

# Automation in Construction –The Need of Mega Construction and Fast Track Construction

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**Abstract-** Today most of the people desire to live in megacities for having better lifestyle due to which the population in megacities increases drastically. This leads to the development of megacities and slum rehabilitation projects. But the development of megacities by conventional construction is a costly affair as the procurement of huge quantity of materials, availability of labours, generation of huge waste and moreover it is time consuming. Also some of the conventional construction methods are harmful to the environment as it involves lots of wastage of material and lot of carbon dioxide emission into the environment. Today Construction industry is facing so many problems such as decreasing quality of work, skilled labour shortages, lack of safety of labour and working conditions, etc. In short, construction industry requires more number of skilled workers, good quality of work, safety conditions for laborers which help to enhance the overall productivity of construction industry. To meet the above, Automation an advanced technology has been developed and introduced. The objective of Automation in construction is to have rapid construction with less risk and good quality which increases the productivity of construction project, reduces the time duration, laborious work, increases the construction safety, and increases quality of work etc. Automation is very advanced technology in construction sector but the growth of automation in construction sector is quite slow because automation cannot construct large structures. Contour Crafting (CC) technology has a great potential in automated construction of whole structures as well as its sub-components. Contour Crafting is an advanced building printing technology. This is a recently invented technology which is researched by Behrokh Khoshnevis.<sup>[5]</sup> In CC, computer control is used to make the superior surface forming capability of troweling to create smooth and accurate, planar and free-form surfaces. Automated reinforcement, plumbing, electrical wiring, painting etc. can be done by using contour crafting (CC) technology. Today CC technology is very much involved in emergency housing and low cost housing. An attempt has been made in this paper to discuss the developments of Automation and Contour Crafting technology in Construction Sector as well as a comparison between contour crafting and the conventional methods.

## I. INTRODUCTION

Construction phase is one of the important aspects of civil engineering. Success of construction project depends upon when the project is completed with the lowest possible cost, the highest quality, no accidents, etc. Construction industry is labor-intensive and construction works performed in dangerous or risky situations because of many problems associated with labours like education, skill, experience, human tendency, strike, etc. Construction industry is facing so many problems such as decreasing quality of work, labour shortages, safety of labour and working conditions of project. Basically construction industry requires more number of skilled workers, good quality of work which helps to increase the overall productivity of industry. To overcome the problems associated with construction industry new innovative technology such as automation has the potential to improve the quality of industry. Hence, the importance of construction automation has grown rapidly. Automation is defined as a self-regulating process performed by using programmable machines to carry out series of tasks. Introducing the use of machines to a production process is called mechanization. Automation goes one step further and the process is not only supported by machines but these machines can work in accordance with a program that regulates the behavior of the machine. <sup>[4]</sup> Automation increases the productivity of the construction project, reduces the duration and laborious work, and increases the construction safety, increases the quality of work as compared to unskilled workers.<sup>[1]</sup> Automation in construction can be done in building construction which includes uniform brick laying, plastering work, interior and exterior walls, wall painting, tiling of floor and wall, plumbing work, reinforcement, electric work, road construction, ports and tunnels etc.

## II. OBJECTIVE

The objective of Automation in construction is rapid construction with less risk and good quality which increases the productivity of construction project, reduces the duration & laborious work, increases the construction safety, and increases quality of work.

**Key Words:** Automation, contour crafting

### III. SCOPE

The scope of automation in construction is broad, encompassing all the stages of construction life from initial planning and design, through construction of the facility, its operation and maintenance, prefabrication of construction components, on site construction, to the eventual dismantling and recycling of buildings and engineering structures.

### IV. ADVANTAGES

Automation and robotics in construction work execution has various advantages that could help the implementation of these systems. Among the most meaningful advantages belong:

#### A. Less dependency on direct labour –

Fewer problems related to quality and the repetitiveness of work carried out, as well as costs may be reduced by reducing labour, whereas less operators are needed for the automated system

#### B. Productivity increase –

Besides the speed of production increasing the productivity is improved by disengaging the operation of the limitations of the human factor.

#### Occupational safety increase –

The automated systems may carry out their work in dangerous zones for humans, this makes it possible to reduce labour injuries.

