

DEVELOPMENT OF THE AUTOMATIC REINFORCING STEEL PLACING ROBOT

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ABSTRACT

The work of placing the reinforcing steel had been carried out manually in the past because automation of this process was extremely difficult. We have developed an automatic reinforcing steel placing robot this time.

The objectives of this robot are elimination of labor and increase in work efficiency. These objectives have been practically realized by tests. The results are introduced in this report.

1. Introduction

With escalating labor shortage in the construction industry because of the aging of workers and the hard labor involved in reinforcing steel placing operations, the employment of skilled workers has become a major problem. This problem is more pronounced in this industry than any other.

The demand for a solution to these problems by automation and robotization of reinforcing steel placing operations has become more urgent now than in the past. The mechanization or robotization of reinforcing steel operations was a very difficult process because of the special characteristics of the work. Dependence on manual laborers was unavoidable.

This report describes a reinforcing steel placing robot that places the reinforcing steel directly and automatically at the installation position.

2. Outline of the equipment

2.1 Configuration of the equipment

The equipment consists of a gantry type support frame that travels on rails installed on both sides of the box culvert, and an automatic feeder. Fig. 1 shows the general arrangement of the equipment. Photograph 1 shows the overall view of the equipment.

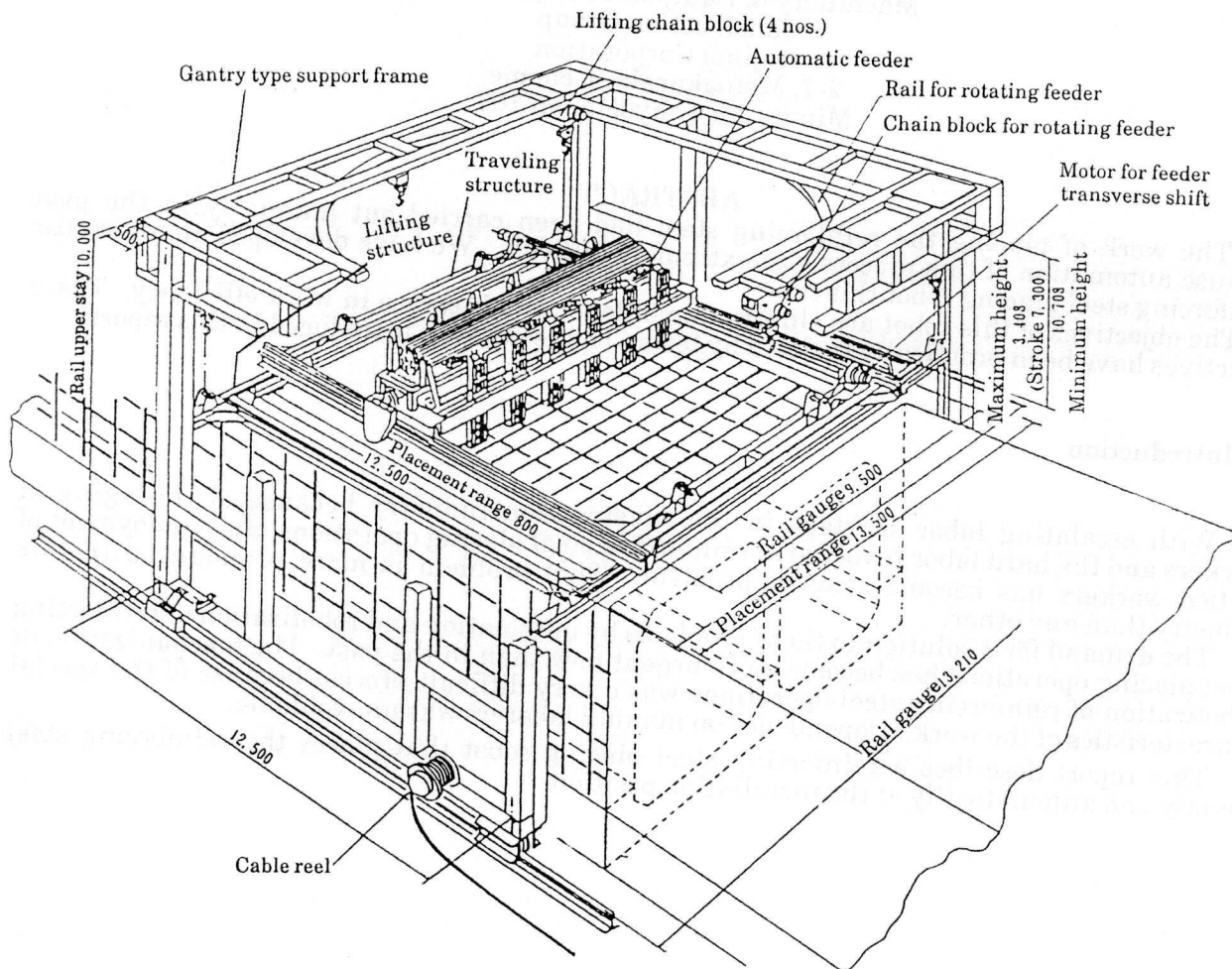
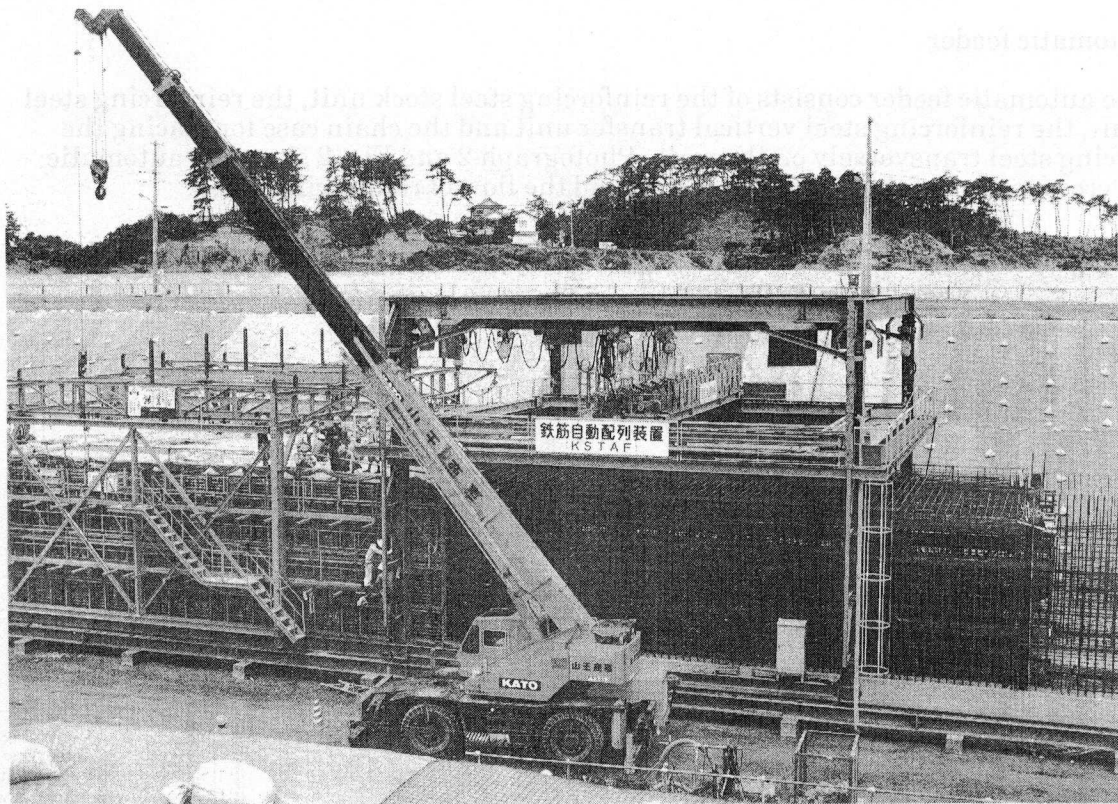


