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Analysis and implementation of construction automation (Robotics) for glazing curtain wall

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ABSTRACT

Glass panel (curtain-wall, glass ceiling etc.) is a type of building material for interior/exterior finishing. The demand for larger glass panel has increased along with the number of high-rise buildings and an increased interest in interior design. In Typical construction methods most of the construction works have been still managed by a human operator. Construction processes having number of problems cost overrun and risk factors that may cause various accidents such as falling, colliding, capsizing, and squeezing in work environments. The idea of this study to identify the new technological robots for installing large glass panels on construction sites to the reduce the time, cost and accidents. On evaluation, analyze and propose robotic construction methods for manipulating large glass panels in risk zones on high rise buildings. and to identify the cost and time difference compared to human manipulate.

***Keywords**: Construction industry challenges in high rise buildings, Robotics, Glazing Robotics in construction industry*

1. INTRODUCTION

In India, construction industry is the second largest employer when compared to agriculture. Throughout the world, the construction area of civil engineering is one of the most hazardous industries. The Indian construction labor force is 7.5% of the total world labor force and it contributes to 16.4% of fatal global occupational accidents. In the construction industry the possibility of a fatality is five times more likely than in a manufacturing industry, whereas the risk of a major injury is two and a half times higher. India has the world's highest accident rate among construction workers, according to a recent study by the International Labor Organization (ILO) that cited one survey by a local aid group showing that 165 out of every 1,000 workers are injured on the job.38 fatal accidents take place every day in the construction sector. At least 300 workers every year or nearly one every day, die at construction sites across Tamil Nadu, 34 were due to falls from high rise buildings. The Government of India may be seeking to project India's construction sector as the country's second-largest employer of the country after agriculture, providing jobs to more than 44 million people, and contributing nearly 9% to the national GDP, Data suggest that the possibility of a fatality is five times more likely in the construction industry than in a manufacturing industry, and the risk of a major injury is 2.5 times higher. The conventional process of executing the construction work requires highly skilled workmen in order to achieve sufficient and consistent quality. This labor-intensive construction process results in relatively high cost. To achieve higher rationalization and humanization, have to implement robotics.

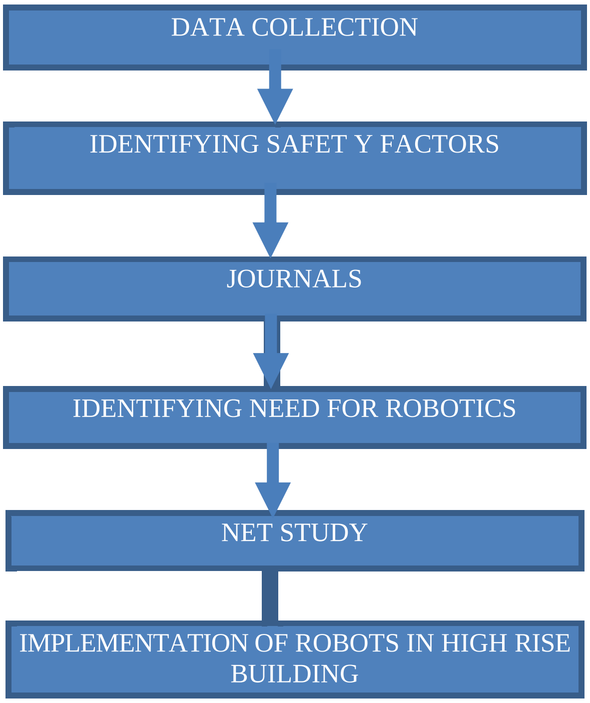
2. AIM

- Analyze the need of robots in high rise building based on time cost and accidents.
- Identify Robots and Implement in G+6 storey construction.
- Identifying the reduction on time, cost and accidents after the implementation of Robots.

3. OBJECTIVE

- Identifying zone in construction creating maximum death occurs and increase in cost and time.
- Using labors up to g+6 floor, and for above floors using robotics.
- Study on robotics for implementing in above g+6 floors
- Implementation of robotics in high rise building.
- Analysis and scheduling.