#### C. Quality increase –

Operations with automated systems are typically carried out with less variability than human workers.

#### D. Greater control over the productive process –

Problems may be detected in an easier way as each stage of the process is controlled in order to verify the correct functioning of the system and the result of each one.

#### E. Greater control over the final result of the process –

The final result may be controlled in a more efficient way by controlling the result of each step of the aforementioned process.

### V. DISADVANTAGES

Automation in construction work execution has various disadvantages –

#### A. High Cost

Expensive technology is the greater obstacle to implementation of automation in construction. Cost would be a major factor in deciding on whether take or not to take on a technology. Cost consideration should include not only the purchasing cost, but also the maintaining the automation technologies and see that it can improve overall efficiency and productivity.

#### B. Limited Resource Available to Small and Medium Size Firms

For small and medium size firms the resource should be available for using automation technology. The funding of small and medium size firm is sufficient to purchase the automation technology according to their turnover. The small and medium size firms are unable to purchase new technologies because of fund available is very less as compared to big firms. Small and medium size firms have not enough skilled labor which can handle automation techniques.

#### C. Automation Technologies are Expensive to Update and Maintain

As discuss earlier, that the cost of implementing automation techniques are high. These techniques are so expensive to update and maintain the progress of automation techniques. There maintenance cost is also high so that nobody wants to invest in such expensive technologies, especially the smaller companies. The main obstacle in implementing automation technologies is mostly on-site construction work.

#### D. Automation Technologies are Unavailable Locally or Difficult to Acquire

Automation would suit repetitive works where standard components or layouts are used, may be pre-cast components or pre-fabricated housing, siphorex blocks etc, but these are only application within certain areas. Implementation of automation may be a problem if the technology is not readily available commercially or is difficult to acquire because of some restrictions or other.

**VI. AUTOMATED CONSTRUCTION BY CONTOUR CRAFTING**

Automation is very advanced technology in manufacturing sector but the growth of automation in construction sector has been quite slow. The rate of growth in construction automation is slow because conventional methods of manufacturing automation cannot construct large structure. Contour Crafting has a great potential in automated construction of whole structures as well as its

sub-components. Contour Crafting (CC) is an advanced building printing technology. Contour Crafting (CC) technology is researched by Behrokh Khoshnevis. Contour Crafting (CC) technology uses a computer controlled crane to build homes quickly and efficiently with less manual labour. Contour Crafting is an emerging technology that uses robotics to construct free form building structures. By using Contour Crafting (CC) technology a single house or a colony of houses with different design and shape can be automatically constructed in a single run.<sup>[3]</sup>

**VII. COMPARISON BETWEEN CONVENTIONAL CONSTRUCTION METHOD AND CONTOUR CRAFTING METHOD**

Contour Crafting method differs from conventional construction method with respect to speed of construction,

cost of construction, architectural flexibility, safety of construction & sustainable to environment are explained below:

**TABLE VII. I COMPARISON BETWEEN CONVENTIONAL CONSTRUCTION METHOD AND CONTOUR CRAFTING METHOD**

Particulars	Conventional Construction Method	Contour Crafting Method
Speed of Construction	Conventional building method requires at least about a month construction of a single house unit excluding painting work	Contour crafting technique boasts of completing a multiple units within 24 hours
Cost of Construction	In the conventional method, there is a high cost of production because of the quantity of materials, labor, waste, and time. In addition, sometimes it becomes even higher due to the complexity of projects.	Contour Crafting can decrease about four times of the construction cost because of its simplicity, materials saving and short time productivity
Architectural Flexibility	Construction of irregular and dome shaped structures will difficult to construct	Irregular and dome shaped structures will also be able to be constructed with ease
Safety	Conventional construction is risky in labour point of view.	With Contour Crafting, work injuries and fatalities are reduced to zero because of the very safe method of construction.
Sustainability	This method is very harmful to the environment. This is because the process involved in construction of any structure by conventional methods involves lot of wastage of materials as well as emission of lot of Carbon Dioxide into the environment.	Due to its accuracy, Contour Crafting technology provides construction without waste, being considered as environmental friendly and a sustainable process

