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The manipulator to turns raw land into building lots

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ABSTRACT

The construction industry has been confronted with both a stagnation of productivity, and an increase in the number of accidents, as the age of skilled labors increases and their number decreases.

In today's booming construction market, these problems have become readily apparent at urban renewal and housing subdivision construction sites.

At many of these construction sites, heavy prefabricated concrete materials such as retaining wall blocks and underground pipes, are still conveyed and placed manually. Not only is this method slow, but it is also dangerous.

This is why we have developed, and are introducing, a machine that can quickly and efficiently perform a number of tasks, -including excavation, conveyance and placement of heavy prefabricated concrete materials and ready mixed concrete, transportation of ballast, and so on, -without having to change parts of the machine. Our new machine is called "The construction site manipulator that easily turns raw land into building lots".

We know this machine will increase our job site productivity and labor efficiency by quickly and safely laying prefabricated concrete pipes and placing prefabricated blocks.



Photo.-1 Operation scene of the manipulator

## 1. How it has been done (until now)

Concrete blocks that are used to construct subdivision retaining walls weigh 60 kg each.

Until now, to transport these blocks around a construction site, they have been manually loaded into the bucket of a power shovel, brought to where they will be placed and then once again unloaded and set in place by hand.

When workers handle these heavy blocks, often as many as 150 blocks a day, they will often injure their hands and/or backs, causing injury lost time days. And, especially, for older workers, this method of handling blocks can be an arduous and dangerous job.

To eliminate the need for this hard and costly work, "The manipulator" has been developed.

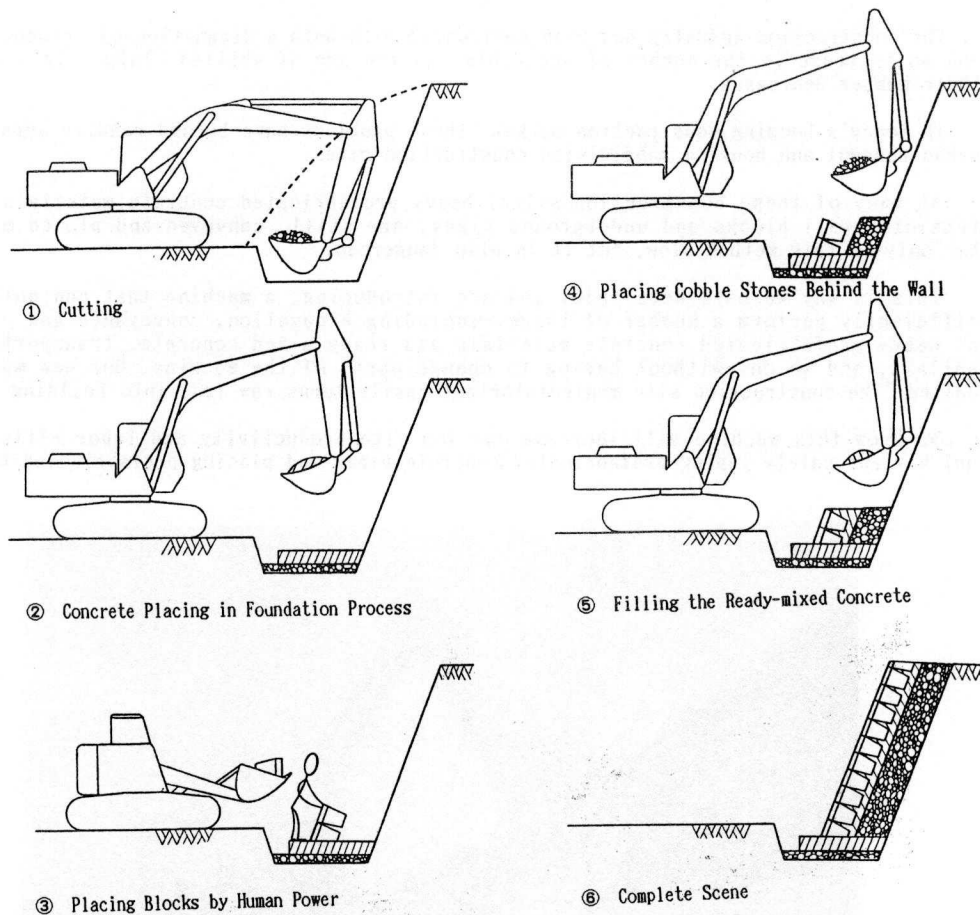


Fig.-1 Traditional way of retaining wall

## 2. Characteristic

2-1 Without having to change attachments, this machine can in rapid succession perform excavations, handle blocks and place ready mixed concrete.

2-2 The extendable slide arm and the grippers, which can be articulated 360° degrees, enables this machine to handle various job side tasks, and makes it easy to place blocks and concrete pipes in the designed location.

