

CONSTRUCTION AUTOMATION AND ROBOTICS IN THE 21ST CENTURY

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Abstract: Construction automation and robotization effort was started in around 1980 as ISACR and IAARC promising great progress by promoted technologies in the 21st century.

Keywords: automation, robotics, construction, technologies

1. Introduction

The total scale of construction industry in Japan in recent years is ¥50 trillion and the industry employees about 6 million workers (10% of total working population). The Fig 1 shows the infrastructures of construction industry constructed cities and long bridge in Fig. 2.



Fig. 1 View of the modern city

Automatization and robotization of the industry was started in 1980's in Japan. The first ISARC was started in the United States in 1984. Then the symposia were held every year in many countries in turn. The International Association for Automation and Robotics in Construction (IAARC) was started in 1990, and the association has helped automatization and robotization of construction greatly. The Fig. 3 shows a shield machine, and the machine is now used for the construction of the capital city underground expressway.



Fig.2 View of the world longest bridge

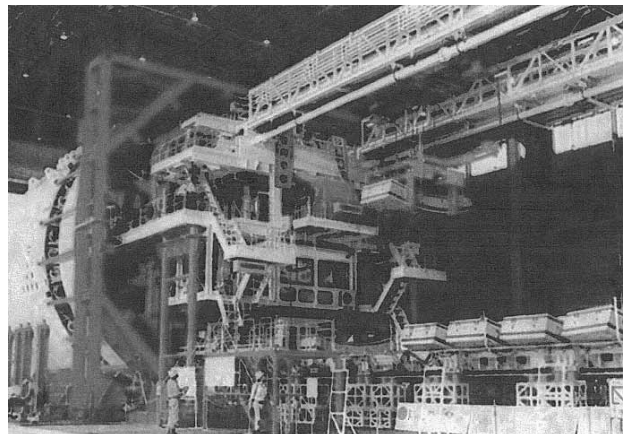


Fig.3 A shield machine used for constructing underground expressway

Fig.4 shows the concrete floor surface finishing robots. The robots are used in many building construction sites by many general contractors and released workers from 3K operations.

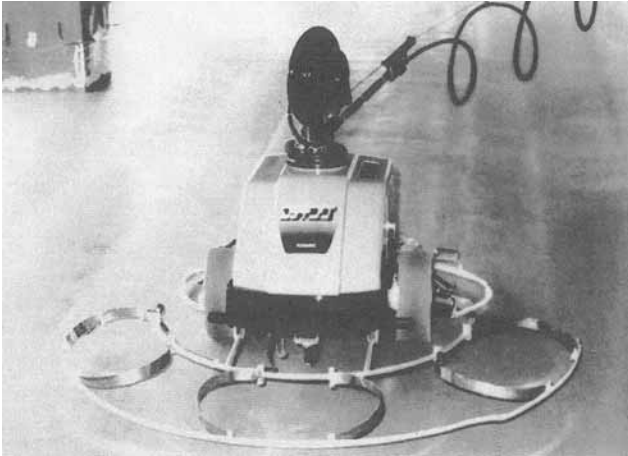


Fig.4 A floor concrete surface finishing robot (courtesy Kajima Corp.)

Fig. 5 shows a case of totally automated building construction systems. Several contractors are developing similar systems and development of the systems promoted easiness of robots introduction into the construction sites.

