International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-8, Issue-6; Jun, 2021
Journal Home Page Available: https://ijaers.com/
Article DOI:https://dx.doi.org/10.22161/ijaers.86.16

3D Printing of Concrete in India

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Received: 08 Apr 2021;

Received in revised form:

19 May 2021;

Accepted: 03 Jun 2021;

Available online: 15 Jun 2021

Keywords*— *3D Printing, Concrete, Layer Based, Contour Crafting, Printer.

***Abstract*—** *In this study, we have examine the importance of 3D printing of concrete in this era. It is a handy replacement of self compacting concrete and sprayed concrete which does't need formwork, Moreover,it will save time ,labour and cost efficient.To achieve this technique we need both hardware and software.In India L&T Construction Ltd. Were first to accomplish this technique which was two Storey building. and thus has a unique advantage over conventional construction methods.*

I. INTRODUCTION

There were a lot of problems faced in traditional construction like the cost of formwork increases the project economy, cost of man-power & time and thus effects the quality of construction. 3D Concrete printing aims at enhancing construction on several levels: it minimizes the duration of the construction process by eliminating some time-consuming processes in the traditional method, it reduces costs of the project by minimizing waste and overproduction. In addition to minimizing the use of labor, it also provides flexibility in building structural shapes which are not possible to build by traditional methods which results an improvement in the overall safety and economy of structures.In principle, 3D printing of concrete has the advantages of both self-compacting concrete (i.e. self- compacting without any assistance of vibration) and sprayed concrete (i.e. fresh concrete is expelled from a nozzle to fabricate complex forms) to meet the critical requirements of a freeform construction process. We can clearly observe in Fig 1 that to construct a building we have to face many complications like orientation of formwork carried out by heavy machineries thus a minor mistake can causes a loss of money, time and the property.Hence to eradicate this problem a new and better construction technique is presented called 3D PRINTING OF CONCRETE

Fig. 1: Complications in Convection Construction Technique

II. OBJECTIVES

The main objective of the project is the implementation of a contour crafting system to a 3D concrete printer. The goal is to assemble a 3D printer that gives the user a greater degree of freedom in designing different forms and

improves the aesthetic of the finished product. To print few objects by using the 3D printer developed. The long term objective of the project is to patent the 3D printing technology for concrete and there by introduce the same in the construction industry.

III. METHODOLOGY

3D Concrete printing is a construction method that has the potential of fabricating a predesigned building in 2D layers on top of each other, the repetition of which completes a 3D model. The concrete, which is erected out from a printing nozzle, does not need any vibration or formwork.Contour Crafting (CC) is one method of concrete printing that shows great potential in improving construction techniques and methodologies.CC constructs objects layer by layer using robotic arm or such mechanical tools; it is used for small-scale industrial parts and also was identified as a method which is capable of delivering components large enough for building structures. Moreover, components are designed as volumetric instruments using 3D modeling software's like SolidWorks & Inventor.Afterwards, they are sliced and represented as a series of 2-D layers. The information is then exported to a printing machine which obeys layer-by-layer Pattern in order to print structural components by the controlled extrusion of a cementitious material.

The evolution of a printing concrete is utilize the likely of this advanced method of construction.The correct needs to have an acceptable degree of extrudability to be extruded through a printing head which consists nozzles to form small concrete filaments.The filaments must adjoin together to form each layer, as the fresh concrete is continuously extracted to form consecutive filaments layered on the previous ones to build complete 3D components.Furthermore, the material must have sufficient build-ability characteristics to enable it to lay down correctly, remain in position, be stiff enough to support further layers without collapsing and yet still be suitable to provide a good bond between layers. A high strength (of the order of 80 MPa in compression) is proffered because the layered structure of components fabricated by this method is likely to be inherently weaker than conventional in-situ and precast concrete.

A typical 3D concrete printer is designed for the nozzle head movement of maximum of 475 mm in the X-direction 650 mm in the Y-direction and the printing base of 750 mm in the Z-direction. This can be done by 300 W servomotors which actuates linear screws. A 660 watt servo motor can be used for driving a screw-type extruder. The concrete printer will be controlled by Software's which could be better used by mechanical engineers. Software's like Solidwork or Inventor plays a major role to produce printed concrete. Some are not open source software but software used in CNC milling machines are beneficial to design structure. An open source slicer-software converts stereo-lithography files to the G-code instructions used by these software's.