2-3 The pincer force of the lifting jaws can be regulated to 3 different strengths, so that the lifted items will not be damaged.

2-4 For special masonry operations, the bucket can be easily removed. When utilizing the bucket for excavation, the pincer jaws can similarly be easily removed and stored.

2-5 This machine possesses a materials-transport platform which enables it to transport materials to jobsite locations which delivery trucks can not reach. This platform can be articulated up and down so that materials can be smoothly transported without being toppled or damaged.

2-6 Because the bucket is self leveling, the machine is easy to operate and drive.

2-7 The machine can be operated by remote control, which enables safe operations, even in difficult jobsite circumstances.



Photo.-2 The scene of holding  
a prefabricated concrete block

### 3. Design

#### 3-1 Bucket

The bucket has a capacity of 0.45m<sup>3</sup>. It can be used for excavation, transshipment and placement of ready-mix concrete, and for the removal of rubble or cobble stones.

Because the bucket incorporates a hydraulic center joint system and can be articulated 360°, all sorts of configurations are possible for the placement of materials. On the back side of the bucket is a "gripper" system (pincer jaws). When the jaws are being used for continuous masonry placement, the bucket can be easily removed.

#### 3-2 gripper (pincer jaws)

The gripper which are mounted behind the bucket, can grasp materials with a width of up to 700 mm, and can lift up to 490kg of weight.

Because the maximum force of pincer jaws is 1800kg, the gripper can securely lift and transport material.

The gripper will also conform to the shape of the material, there by minimizing damage and insuring that the material will not be unintentionally dropped.

The gripper mechanism utilizes ball and socket construction that improves flexibility and enables it to carry even unusually shaped blocks (there is a stop mechanism that prevents unwanted rotation).

The gripper can be quickly stored in a compartment on the backside of the bucket, removing them as a hindrance when the bucket is used for excavating or placing concrete.

Reassembling the gripper is also easily accomplished.

#### 3-3 Bucket control (self leveling) mechanism

The bucket control mechanism employs a sensor which monitors the inclination of the bucket, and, by electronically governing the bucket hydraulic system, automatically maintains level positioning of the bucket.

Because of this regulating device, when the boom and/or machine is in motion, the bucket remains level and concrete can be transported without spillage.