## VIII. APPLICATIONS OF CONTOUR CRAFTING TECHNOLOGY<sup>[2]</sup>

- i) Contour crafting technology provides flexibility while designing structures.
- ii) Different types of materials for outside surfaces and as fillers between surfaces may be used in Contour Crafting.
- iii) Contour Crafting (CC) technology can create shapes with smooth outer surfaces and reinforced internal structure automatically and in single setup.
- iv) Automated Reinforcement, automated painting, automated plumbing, automated electrical wiring can be possible by Contour Crafting technology.
- v) Contour Crafting can significantly reduce the cost of commercial construction.
- vi) Contour Crafting technology has the potential to build safe, reliable, and affordable lunar and Martian structures, habitats, laboratories, and other facilities before the arrival of human beings.
- vii) Contour Crafting can build dignified houses or colony of houses with all the utilities for electrical and plumbing in less than 24 hours (per house).

viii) Contour Crafting technology can deliver strong dignified houses to disaster victims very rapidly.

## IX. CASE STUDY ON AUTOMATED CONSTRUCTION BY CONTOUR CRAFTING<sup>[3]</sup>

In China, a company named WinSun Decoration Design Engineering has built ten 3D printed houses entirely out of recycled materials in less than 24 hours. The printer used for this purpose was assembled by importing its parts from overseas. It measures 32 meters long by 10 meters wide and is 6.6 meters in height. The printer is capable of printing houses having a plan area of about 200sq.m. The materials used for construction included a mixture of industrial wastes and other inexpensive materials.

The construction task was fully automated and there was no requirement of labour at all. The approximate cost for construction of each unit was under 5000 USD, which is quite an achievement for a relatively new construction process.

## X. INDIAN SCENARIO OF CONTOUR CRAFTING

India is one of the fast developing nations of the world which is facing an acute shortage of space due to major population migrating towards the big cities in search for jobs and better living. As a result of this various redevelopment projects are being undertaken in the mega cities. But with the use of conventional techniques the rate

of construction is very slow to match the demand for space and moreover the harm to the environment due to these construction practices is very alarming. Also the rate of construction is bound by the economy as the cost involved in the redevelopment and city expansion projects is huge. But with the advent of contour crafting.

## XI. CURRENT DEVELOPMENTS OF CONTOUR CRAFTING WORLDWIDE

a) A New York City Architect/Contractor Adam Kushner has begun the construction of the first ever 3D printed estate which will feature a 2400 Sq.ft. home, with 4 bedrooms and a swimming pool. The rebar's to be used in the constructed will also be automatically placed using the 3D printer itself.

b) The Chinese have built another gigantic 3D Printer which will be used to print a replica of the

world famous 'Temple Of Heaven' which is located in central Beijing. The replica will be 7 meters in diameter and 8 meters high, and is expected to take around 6 months to complete.

c) In USA, NASA is sponsoring a project in co-ordination with University Of Southern California headed by Dr. Behrokh Khoshnevis himself. The project is based on building bots similar to the 3D printers used in Contour Crafting which would be used to construct roads, landing pads, hangars for landing, radiation proof walls etc. on the lunar surface.

## XII. CONCLUSION

Automation is very advanced technology in manufacturing sector but the growth of automation in construction sector has been quite slow. Contour Crafting is a new approach to solving problems facing the construction industry, particularly at the automation and process level. Contour Crafting has a great potential in automated construction of whole structures as well as its sub-components. Contour Crafting(CC) is an advanced building printing technology. In building construction, operations like design, plumbing, reinforcement, electrical systems, painting has been possible by using CC technology. Contour Crafting technology has a great advantage of building houses in few hours, without wasting any material. As workers and materials used in CC technology are less it's cost can be much lower than conventional method. This has been environmental friendly technology as it does not pollute or cause any bad effect to our environment. However, even with all its benefits, Contour Crafting has some challenges to overcome. First, CC developers should study how this technology would be managed at a construction site. Second, it is necessary to see how people would react to this transition between conventional method of construction (many workers, wasting and fatalities) and

the automated construction method (less workers, wasting and more safety). Lack of job opportunities has been important issue of this CC technology. Finally, the great challenge is to overcome the current cost barrier of this technology.

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