Semester : **II**

Course : **Introduction to civil engineering**

Course Instructor : **Aryada Deshpande**

Note: In addition to this handout students must refer to textbooks and reference books as suggested.

UNIT 2

AUTOMATION AND ROBOTICS IN CONSTRUCTION

INTRODUCTION

What is automation?

Automation can be explained as a process to create, control and monitor the applications of technology. It is the process of handling the operation of equipment such as processors, machinery, and many applications with minimum human efforts. The use or the introduction of automatic equipment's or other process or facilities in construction is called as automation in construction industry. These technological advances enable construction firms to perform increasingly complex tasks with minimal difficulties.

Construction is a part of infrastructure, which is essential to promote growth in the economy. India is one of the fastest growing economies in the world.
The scope for infrastructure industry is enormous as the Indian industry has been witnessing large growth. Thus, the effective use of automation is one of the greatest opportunities.

Need for automation in construction

1. It increases labour productivity and reduces labour cost.
2. It also mitigates the effects of labour shortages.
3. It reduces or eliminates routine manual and clerical tasks.
4. It helps in improving worker safety and efficiency.
5. It gives a better product quality and reduced manufacturing lead time.
6. Processes that cannot be done manually are accomplished using automation and robots.

7. Automating construction process is necessary in order to reduce production times.
8. With automation, dangerous work can be avoided for manual labour.
9. It does the work, people cannot do easily, and increases the performance.
10. Automation gives quality construction.
11. With automation the measurement are more accurate ;the weighing and proportion of mixing ingredients is better.
12. Since India has second largest manpower in the world, automation is not replacements of human power but is an important supplement that caters to the need of mega construction and fast-track construction.
13. The problems associated with constructed work such as decreasing quality of work, labour shortages, etc. Can be overcome by new innovative technologies such as automation which has the potential to improve the quality, safety, productivity of the construction industry.
14. The importance of implementing automation technologies is the need of today's infrastructure project and construction firms in order to increase the productivity and good quality of work.

Advantages of automation in construction

- Helps to improve efficiency of work and increases productivity.
- There is improved safety and remote access to data.
- It reduces the time required for construction.
- The possibility of human error is reduced that is accuracy of work is increased.
- Heavy work can be completed satisfactorily within the stipulated time, resulting in greater control and consistency of product quality.
- There is uniformity in quality product and high volume production.
- It enhances work environment because workers will be distanced from uncomfortable work position.

Disadvantages of automation

- There is less versatility and more pollution
- The initial investment is high
- Increase in unemployment will be seen due to less workman necessarily.
- Continuous power supply will be needed.

- Maintenance cost is very high because maintenance labour of high calibre are required.
- It also leads to brain drain from the country.

Automation in construction

- Roads & Runways construction
- Structures
- Buildings construction
- Ports
- Tunnels
- Factories and industries

Surveying

1. Surveying

Sites can be surveyed with the use of modern instruments such as 'total station' having a PC connectivity and software. The survey readings are directly recorded on a CD and an engineering drawing is obtained as end result The readings are measured on the field using electronic signals and lasers.

TOTAL STATION

2. Roads

Asphalt mixers and asphalt pavers are automatic machines. Similarly concrete pavers are used for roadwork. Use of highly automated hydraulic drilling for piling has become common, for all highways and flyovers.

ASPHALT MIXERS MACHINE

3. TUNNEL

For tunnel work, high level of automation exists. Drilling jumbos, road headers and Tunnel boring machines are used. TBM can drill a tunnel 3to8 m in diameter, at the rate of 1m/hr, giving an overall progress of 12to15m/day. By the conventional Method, the rate would be 3to5m/day.

TUNNEL BORING MACHINES

APPLICATIONS OF AUTOMATION AND ROBOTICS IN CONSTRUCTION

1. Automation and robotics Bricklaying

Works in tandem with construction workers, but lays down 3x as many bricks as human. Automation and robotics are also used to lay bricks such as shown Figure which can lay up to 1000 bricks in an hour.

2.Automation and Robotics in Prefabrication of Masonry and On-Site Masonry Construction.

Automation and robotics in masonry prefabrication play significant role and has considerable advantages because not only it substantially raise the production of masonry blocks but also it decrease manpower and labour cost. Plants that produced masonry elements may be completely automatic or partially automated and individually designed masonry blocks can be prefabricated.

3. Automation and Robotics in Production of Steel Components

Automation and robotic have been used to a great extent by steel companies which prefabricate building components according to contractor demand. The steel components will be transferred to project site for erection.

