ROBOTS IN THE SWEDISH CONSTRUCTION INDUSTRY

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ABSTRACT

This article describes a number of robots used in the Swedish construction industry. The robot concept is considered in a broad sense. Present robots are used for tunnel drilling, demolishing concrete, load carrying, concrete grinding and floor cleaning. There are not many robots at present in the Swedish construction industry depending primarily upon a small market, variable sites and changeable weather conditions. Some Swedish research reports have been published, and research programs have been undertaken.

Definitions

The robot concept is defined differently and means different things to different people, i.e., there are at present various definitions of the concept. The definitions also vary in different countries and they change with time. For example, the American definition of robots is in a way much narrower than the Japanese. In this article, the robot concept is considered in broader terms, i.e., close to the Japanese definitions. As such, robots are here classified in the following four levels:

1. Manual Manipulators - which perform fixed or pre-determined work sequences. These include even remote controlled machines which are sometimes called low level robots, as they often constitute a preliminary stage to fully developed robots, but often offered for sale as robots.

2. Playback robots - which repeat fixed instructions.

3. Numerically controlled robots - which perform works or duties through numerically recorded information or data.

4. Intelligent robots - which perform given works or duties by using "their own experience".

Robots in the Swedish Construction Industry to-day.

Except in the construction industry, there are at present many robots being used in Swedish industries, such as those used by Volvo in car manufacturing/production. ASEA and Atlas Copco are examples of firms or companies which have developed various robots for manufacturing and construction. The Swedish construction industry utilizes robots which have been developed both domestically and abroad. As an example, Silent-Piler is a Japanese developed remote controlled piler-machine which is now used for rehabilitation works at the Central Station in Stockholm. In the following presentation, only robots developed by and for the Swedish construction industry are analysed.

Following is a list of some robots used on construction sites:

1. FORO: Tunnel drilling technique with a FORO drilling machine developed by Atlas Copco.

   This drilling technique allows continuous drilling without loss of time otherwise needed for re-fixing or re-adjusting the grippers. The conventional tunnel drilling methods require about five minutes to do the above adjustments. The whole equipment or complex is approximately 150 m long and is capable of drilling tunnels with diameters in the range 2.1 m to 10.0 m. Secondly, there is ample space behind the machine to allow for rock bolting, erection of steel frames/archs, etc. The machine or complex is capable of drilling about 20 m per day. It takes only two days to complete or perform a piece of work that would otherwise take one week by using traditional methods.

2. BROKK 80/BROKK 100/BROKK 250.

   This is a remote controlled robot developed by Atlas Copco. It is used for demolishing concrete and other construction structures. The robot has small dimensions which facilitates its utilization in narrow or congested working sites or areas. It is capable of passing through 80 cm door openings and can climb and descend staircases. The robot is available in three models: BROKK 80, BROKK 100 and BROKK 250.

3. DEMEC 520.

   A remote controlled robot used for demolishing purposes, and developed by Diamantex AB. The robot is specifically designed for demolishing works and has a maximum operational range of 5200 mm. The robot can also be equipped with a bucket/digger or it can function as a simple mobile crane.

4. HANDY CRUSHER.

   A hydraulic cutting or shearing tool developed by Svenska Handycrusher. This tool is available in four series or models, and is used mainly for quiet and dust and/or vibration free demolition of concrete walls, etc with a maximum thickness of up to 350 mm. Handy Crusher is remote controlled, and may be used on suitable carriers such as BROKK and DEMEC.

5. LARVEN.

   A load carrier manufactured by Svets Mekano AB in Växjö. Larven is a remote controlled handdriven load carrier. It is capable of mounting stairs and can work in narrow spaces. The utilization of Larven minimizes risks connected with back and squeeze injuries. The machine is 131 cm long, 66 cm wide and 37 cm high. The maximum loading capacity is 800 kg; and for a 45 degree gradient 500 kg. The robot is available in three versions with different engine capacities.

6. LASER CONTROLLED ROTOR MACHINE.

   This robot is used for concrete levelling and was developed by Leif Johansson, ABV and Chalmers Industri Teknik (CIT). The machine was developed in order to avoid heavy and stressful operations or works during concreting of slabs and archs or roofs. The utilization of this robot minimizes the need or necessity of having several concreters for laying out and adjusting concrete forms, controlling concrete supply, vibrating, pulling vibration equipment, etc. Up to now only a prototype has been made.