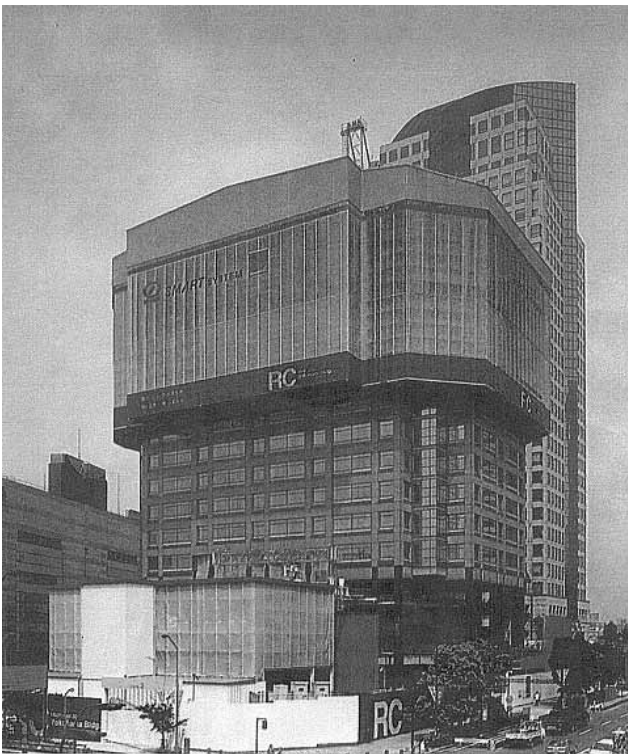


Fig.5 A totally automated building construction system (courtesy Shimizu Corp.)

Generally speaking, the introduction of robots into construction sites are farther behind than the case of manufacturing industry. In the case of construction industry, construction sites move

each time, building structure members are big heavy and, the most operations are done outdoors. By such a reason automatization and robotization in construction industry is farther behind than in manufacturing industry. Fig. 6 shows the comparison of labor productivity in both industries. You can see productivity of the construction industry is lower than that of manufacturing industry.

In 2007 in Japan it is anticipated that many working forces will retire from construction industry and the labor shortage is forecasted. That is a big promotion necessity of automatization and robotization in constructing industry. We shall have to promote those activities earnestly under international co-operation. In 21st century, fortunately, we shall have the following man-supporting new technologies which will assist our efforts.

1) CT (Construction Technologies)

Previously all fabrications of the building members were done in the construction site and automatization of those operations were difficult. We decided to introduce innovative methods. We develop a new on-site factory, and fabricate all building members automatically by using automated machines and robots. Assembly operations of the building structures are automatically conducted by using different type of robots. Also infill systems are introduced.

At the beginning stage of the building construction, the fundamental beams and pillars and structures are constructed on the construction site. And the infill unit for the interior structures is standardized as on-site factory made and inserted into the fundamental structures. At the next renewal opportunity another newly and automatically manufactured infill unit is inserted.

2) RT (Robot Technology)

It has enough capacity which handles big and heavy building structure members, and intelligence to do complicated operations easily. The robot body must have less weight as it easily escapes from the working place when it is not used.