Figure: Automated and Robotic Steel Panel Production Facility

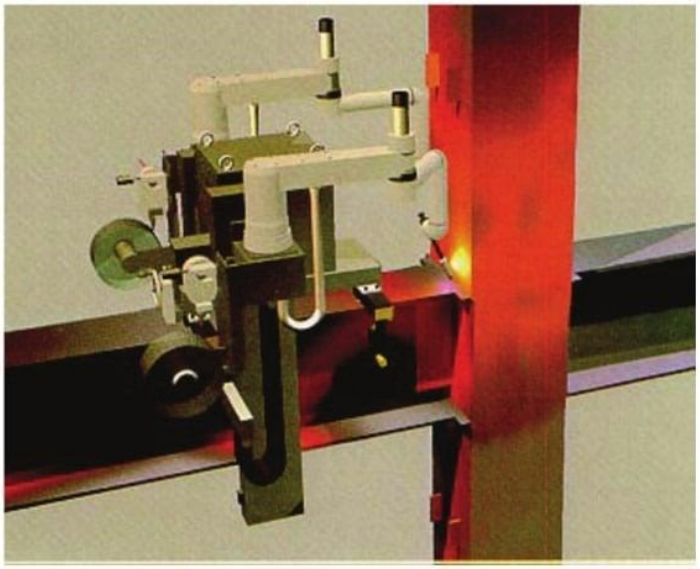


Figure: Transformable Welding Robot in an Integrated Automated Building Construction Site

4. Automation and Robotics in concrete finishing

Automatic concrete towelling and Paving. Automates task that is repetitive and hard for humans to do well .

Figure: Concrete Surface Finishing Robot

5. Automation and Robotics in Construction Sector and Precast Concrete Industry.

Regarding concrete precast component production, large degree of automation is utilized and necessary number of precast components can be produced as per buyer's demand. The automation of precast components is very beneficial because it provides products which its quality is not changing and waste of the factory is declined.

Figure: Robots used in prefabrication.

6. Automation and robotics in demolition of buildings

Demolition robots are used in the construction industry to demolish buildings at the end of their lifecycle. Automating demolition is all about safety and efficiency, both of which drive major cost savings for construction and demolition companies. They feature breakers, crushers, drills or buckets to break through building materials in the demolition of old structures. Demolition is an inherently dangerous job. Robotic automation puts human workers out of harm's way and lets them complete more productive tasks. Demolition robots offer much needed safety, efficiency and cost-savings in a labour-intensive industry.

Figure: Robots used in demolition of buildings.

7. Exoskeletons/ Exosuits

Exoskeletons are wearable machines suited with motorized joints that provide lift support, weight dispersion, posture correction and other capabilities to minimize strain and injury. The exosuits are metal frameworks fitted with motorized muscles to multiply the wearer's strength. Also called exoskeletons, the robotic suits' metal framework somewhat mirrors the wearer's internal skeletal structure.

Figure: exoskeletons/exosuits

8. Automation and robotics in paving

Robots pave roads with bricks or concrete. Relieve workers from physically straining work, improve efficiency.

Figure: Robots used in paving

9. Automation and robotics in recycling

Robots help sort construction materials and waste for easier recycling.

Figure: Robots used in recycling

10. Automation and robotics in mass tiling work

Robotic production of tiling work. Allows for the existence of tiles with unprecedented detail. Otherwise these tiles would be economically unfeasible.

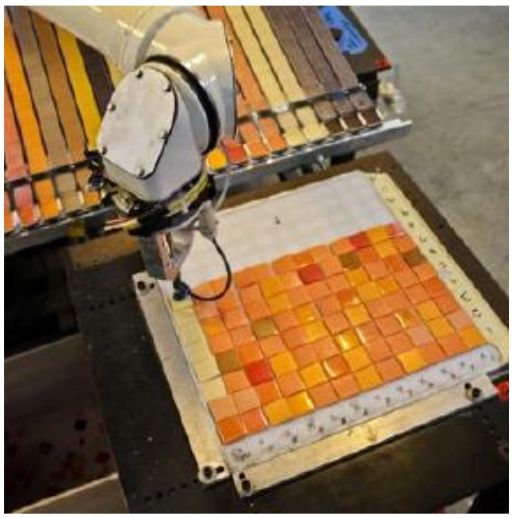
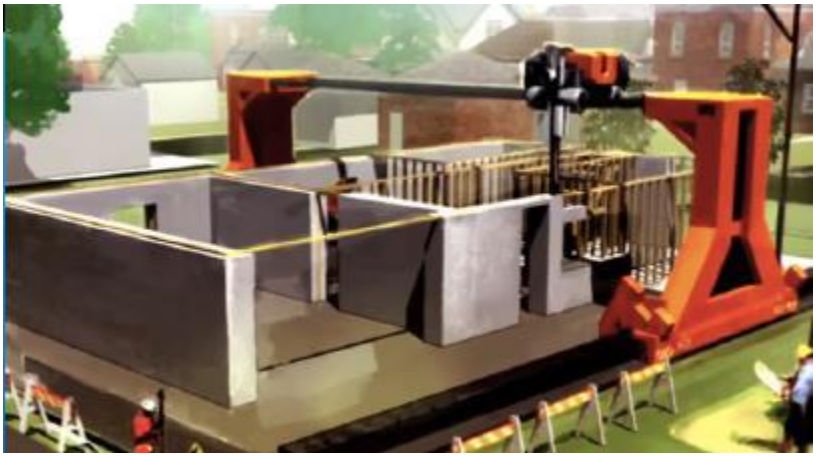


