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Leading Methodologies in Construction Industry

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Abstract— **The construction industry is repeatedly criticised for being inefficient and very slow to innovate. The basic methods of construction techniques and technologies had changed little since Roman times. Design of man-made structures are more complex and critical than ever before, and they are getting no-simpler. Requirements are keep-on increasing. The reason is that the tendency of the human to compare the previous project with the future one. Other reasons for pushing the construction engineering off limits, include urbanisation, usage of newly developed materials together with software developments, which allow us to design these complex structures. The engineering techniques required for the designs are highly specific in nature and vary from design to design. When we look back throughout this industry's history we can notice few great advancements have taken place. But every construction project is different, every site is a singular prototype, construction works are located in different places, and involve the constant movement of personnel and machinery. In addition, weather and other factors also prevent the application of previous experience effectively. So it is mandatory to have many advanced construction techniques in hand to use those things in the right place at the right time.**

Index Terms— **Construction,3D printing, technology, building,development,labour.**

I. Introduction

The word 'advanced construction technology' includes a broad range of contemporary techniques and practices that enclose the newest developments in design procedure, facility management, sevices, materials technology, quantity surveying, structural analysis and design, and management studies.

Implementing advanced construction technology can increase the quality level, efficiency, safety, sustainability and the value for money. However, there is always a problem between the traditional industry method and innovative practices, and this is often blamed for the relatively slow rate of technology transfer within the industry.

The adoption of advanced construction technology requires a good quality control, appropriate design, suitable procurement strategies, commitment from the whole project team, appropriate training and careful commissioning.

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II. Technologies

Some of the advanced construction techniques discussed in this paper are listed below:

1. 3D Printing
2. Drones
3. Self healing concrete
4. Wearable technology
5. GPS
6. Building integrated Photovoltaics(BIPV)
7. Robotics

III. 3D Printing In CONSTRUCTION

The term "3D printing" (sometimes referred to as Additive Manufacturing (AM)) incorporates the computer-controlled sequential layering of materials to create three-dimensional shapes. It is particularly used for prototyping and for manufacturing of geometrically complex components.

It was initially developed in the 1980s, but at that time it was a very difficult and expensive operation and so had very few applications. It is only since 2000 that it's become comparatively simple and reasonable then has become viable for a wide range of uses as well as product designing, component and tool manufacture, aerospace engineering consumer electronics, metalworking, plastics, dental and medical applications and footwear.

The 3D printing systems which are developed for the construction industry are termed as 'construction 3D printers'.

A 3D digital model of the item is formed, either by computer-aided design (CAD) or using a 3D scanner. The printer then reads the design and lays down successive layers of printing medium (this can be a liquid, powder, or sheet material) which are joined or fused to create the item. The process is slow, but it enables almost any shape to be created. Based on the technique adopted, printing can produce multiple components simultaneously, can use multiple materials and can use multiple colours. Accuracy is enlarged by a high-resolution reductive method that removes the material from an oversized printed item. Some techniques include the utilization of dissolvable materials that support overhanging options during fabrication.

Materials such as metal can be expensive to print, and in this case it may be more cost-effective to print a mould, and then to use that to create the item.

In the construction industry, 3D printing can be used to create construction elements orelse to 'print' the entire buildings. Construction is well-suited to 3D printing as the maximum amont of knowledge necessary to produce an item can exist as a result of the design process, and the industry is already experienced in computer aided manufacturing. The recent emergence of building information modelling (BIM) particularly might facilitate greater use of 3D printing.

Construction 3D printing may allow, faster and more accurate construction of complex items as well as lowering labour costs and producing less waste. It might additionally modify construction to be undertaken in harsh or dangerous environments not appropriate for a human workforce such as in space.

Fig 1: 3D Printing

IV. DRONES

There is an aerial revolution that is happening across the world. Drones have emerged as a extremely viable commercial tool with applications in various sectors, most notably, construction. This isn't surprising, as their advantages range from on-site safety to a level of project monitoring which wasn't possible before.

Many construction sites have already highly dependent on the employment of drones. These drones are very useful in the sense that they save a lot of time. For instance, surveyors can survey an entire site in just a very few minutes, whereas it'd take them several weeks or months previously. Obviously, this will also considerably save construction companies a lot of money. In the past, many companies avoided to use drones because they still needed a controller, but today as the technology grows much more efficient, more construction companies are willingly and openly embracing this technology.