Fig.1 General arrangement of the automatic reinforcing steel placing equipment



Photograph 1. Overall view of automatic reinforcing steel placing equipment

(1) Gantry type support frame

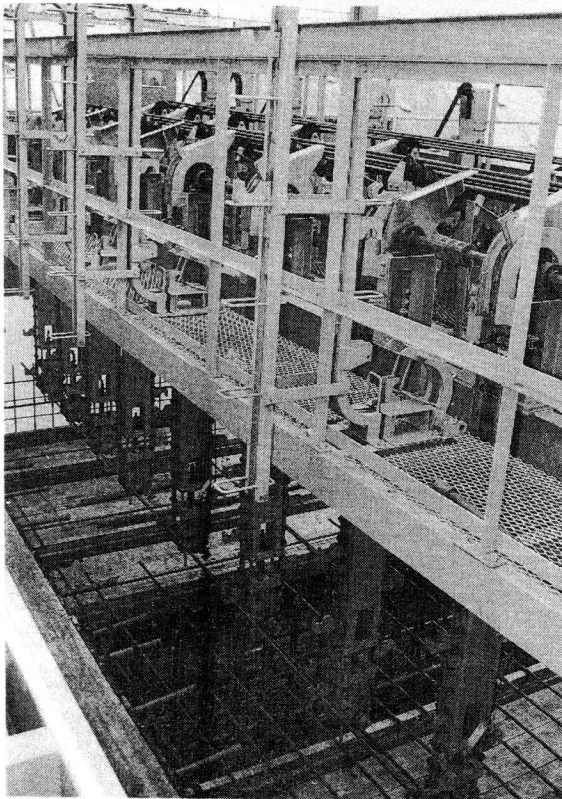
The lifting crossbeam structure in the gantry type support frame can be freely suspended by the lifting chain blocks installed at the four corners of the gantry type support frame. A traveling crossbeam structure is installed on the lifting crossbeams. The traveling crossbeam structure can be moved in the transverse direction means of the transverse shift motor. Furthermore, circular rails are installed on the top of the frame. The two pairs (4 nos.) of feeder rotation chain blocks installed on the rails can lift the traveling crossbeam structure, swivel it by 90 degrees, and set it on the lifting crossbeam structure.

The automatic feeder can travel on rails laid on both sides of the traveling crossbeam structure. It is operated by the travel motor.

A proximity switch for detecting the position is installed on the left side of the automatic feeder. Several proximity switch fittings are installed at a specific pitch on one side of the other traveling crossbeam.

(2) Automatic feeder

The automatic feeder consists of the reinforcing steel stock unit, the reinforcing steel feed unit, the reinforcing steel vertical transfer unit and the chain case for placing the reinforcing steel transversely on the wall. Photograph 2 and Fig. 2 show the automatic feeder, cross section of the automatic feeder and the flow of reinforcing steel.



Photograph 2. Automatic feeder

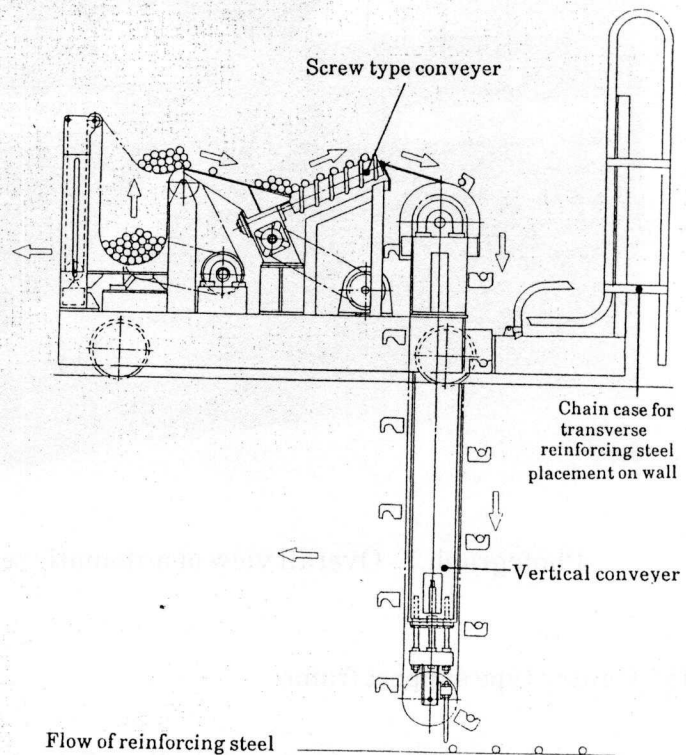


Fig. 2 Cross section of automatic feeder and flow of reinforcing steel

Sprockets and drive unit are installed in the reinforcing steel stock unit. The reinforcing steel is stocked on the chain. The sprockets and the drive unit stretch the chain from a slack to a taut condition and feed the reinforcing steel to the feed unit. The reinforcing steel feed unit has a screw type conveyer, drive equipment and a stopper plate for preventing displacement of the reinforcing steel.

The reinforcing steel feed unit receives the steel from the stock unit and feeds it to the vertical transfer unit.

A vertical conveyer and drive equipment are installed in the reinforcing steel vertical transfer unit.