Hardware: The purpose of contour crafting is to ease the surface of the concrete flowing out of the outer of nozzle. To implement this to the concrete printer, a new nozzle with trowels that follow the outer edge is needed. The trowels should also also be capable that it can create an angle according to the shape of the printed object to allow angled walls to be printed. Additionally the trowels should not be in contact of the concrete paste during The fill cycle. An idea of Printing Concrete the help of robotic hand was purposed by Lund university, Sweden as shown in Fig 2. This robotic hand is operated by a software and thus improves the accuracy of 3-D printed structure.

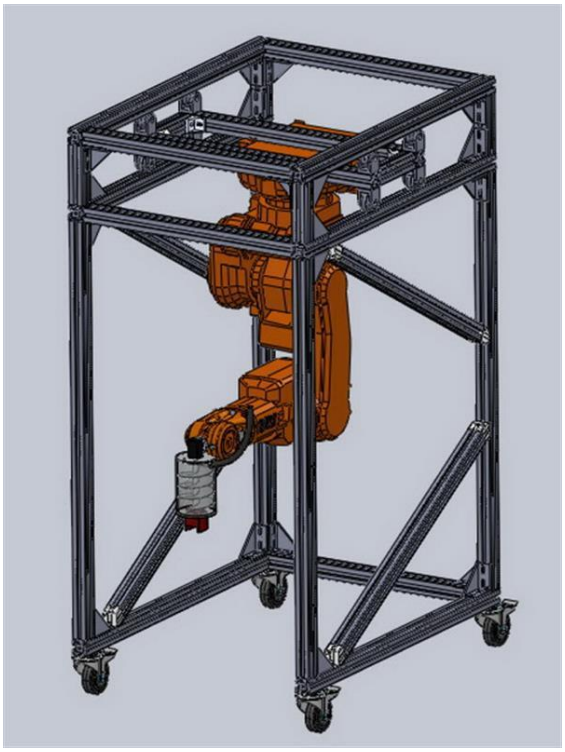

Fig. 2: Prototype of robotic hand presented by lund Univesity, Sweden

Software: To implement contour crafting,An additional axis is needed which is known as G-Code.In the original setup of the printer, G-code is generated from a CAD model by the open source software like slic3r or some paid softwares like solidworks.These software's break the CAD model in stereolithography format down to points in the X-Y plane.CAD software moves the nozzle according to the path given by the G-code. In order to control the additional axis, a program will be written in programming language.

The program should be able to read the coordinates, written in the G-code file as well as calculates the angle for the nozzle.

Concrete mixture

Contour crafting method needs some additional requirements on the concrete property which is being used like ,The printability of a concrete mix are defined as extrudability (the ability of the mass to easily flow through the extruder), Buildability (the resistance against deformations by the subsequent layers) and Formability of concrete.The existing recipe has to be reconsider to accommodate the implementation of the contour crafting system.While water and Admixture content of the mix has to be adjusted until the criteria listed above are deemed fulfilled. Fig 3 show an idea Concrete mixture used for this Technique

Fig. 3: An experiment of 3D printing of Concrete.

IV. RESULT

The advantages of this process includes: (1) Influence of mechanical and electrical services within voids formed in the structure could optimize materials usage and can easily work on site; (2) Enhancement of build material can produce internal and external finishes (3) Designing integrated units will reduce interface detailing and hence the can be cost efficient and (4) By Contour crafting method which obeys layer-by-layer concreting with solid modeling techniques will give greater design freedom.

V. CONCLUSION

Over time, building components and engineering practices have an exponential growth, with the approach of building superstructures to building a most economical building 3-D printing of concrete is able to complete a construction project more accurately, economically and early as compared to traditional Construction techniques. As in some countries due to topographic factors the amount of admixture should be used accordingly. Whereas this technique needs experts from multi-disciplinary departments from Civil, Mechanical, Robotical and Computer which could result in some complications However it can be solved with less efforts.

ACKNOWLEDGEMENT

I Owe a Debt of Gratitude to Mr. Yash Surti(M.tech in Structural Engineering),Charusat university,Gujarat,India for the vision and foresight which inspired me to conceive this research. I express my gratitude to him for providing me with proper guidance and environment for completing this research

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