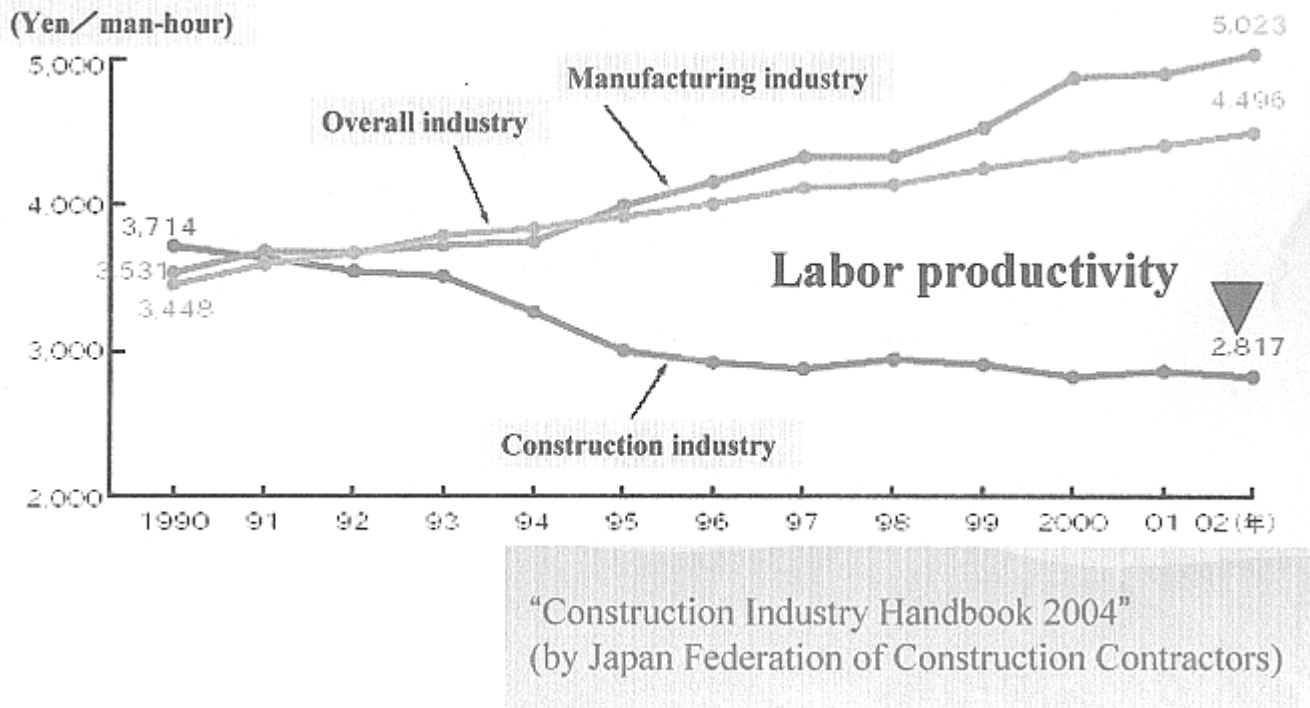


Fig.6 Labor productivity comparison of construction and manufacturing industry

3) IT (Intelligent Technology)

Innovation of ubiquitous type computer releases the people who work at the construction sites. By using portable phone with camera managers can easily collect information in each site and give appropriate orders on time. In the past, separated locations of construction sites were serious hazard to avoid timely management in separated places. Today each hazard becomes not serious problem by introducing advanced information technologies.

Also those technologies are going to decrease the information handling noise. For instance, by the introduction of micro tips for avoiding gaps between actual building structures and their information additional measurement of distances is done by using larger beams, and the location information is obtained by applying GPS system. By applying those systems we can make easier construction robot driving operation.

4) MT (Management Technology)

For utilizing robot systems the storage of many types of robot is necessary. Such as transportation of robots among storage areas and

construction sites. Robot lease systems or robot and operators lease systems have to be developed. With introducing robots into construction industry the development of new construction management system must be very important.

Conclusion

At the present time, the productivity of construction industry is not good enough as advanced manufacturing industry. Even though by utilizing new technologies we can raise the productivity of the industry in the new century.

Fig.7 shows the trend of relationship between those of construction related technologies progress and labor productivity increment

Also we can solve the serious 3S problems of the construction industry. To do so the construction industry will become more and more attractive in the future by our international co-operation.

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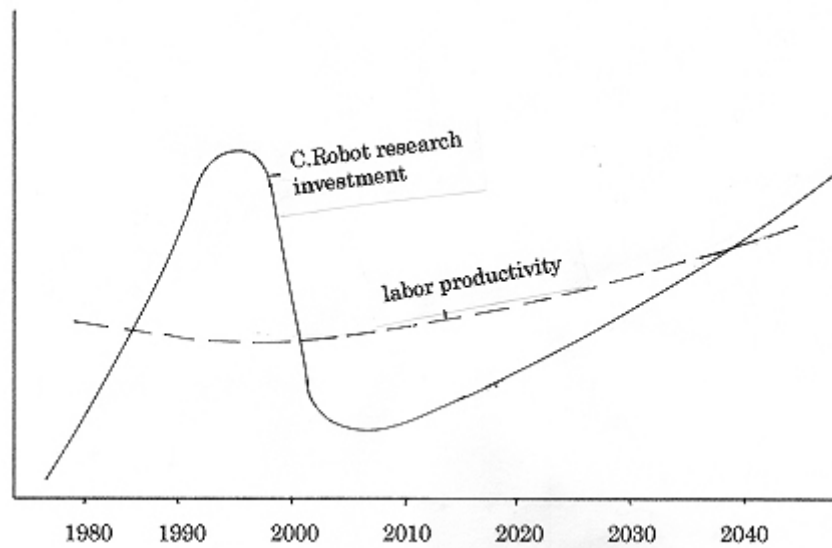


Fig. 7 The trend of relationship between C.Robot research investment and labor productivity