Figure: Robots used in mass tiling work

Emerging Technology Contour crafting

Contour Crafting (CC)is a layered fabrication technology developed by Dr. Behrokh Khoshnevis of the University of Southern California. Contour Crafting technology has great potential for automating the construction of whole structures as well -components. Using this process, a single house or a colony of houses, each with possibly a different design, may be automatically constructed in a single run, embedded in each house all the conduits for electrical ,plumbing and air-conditioning.



D-shape

D-Shape is a new robotic building system using new materials to create superior stone like structures. This new machinery enables full sizes and stone buildings to be made without human intervention, using a stereolithography3-D printing process that requires only sand and our special inorganic binder to operate. D-shape is a new building technology which will revolutionize the way architectural design is planned, and building constructions are executed.

CONSTRUCTION EQUIPMENTS

1. EXCAVATORS

Excavators are important and widely used equipment in construction industry. Their general purpose is excavation but other than that they are also used for many purposes like heavy lifting, demolition, river dredging, cutting of trees etc. Excavators contains a long arm and a cabinet. At the end of long arm digging bucket is provided and cabinet is the place provided for machine operator. This whole cabin arrangement can be rotatable up to 360o which eases the operation. Excavators are available in both wheeled and tracked forms of vehicles.

2. Backhoe

Backhoe is another widely used equipment which is suitable for multiple purposes. The name itself tells that the hoe arrangement is provided on the back side of vehicle while loading bucket is provided in the front. This is well useful for excavating trenches below the machine level and using front bucket; loading, unloading and lifting of materials can be done.

3. **Dragline Excavator**

Dragline excavator is another heavy equipment used in construction which is generally used for larger depth excavations. It consists a long length boom and digging bucket is suspended from the top of the boom using cable. For the construction of ports, for excavations under water, sediment removal in water bodies etc. can be done by dragline excavator.

4. Bulldozers

Bulldozers are another type of soil excavating equipment which are used to remove the topsoil layer up to particular depth. The removal of soil is done by the sharp edged wide metal plate provided at its front. This plate can be lowered and raised using hydraulic pistons. These are widely used for the removal of weak soil or rock strata, lifting of soil etc.

5. Graders

Graders also called as motor graders are another type of equipment used in construction especially for the construction of roads. It is mainly used to level the soil surface. It contains a horizontal blade in between front and rear wheels and this blade is lowered in to the ground while working. Operating cabin is provided on the top of rear axle arrangement. Motor Graders are also used to remove snow or dirt from the roads, to flatten the surface of soil before laying asphalt layer, to remove unnecessary soil layer from the ground etc

6. Wheel Tractor Scraper

Wheel Tractor Scrapers are earth moving equipment used to provide flatten soil surface through scrapping. Front part contains wheeled tractor vehicle and rear part contain a scrapping arrangement such as horizontal front blade, conveyor belt and soil collecting hopper. When the front blade is lowered onto the ground and vehicle is moved, the blade starts digging the soil above the blade level and the soil excavated is collected in hopper through conveyor belt. When the hopper is full, the rear part is raised from the ground and hopper is unloaded at soil dump yard.

7. Trenchers

Trenchers or Trenching machines are used to excavate trenches in soil. These trenches are generally used for pipeline laying, cable laying, drainage purposes etc. Trenching machines are available in two types namely chain trenchers and wheeled trenchers. Chain trenchers contains a fixed long arm around which digging chain is provided. Wheeled trenchers contains a metal wheel with digging tooth around it. To excavate hard soil layers, wheeled trenchers are more suitable. Both types of trenchers are available in tracked as well as wheeled vehicle forms.

8. Loaders

Loaders are used in construction site to load the material onto dumpers, trucks etc. The materials may be excavated soil, demolition waste, raw materials, etc. A loader contain large sized bucket at its front with shorter moving arm. Loader may be either tracked or wheeled. Wheeled loaders are widely used in sites while tracked or crawled loaders are used in sites where wheeled vehicles cannot reach .