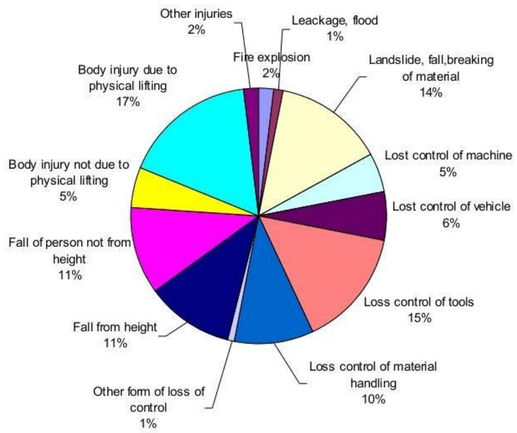
4. METHODOLOGY

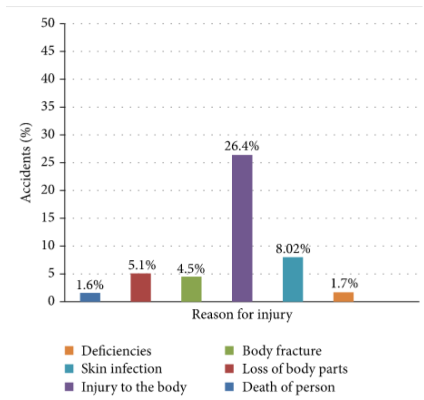


5. FINDINGS

5.1 Issues identified

- Construction business is huge and is experiencing vital delays. Delays in construction comes can't be one hundred percent avoided or eliminated.
- Delay occurs virtually in each construction project and therefore the cause liable for the delays varies from project to project.
- Delay are often outlined as the time overrun or the extension of time to complete the project on a timely basis.
- Delays will be minimized, once the foundation causes are identified.





5.2 Project complexity

- Construction projects are becoming more demanding and complicated in design.
- Structural complexity, technical complexity and high levels of dynamism on the end user needs flexibility to adopt to changes and re-engineer during construction, with zero impact to project end results.
- Environmental sustainability: Robots with their precision, can contribute towards reducing the carbon footprint by means of reduced usage of fossil fuel, reduced air and noise pollution and in addition can contribute to safe work practices and minimize other environmental risk associated with construction.

5.3 Time constraint

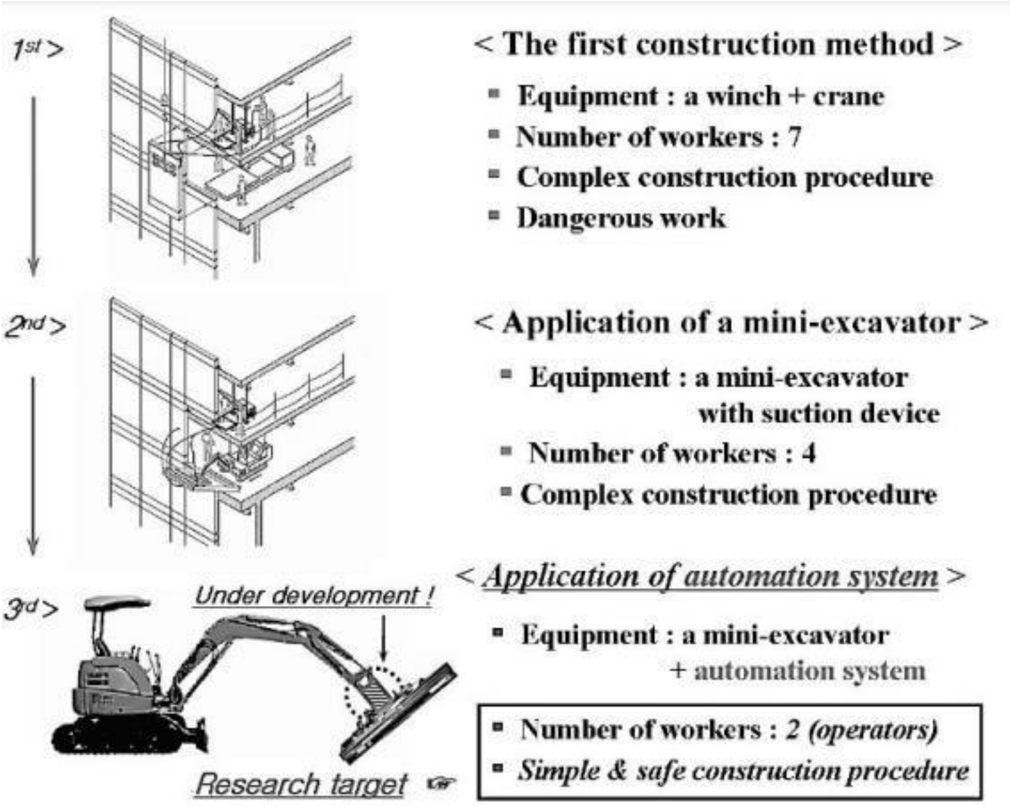
- As projects continue to become increasingly complex, contractors face a huge risk on timely delivery.
- The advent of precast technology in the present form, and integration of robots with technology helps to optimize and expedite project timelines.
- As a result of these, the demand for industrial robots has accelerated considerably in the past couple of years.
- Between 2011 and 2016, the average robot sales grew at 12 per cent per year (CAGR) with the number of industrial robots deployed worldwide estimated to increase to 2.6 million units by 2019.
- Manufacturers are taking a note of this surge in demand.