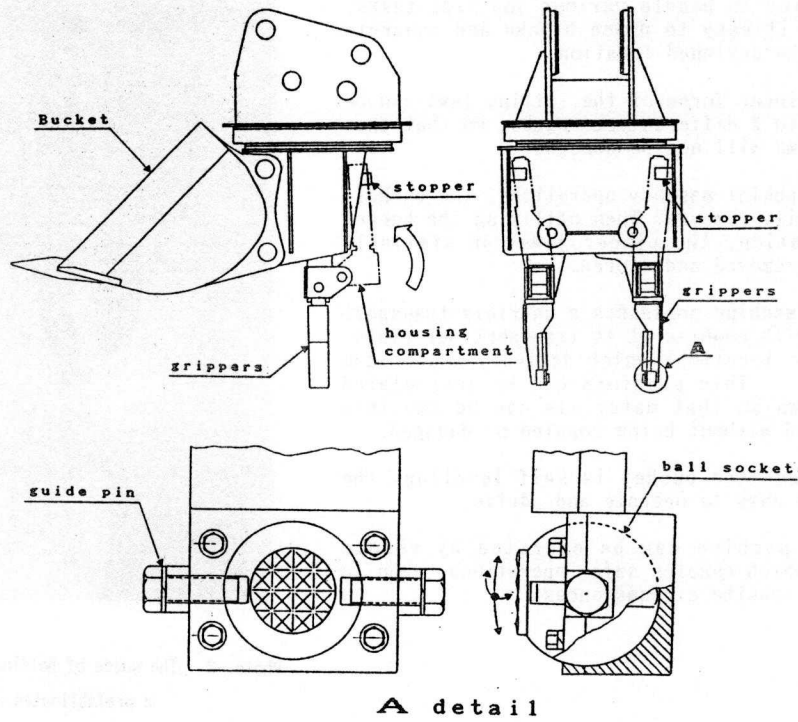


Fig.-2 Bucket and gripper

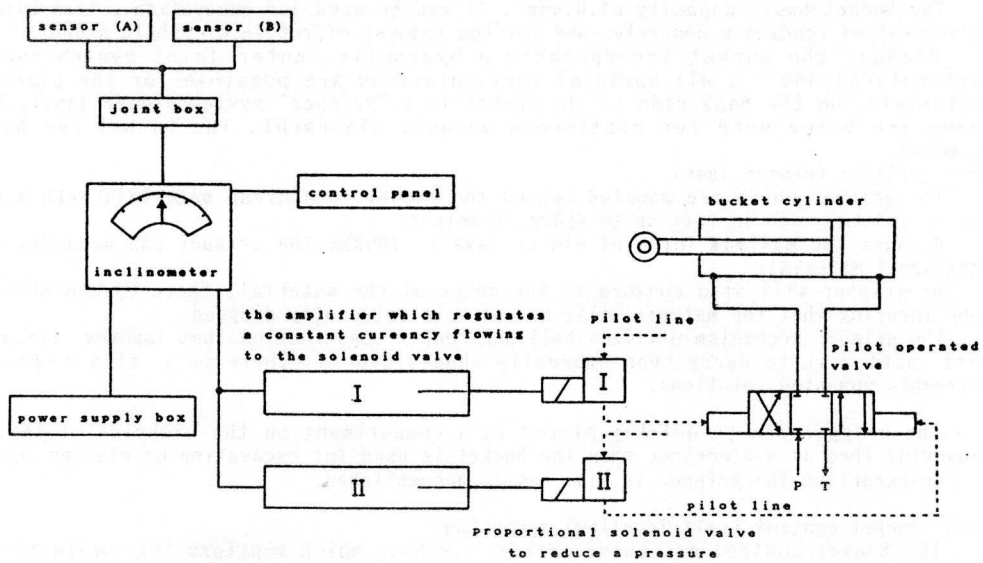


Fig.-3 Circuit of automatic levelling system

This system operates even when the main body of the machine is at an angle, so uneven terrain can be efficiently traversed, again without spillage.

### 3-4 Extention arm (boom)

The boom has an extendable distance of 1000mm, this allows a large operating range.

### 3-5 vessel

In front of the tractor is a vessel, or platform, which is capable of carrying 2 tons of materials.

The front edge of this platform can be raised or lowered by 20° degrees.

This enables the machine to overcome obstacles and to traverse uneven ground, without topping the materials being transported.

Also, the platform has a horizontal slide range of 900mm.

This function facilitates the movement and placement of materials, and makes the lifting of materials with the gripper easier.

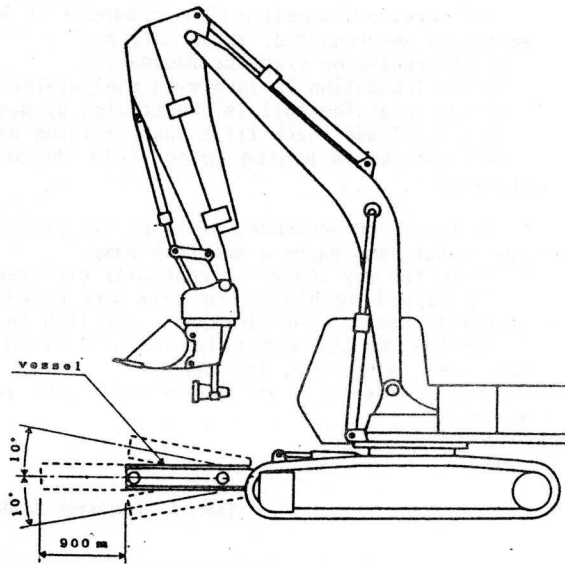


Fig.-4 Function of vessel

### 3-6 Remote operation

The construction manipulator is normally operated from the drivers seat inside of the tractor, however, remote operation is also possible.

The remote operation uses electronic controls that allows the operator to control the machine just as if he were in the drivers seat.

Remote control allows the operator to get a good perspective on delicate placements and also allows for safe operations in situations where the view from inside of the tractor is obscured.

### 3-7 Main body

The tractor of the manipulator is the EX200LC, manufactured by Hitachi Construction Machinery CO.,LTD.

This tractor is equipped with state of the art hydraulic and electronic controls which allows for effortless operation and reconfiguration of the machine.

This model is also quiet and energy efficient.

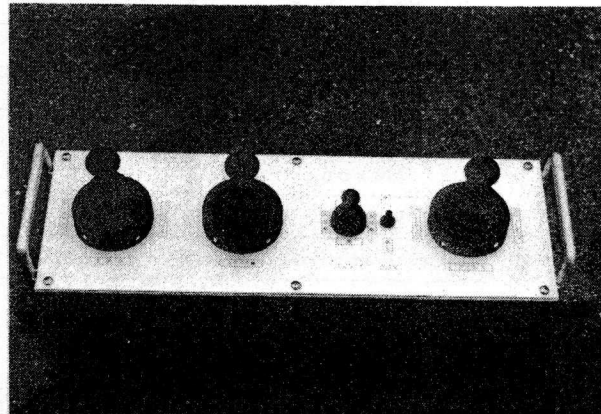
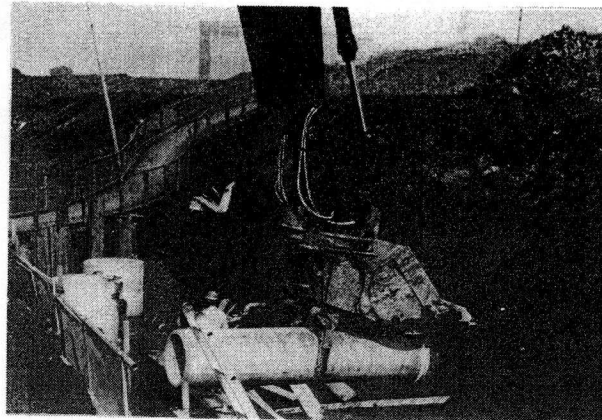