This conveyer has various fittings for storing the reinforcing steel fed from the screw type conveyer. A bar for unloading the reinforcing steel retained by the fittings is also installed in this unit.

The chain case for placing the reinforcing steel transversely on the wall, has fittings for receiving the reinforcing steel. These fittings are used for placing the reinforcing steel on the wall. It also has several chain covers. Fig. 3 shows the screw type conveyer.

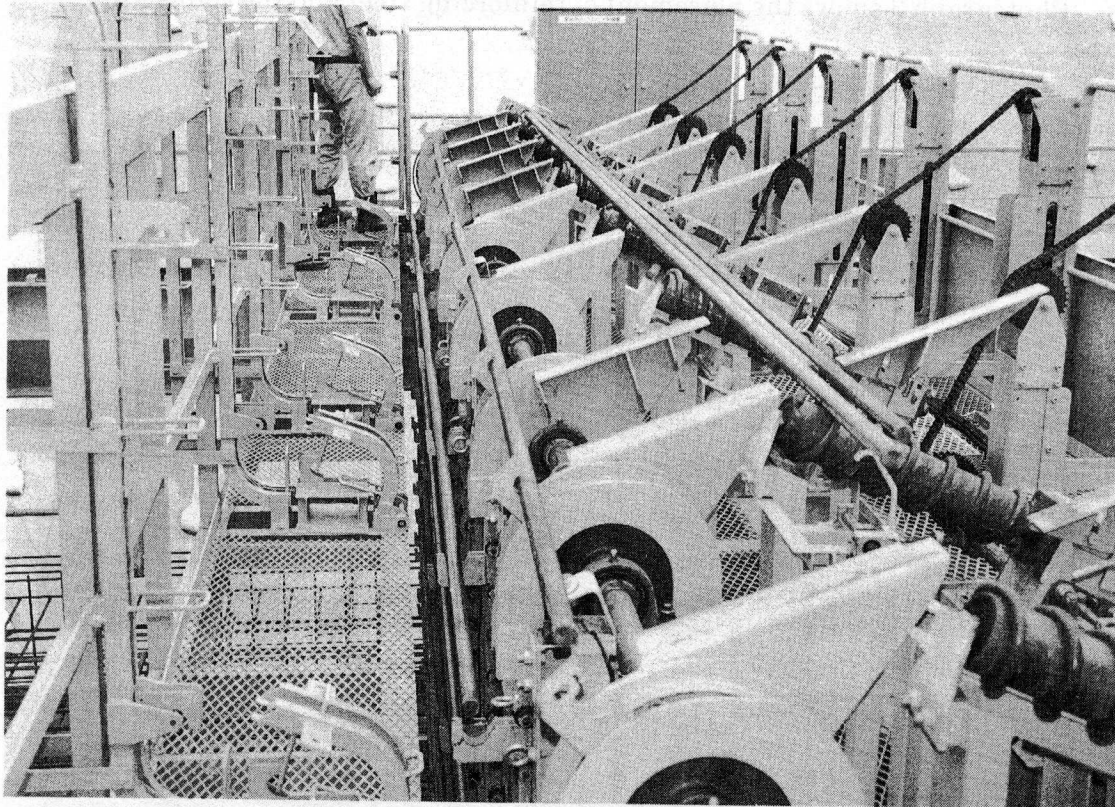


Fig. 3 Screw type conveyer

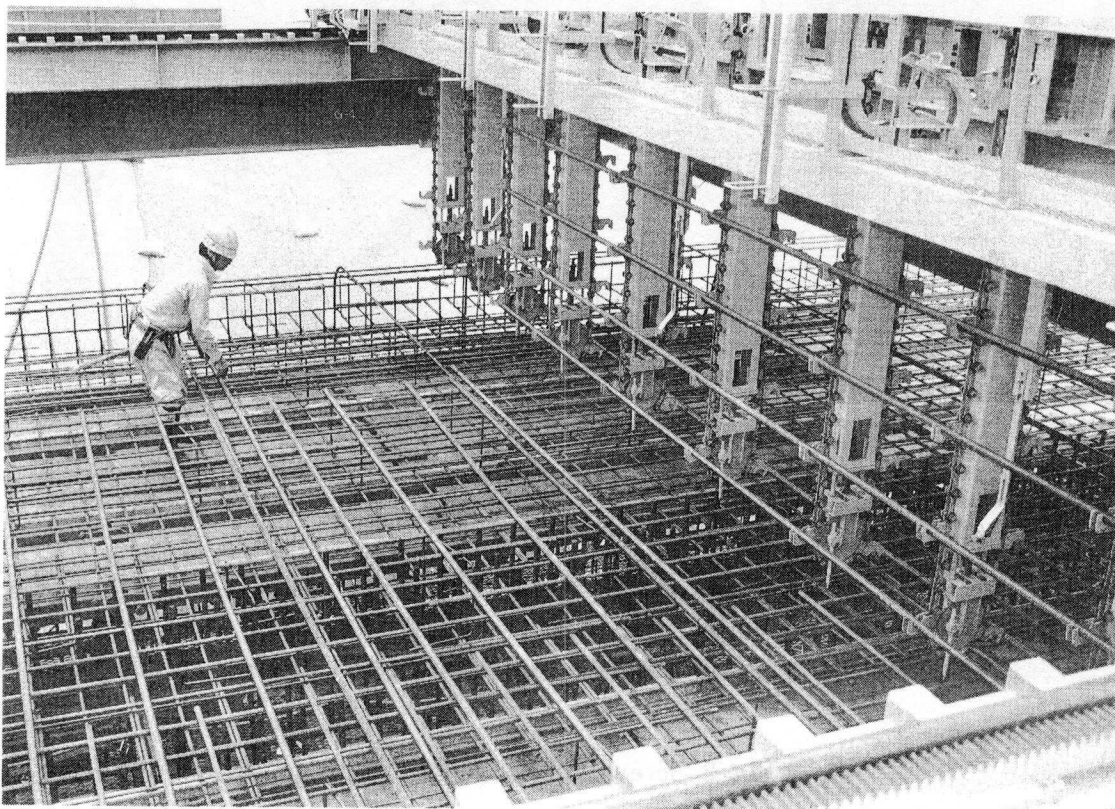
2.2 Placing operation

The gantry type support frame is set at the position where the reinforcing steel is to be placed. The lifting crossbeam structure is set the required height. Then, the traveling crossbeam structure is shifted on the lifting crossbeam structure and set at the required position. Next, the reinforcing steel necessary for the operation is placed on the loose chain of the reinforcing steel stock unit in the automatic feeder.

The feeder is set at the start position for placing the reinforcing steel and the start switch is turned on. The chain becomes taut and it transfers the reinforcing steel to the screw type conveyer. The conveyer feeds the reinforcing steel and sets the steel on the receiving fittings of the vertical conveyer.

The vertical conveyer operates, transfers the steel below, by the reinforcing steel unloading bar and places it at the required position. After the placement, the automatic feeder travels the required distance and stops. This process is repeated in the same way and the reinforcing steel is placed. After the longitudinal reinforcing steel is placed, the traveling crossbeam structure swivels by 90 degrees and places the reinforcing steel transversely, by a similar procedure.