- For example, a New York based company, Construction Robotics has created a Semi-Autonomous Mason - Sam100, whose margin of error is now measured in millimeters.
- It can apply mortar to any size brick and place one every 8.5 seconds. Where a human mason can lay 300-600 bricks in an eight-hour shift, Sam can lay more than 3,000.
- A robot, called WALT (by Endless Robotics) can paint walls about 30 times quicker than a human at a speed of about 60 square feet per minute and can work at heights from 8ft to 14ft.
- Another disruptive technology is 3D printing. It drastically reduces time overruns and labour cost needed for construction projects.
- With 3D printing, one can effectively print an entire prefabricated building structure and later assemble them into a complete building onsite.
- Companies such as Caterpillar, Cazza, have already introduced products around this.

5.4 Robotics

5.4.1 Glazing robots

- To satisfy curtain-walls handling needs for precise and safe work, especially, a hybrid motion typed curtain wall glazing robot (HCGR) has been developed and applied to real construction sites.
- The developed robotic system overview is a macro – micro motion manipulator. A mini- excavator is considered to be the macro motion manipulator for lifting and moving of curtain-walls.
- The new developed 3 DOF robotic arm is considered to be a micro motion manipulator for precise handling of curtain-walls



6. CASE STUDY

6.1. Net case study

Gambao, Balaguer and Gebhart are the three buildings obtained the robotic systems that improve the manual block assembly tasks reducing dramatically the construction time and efforts. **Ostoja-Starzewski & Skibniewski** designed the master-slave force-feedback hydraulic manipulator that contributes to the flexibility and productivity enhancement of related work tasks. **Santos et al.** introduced a manipulator to assist the operators in handling and installing pre-manufactured plaster for indoor-wall construction. **Skibniewski & Wooldridge** described an automated materials handling system concept for managing and handling construction materials within automated building construction systems the shape of the completed HCGR and the 3-DOF modularized manipulator. Each module is combined with consecutive order to embody the selected DOF, and the order is then closely related to the working efficiency and safety of the system. That is, it is unreasonable for an actuator to generate beyond the necessary force and torque. This would cause the whole work capability to fall after a worker had run the manipulator with beyond-necessary power.