Photo.-3 Remote control box

Photo.-4 The scene of placing a prefabricated concrete pipe





4. The advantage in using the manipulator

The typical construction sequence in building a masonry retaining wall, and the machinery and required, is as follows;

- ① The excavator digs the foundation
- ② The foundation is laid with manipulator and an excavator or pay loader
- ③ The retaining wall is constructed by man power and pay loader
- ④ A pay loader back fills the retaining wall
- ⑤ Concrete is poured to complete the process. A pay loader and/or concrete pumps is required

In the above sequence, at least two pieces of equipment are necessary, an excavator, a pay loader, and maybe a concrete pump.

Also, the pay loader is generally utilized to transport masonry blocks to the site.

Transporting blocks in this way requires that they first be loaded into the pay loader by hand at the stockyard, and then be unloaded again by hand at the site.

Employing the manipulator will greatly stream line this process, saving time, machinery, man power, and money.

The following chart demonstrates the advantages in using the manipulator for this process.

Table-1 Comparison traditional method with new method

	until now	with the manipulator
Back hoe	1	0
Tractor shovel	1	0
Manipulator	0	1
Operator	2	1
Masonry	1	1
Worker	4	2
Completed amount of blocks par day	150	250

The above chart clearly shows that the manipulator saves resources and money.

Productivity will also be increased.

Compared to the traditional construction method, the manipulator is faster.

150 blocks can be placed in a day by the traditional method.

The manipulator method can place 250.

There are additional side benefits to the manipulator method.

The stream lined method requires less physical exertion, minimizing worker fatigue and increasing job site safety.

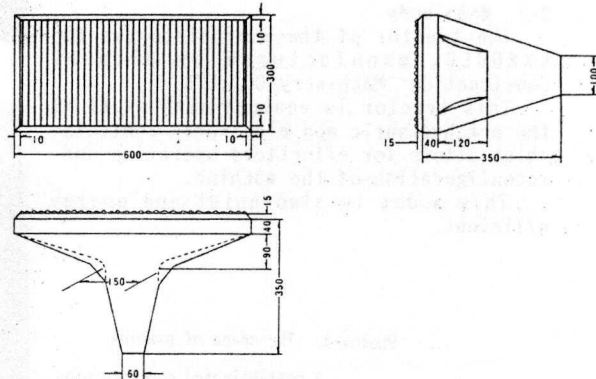


Fig.-5 Prefabricated concrete block(an example)

Table-2 Cycle of execution with the manipulator

work breakdown	AM					PM					total time	total quantity
	8	9	10	11	12	1	2	3	4	5		
placing blocks											141 min	250 pieces
placing cobble stones											40 min	6 m <sup>2</sup>
filling concrete											157 min	17 m <sup>2</sup>
washing bucket											18 min	
stand by											171 min	
folding grippers											10 min	
operator for a manipulator												
masonry												
workers												

5. A note of thanks

The development of this "Construction site manipulator" would not have been possible without the cooperation and earnest efforts of the Hitachi Construction machinery CO.,LTD.

Table-3 Technical data

**WORKING RANGES**

A	Max. digging reach	11300 mm
B	Max. cutting height	9570 mm
C	Max. digging depth	8140 mm

**DIMENSIONS**

D	Distance between tumblers	3350 mm
E	Undercarriage length	4350 mm
F	Rear-end swing radius	2760 mm
G	Rear-end length	2745 mm
H	Overall width of superstructure	2610 mm
I	Overall height of cab	2850 mm
J	Min. ground clearance	435 mm
K	Track gauge	2390 mm
L	Track shoe width	600 mm
M	Undercarriage width	2990 mm

N	Overall width	2990 mm
O	Track height	855 mm
P	Vessel end length	3830 mm
Q	Vessel stroke	900 mm
R	Extension arm stroke	1000 mm

### WEIGHT & ABILITY

Operating weight	21500 kg
Rated engine HP	92 kw
Bucket capacity	0.45 m <sup>3</sup>
Max. pincer force	1800 kg
Max. gripping width	700 mm
Vessel carrying capacity	2000 kg