Also, the transverse reinforcing steel for the wall is placed in a bamboo screen shape at the required position when the vertical conveyer chain connects with the chain stored separately in the case. Photograph 3 shows the placement of reinforcing steel and the connecting operation.



Photograph 3. Reinforcing steel placement and connecting operation

3. Equipment specifications

The main particulars of the equipment are given below.

- * Gantry type support frame Width 13.2 m x length 12.5 m x height 10.3 m Rail travel system - power 17 kW
- * Automatic feeder Width 3.0 m x 10.0 m x height 4.0 m Power 5.5 kW
- * Reinforcing steel used D13 - D32 length (max.) 9,000 mm
- * Placing time per steel rod 8 to 10 seconds
- * Placing accuracy ± 50 mm

4. Characteristics of the equipment

- 1) 1/3rd the manual labor can be eliminated.
- 2) The equipment can be directly installed at the reinforcing steel assembly site.
- 3) Placement of transverse steel on walls is possible in addition to placement of slab meshes.
- 4) There is a significant labor elimination by introducing the automatic feeder in the prefabrication process line.

5. Conclusion

This equipment has been used in the assembly of large reinforced steel channel of the concrete box type in a thermal power station. Its operation has been tested on site and recognized as efficient.

In future, we will aim for systematization by combining this equipment with the reinforcing steel connecting machine, to realize further automation in reinforcing steel operations. Introduction of this equipment in various types of constructions, especially in caisson construction, nuclear reactor construction and bulkhead construction, is anticipated.