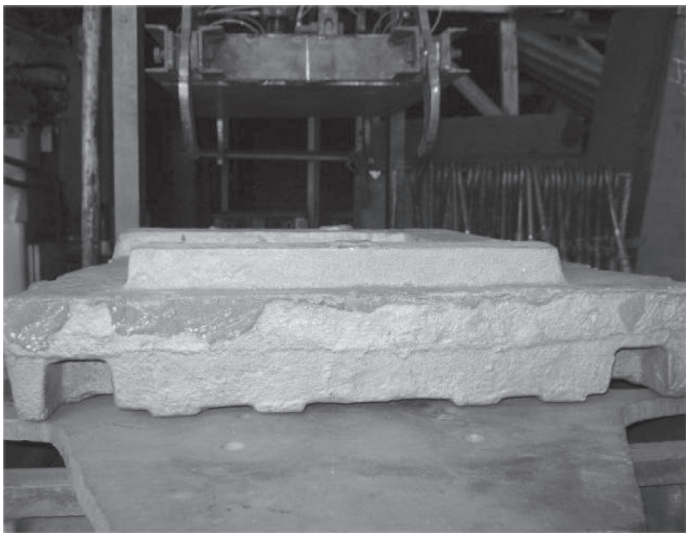

Fig. c (Side View)

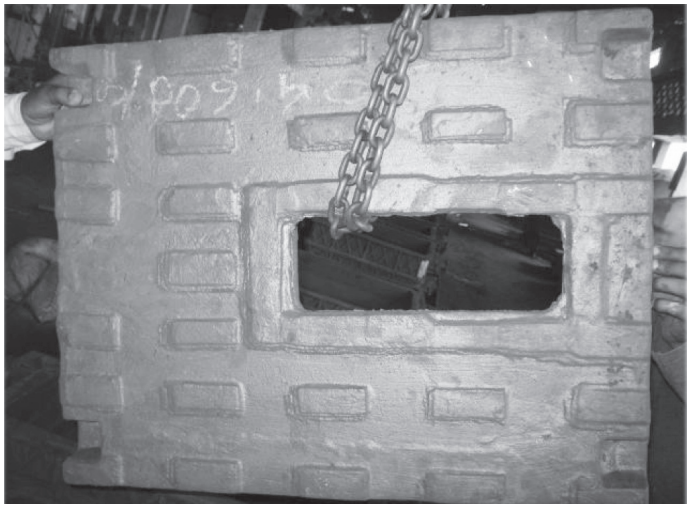

Fig. a (Bottom View)

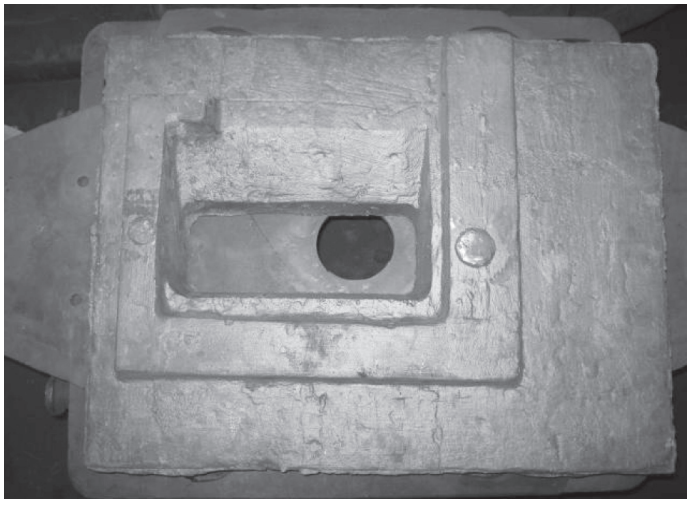

Fig. d (Top View)

Conclusion

The mechanism replaces the manual placing of weights over the mould box which eliminates all the problems related to manual placing of weights. The molten metal loss was reduced by 2 kg. per box. Fettling cost was reduced to a negligible. Reduction in labour overheads (from five persons to single person) increases the productivity of the foundry. The return on investment is in four months. This is an important step towards foundry automation.

Acknowledgement

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