Table 01

SNO	Project	Area	Normal time	Labors	Robot used	Time	Labours used
1	Gambao-Korea	600 SQ MT	34 HRS	4	HCGR & 3-DOF	26 HRS	2
2	Balaguer- Korea	704 SQ MT	71 HRS	13	**Module T&H-bar**	59 HRS	3

3	**Edgbaston Cricket Ground**	850 SQ MT	83 HRS	8	**OSCAR 600**	68 HRS	5
4	**The Grand Arcade Shopping Centre in Cambridge**	**750 SQ MT**	64 HRS	9	**OSCAR 600**	**49 HOURS**	3
5	**The Boldrewood Campus, University of Southampton**	900 MT	64 HRS	14	**SOUTHAMPTON- OSCAR 1000**	50 HOURS	3

6.2. Live Case Study

6.2.1 Kohinoor square –Mumbai-case study. Official name: Kohinoor square-2015-2021. Status -= under construction.
Type – mixed use
Height – 203 m. Floor – 52 floors.
Total area -2,55,000 sq mt. Cost – 21 billion INR.

Table 02

S NO		MANUAL INSTALATION	ROBOTIC INSTALLATION
1	TIME PER GLASS	1 HOUR	25 MINS
2	TOTAL TIME TO INSTALL	32 MONTHS	15.5 MONTHS
3	LABOURS/GLASS	4	2
4	TOTAL LABOURS	1700	10 ROBOTS
5	ROBOT USED	--	OSCAR 1000
6	COST	INR 850 /LABOUR/DAY	11 LAK /PIECE
7	TOTAL COST	3,96,00,000 INR	3,08,00,000 INR/LABOURS
8	ROBOT DEALERS IN MUMBAI	--	• AIS GLASS SOLUTIONS • GLASS WALL SYSTEMS

6.2.2 The Capital–Mumbai-Case Study:

- Official name :the capital
- Status -=2008-2012
- Type – office sale
- Height – 61.26 m
- Floor – 18 floors
- Total area -2,55,000 sq ft
- Roof height- 4 mts ht
- Developed by-wadhwa group
- Architect james law
- Cost for glazing-4.5 cr

Table 03

S NO	GLASS SPACE	GLASS QUANTITY SQ FT	NO OF GLASSES	ROBOTS REQUIRED	LABOURS	DAY S	COST- INR
1	EXTERIOR GLASS/FLO OR	22,000 SQFT/PER FLOOR 3,96,000 SQ FT/18 FLOORS	900 -1050 GLASSES/FLOOR 16,300-16,965 /18 FLOORS	10	30	200-230	34,00000
	UPTO G+6	1,32,000 SQ FT	5320-5400	-	20	135-140	26,00000
	ABOVE G+6	2,64,000	10,650-10,800	10	10	75-86	7,10,400
2	INTERIOR ROOF GLASS	7,500 SQ FT IN FACADES	315-340 GLASSES	5	8	20-32	47,000
3	GLASS HANDRAIL	4,400 SQFT	225-237 GLASSES	-	10	14-16	1,34,000
4	GLASS WALL PARTITION S	13,000 SQ FT	540-580 GLASSES	5	10	8-10	96,000
5	OVERALL GLASSES REQUIRED	4,22,900 SQ FT	18,082-18,430 GLASSES	MAXIMUM OF 10 ROBOTS AT A TIME	MAXIMUM OF 30 LABOURS AT A TIME	400	3,677,000

6.3 Inference

By analyzing both the studies on high rise office buildings , I have worked out on 100 percent labours,100 percent robots and 50 per labour-50 percent robot.by the identification of robot incorporated and combines with labours it reduces 25 percentage of time and 25 percentage of cost. And also can work on with another building simultaneously.in the both the high rise buildings, when they included robot in their installation process they reduce nearly 1 cr of installation cost.so it clearly defines in this competition world the construction industry need to include technology along with labour to complete their project in less time and in low cost.

7. CONCLUSION

By analyzing and identifying on issues faced by construction industry on time, cost and safety, the robotic technology can benefit construction industry in many ways. Use of robots will directly or indirectly save builder/contractor/owner to face legal problem and also the given tasks can be completed at a faster rate. Although the initial cost is high, the robots can be economically employed in the construction of repetitive buildings .so, when comparing to human labour robots are more efficient. In this study concludes not only focusing on only robots it includes not to affect human labours ,so the human labours are also to be used upto the g+6 storeys above that only robots can be used and evaluated. This helps to work on number of projects at a time and it is more efficiency.

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