7. ELECTROLUX EUROCLEAN CLEANER ROBOT AXV-01

This robot is developed by Electrolux AB in co-operation with a Japanese company. Essentially, this is a vacuum cleaner which navigates with the help of ultra-sound sensors. The robot is driven by batteries and works three to four times quicker than a labourer.

8. AUTOMATIC MIXER.

This machine is used for bricklaying. It was developed by BELAB and ABS, Stockholm. The mixer can be considered as one part of the future automatization of the bricklaying process. The mixers add water automatically and mix the aggregates to a pre-determined mortar consistency. The capacity of the machine is about forty (40) litres per minute. Theoretically, such a system is capable of supplying up to 40 bricklayers with mortar.

Robots are also used for manufacturing building materials. Thus, there are robots designed for painting bath tubs, an operation which resembles those found in the manufacturing and processing industries. Further, the manufacture of small houses has been rationalized by utilizing CAD/CAM techniques, specifically developed by Myresjöhus AB, Vetlanda, and Nordisk Kartro AB, Farsta. The manufacture of wall elements is extremely automatized.

Why not more robots?

As it is apparent from the above presentation, there are very few robots being utilized in the Swedish construction industry even though a broad definition of the concept has been adopted. One wonders why?

Many reasons can be given and they ought to be of common or general character for the construction industry all over the world. With regard to Sweden, it can be said that the market is quite small. Among the technical problems, one can attribute to the fact that construction sites are quite different and that they keep on changing during the construction period. The repetition of work operations can at times be very limited. Construction sites are often very narrow and congested, and the weather or climatic conditions change often. Many of these problems contribute to the fact that interest for robots in the Swedish construction industry is mainly focused on multi-functional robots, which can be used for different kinds of operations.

Apart from the technical problems involved in the development of robots, there are as well economic constraints to be considered. First of all, this concerns profitability. Secondly, robots can even cause material damages which lead to serious economical consequences. The introduction of robots can even bring about social problems, such as when labourers are reorganized and new work operations are introduced.

However, reorganization and new work operations can even be regarded positively. The purpose of introducing robots is definitely to achieve improvements in work operations. What is anticipated within the Swedish industry by introducing robots, is to mitigate the number of dangerous, unhealthy and monotonous or repetitive work operations. Secondly, the aim is to reduce production costs, achieve higher product quality and increased productivity.

Actual research.

This year a report from the Swedish Council for Building Research (Byggforskningen, BFR) has been published which gives a review of the international development of robots for the construction industry. The report is based on

studies in Japan and USA. It also describes the demands for robots, applications and requirements. A limited inquiry showed that spray-painting, grinding and puttying were the most interesting jobs for automatization. It was found important to adapt design work to prefabricated construction to make it possible to transport and assemble with robots. Thus there is a clear relation between CAD and robotics.

Another research project, still running, was initiated by Swedish contractors (FoU Väst, which is a union of eight contractors belonging to the Swedish Construction Federation. Project leader is Platzer Bygg AB) and financed by the Development Fund of the Swedish Construction Industry (SBUF). The project is to some part described in a report from the Department of Building Economics and Construction Management at Chalmers University of Technology (2). The research project aims primarily at examining or analysing which type of construction works that ought to be changed. Several interviews have been conducted. Cleaning, concrete pouring, bricklaying and hacking operations are regarded/considered as works which ought to be changed. From these observations, it is intended in the project to identify which type of works can possibly be robotized. But all factors have not yet been considered, such as ergonomic, sanitary and economic factors. Therefore, more investigations are being done in order to define the most suitable applications. The project will contribute in a prolongation to the development of different prototypes of robots. What is required of a robot is as follows:

- reliability
- rapid and effective service to be able to use it effectively
- ability to perform several different tasks
- simplicity to use with other programs
- simplicity to use by people on the site
- playback function

Much research in Sweden has been devoted to those stages of the construction process that come before the production of an object. Beside research in the field of CAD (Computer Aided Design) we have worked with AMA (General Material and Work Description) and in connection with that Production Adapted Quantity Surveying (3). This research seems to be an important step forward to make it easier and of greater importance to robotize the production.

A program on robot research has been proposed by the Department of Building Economics and Organization at the Royal Institute of Technology, Stockholm. The goal of the project is to develop a mobile multi-functional robot, to develop and adapt materials and handling of materials to the robot and to improve the labourer's conditions with at least the same quality of the product as without utilizing any robot.

References

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