9. Tower Cranes

Tower cranes are fixed cranes which are used for hoisting purposes in construction of tall structures. Heavy materials like pre-stressed concrete blocks, steel trusses, frames etc. can be easily lifted to required height using this type of equipment. They consists mast which is the vertical supporting tower, Jib which is operating arm of crane, counter jib which is the other arm carries counter weight on rear side of crane and an operator cabin from which the crane can be operated.

10. Tippers

A truck or lorry the rear platform of which can be raised at the front end to allow the load to be discharged by gravity also called tip truck. Tippers are suited for the rough and tumble of mining & quarrying operations, as well as for carrying bulk loads in construction and infrastructure industries. Complete manoeuvrability, high performance and long-term endurance are common to all trucks, resulting in lower operational costs.

11. Dumpers

A dump truck is a vehicle designed to transport bulk material, often in construction. It has a open jump ahead with the driver seat , and consist of a large boxlike body to contain materials. A dumper usually has 4 Wheels, where the entire load and the movement depends on. The jump can tipped to be the load dump; This is where the name “dumper” comes. They are usually diesel engine. Modern dumpers have payloads up to 10 tons and usually articulate perform in the middle of the housing. There are various sizes of dumpers in the present construction industry. Apart from using them for construction, they are also been used in Large mining tunnels and gem excavations to remove soil and other substances.

12. Trailer

The term trailer refers to such vehicles used for transport of goods and materials in construction or other related field. It is commonly used for the transport of goods and materials. Sometimes recreational vehicles, travel trailers, or mobile homes with limited living facilities, where people can camp or stay have been referred to as trailers.

13. Tanker

A tank truck or road tanker is a motor vehicle designed to carry liquefied loads, dry bulk cargo or gases on roads. The largest such vehicles are similar to railroad tank cars which are also designed to carry liquefied loads. Many variants exist due to the wide variety of liquids that can be transported. In construction its use for carrying concrete mixed.

14. Crane

A crane is a type of machine commonly used in construction, generally equipped with an elevator, ropes or chains and sheaves that can be used both to move and to lift and lower materials horizontally. It is mainly used for heavy lifting and transport to other locations. One or more simple machines are used to provide a mechanical benefit and thus to move loads on the normal ability of a person.

15. Conveyor

A conveyor structure is a common piece of mechanical handling equipment that moves materials from one location to another location. Conveyors are mainly useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries.

16. Hoist

Hoist is a device for raising or lowering a load by means of a drum or wheel lift to which wraps the rope or chain. It can be operated by hand, is driven electrically or pneumatically, and the chain or wire rope fibres are used as lifting device. The load connected to the lifting means of a lifting hook. Also known as a man-lift, Buck-hoist, temporal lift, builder forklifts, lift or elevator, is this kind of lift is often in large construction projects, large as tall buildings or large hospitals. There are many other uses for the elevator. The purpose is to transfer its personnel, material and equipment between the ground and the upper floors, or between plants in the middle of a structure.

17. Forklift

A forklift truck (lift truck, fork truck, forklift, tow-motor) is a powered industrial truck used to lift and transport materials. Forklift trucks are available in many variations and load capacities. In a typical warehouse setting most forklifts used have load capacities between one to five tons. Larger machines, up to 50 tons lift capacity are used for lifting heavier loads.

18. Road Roller

Road roller (sometimes called a roller-compactor, or just roller) is a compactor type engineering vehicle used to compact soil, gravel, concrete, or asphalt in the construction of roads and foundations, similar rollers are used also at landfills or in agriculture.

19. Paver

A paver (paver finisher, asphalt finisher, paving machine) is an engineering vehicle used to lay asphalt on roadways. It is normally fed by a dump truck. A separate machine, a roller, is then used to press the hot asphalt mix, resulting in a smooth, even surface. The sub-base being prepared by use of a grader to trim crushed stone to profile after rolling.

20. Compactor

A compactor is a machine or mechanism used to material soil through compaction in construction industry. In construction, there are three main types of compactor:

I. Plate compactor

II. Jumping Jack.

III. Road roller.

The **plate compactor** has a large vibrating base plate and is suited for creating a level grade, while the jumping jack compactor has a smaller foot.

The **jumping jack type** is mainly used to compact the backfill in narrow trenches for water or gas supply pipes etc. Road rollers may also have vibrating rollers.

The **roller type compactors** are used for compacting crushed rock as the base layer underneath concrete or stone foundations or slabs.

21. Concrete mixer

A Concrete (Cement Mixer) is a machine that combines cement evenly to form aggregates such as sand or gravel and water to concrete. A typical concrete mixer using a rotating drum for mixing the components. For smaller volume works portable concrete mixers are regularly used for concrete, can be produced at the site, so that workers have enough time to use the concrete before it hardens.