In the construction industry, drones provide a very easy access to large and difficult sites as well as complex and tall structures. They can also gather aerial data, mapping information and images. Builders are using drones mainly to collect real-time data about projects and understand what's happening on site. Aerial insights are employed to improve progress tracking and help catch problems early—before they become costly or add weeks to a project's timeline. Drones improve communication and help keep projects on track. They can also increase safety, save time and resources, fast-track surveying, and deliver accurate measurements.

Fig 2: Droning

Drones help to quickly survey your job site and build maps. Rather than using human resources, heavy complex machinery & expensive surveying tools which produce complex data, we can get the job done in half the time & money, with greater accuracy. These tiny crafts can be easily operated by remote, and can transmit quickly the data they are gleaning to a live feed and SD data storage instantaneously. This gives very accurate maps and providing valuable data to numerous companies much easier. Information that you simply acquire are often uploaded quickly to a server, where it can be accessed by individuals all over the world who you allow authorization.

Drones can also reach high-risk areas and tightly-squeezed in locations that are quite a bit harder to reach with a human crew.

Project managers may also opt to use 3D laser scanners that fly over the designated region and provides the surveyor quality pictures of what the terrain appears like. This data is then employed in a process known as GIS mapping, which creates a digital map through a mix of statistical analysis and cartography.

V. SELF HEALING CONCRETE

A self-healing material is described as a material which is capable of repairing itself back to the original state. Self-healing concrete can solve the problem of concrete structures deteriorating well before the end of their service life. Concrete remains one of the main materials used in the construction industry, from the foundation of the buildings to the structure of bridges and underground parking lots. Traditional concrete contains a flaw, it tends to crack when subjected to tension.

Self-healing concrete is defined as a product which would biologically produce limestone to heal cracks which may appear on the surface of the concrete structures. Specially hand-picked varieties of the bacteria genus Bacillus, along with a calcium-based nutrient called calcium lactate, and nitrogen and phosphorus, are added to the ingredients of the concrete when it is being mixed. These self-healing agents will lie dormant within the concrete for up to two hundred years. However, when a concrete structure is damaged and water starts to seep through the cracks that appear in the concrete, the spores of the bacteria germinate on contact with the water and nutrients. When activated, the bacteria start to feed on the calcium lactate. As the bacteria feeds,the oxygen gas is consumed and the soluble calcium lactate is converted into insoluble limestone. The limestone then solidifies on the cracked surface, thereby sealing it up. The consumption of the oxygen gas during the bacterial conversion of calcium lactate to limestone has got an additional advantage. Oxygen is a vital component in the process of corrosion of steel and once the bacterial activity has consumed it all, it will increase the durability of steel reinforced concrete constructions. The two self-healing agent components particularly the calcium lactate-based nutrients and the bacterial spores are being introduced to the concrete within separate expanded clay pellets which are around 2-4 mm wide, which ensure that the agents won't be activated throughout the cement-mixing period. It will be activated only when the cracks open up the pellets and incoming water brings the calcium lactate into contact with the bacteria. Testing has shown that once water seeps into the concrete, the bacteria germinate and multiply quickly. They convert the nutrients into limestone within 7 days in the laboratory whereas outside, in lower temperatures, the process takes several weeks.

Now, Self-healing concrete are used on roads, buildings, and homes. Size and performance of a building often determine the approximate life-span desired for this particular construction.

Small-size buildings are sometimes residential and situated either within the suburbs, villages or towns. And like most buildings, concrete remains one of the main building materials used, particularly for foundation (slabs or columns), as small residential buildings rarely change function it is practical to want to extend their life, and hence use SHC.

Medium-size buildings use a large quantity of concrete than the other size of buildings in contrast to like skyscrapers that use large amount of steel and small-size buildings that use large amount of stone or wood. Both residential and public middle-sized buildings appear to be eligible to the use of SHC, however, and particularly in public buildings as the life-span increases, designs must be flexible and efficient and economical to use of this type of concrete. Therefore, instead of demolition there will be re-modeling when the service held within the building is no longer needed in a particular area, which in its turn has a positive result in reducing the carbon dioxide gas emission by avoiding construction.

.All large-size buildings will defiantly has advantage from the employment of this kind of concrete just as the infrastructure would be enhanced by providing safety and durability.

Fig 3: Self healing concrete

SHC is much more effective than concrete. Since cracks in SHC are easy to close with no extra costs, the safety and security of a particular construction is increased. It is known that the initial cost of construction using SHC is higher, however, on the long-term, durable concrete is much more cost-efficient due to the low cost of maintenance, durability and the long life-span of the construction. According to analysis and experimentation bacteria-based SHC is denser and more durable than concrete.

SHC is particularly adequate for bridges and all road constructions as they sometimes experience small-sized cracks due to heavy loads and need maintenance repeatedly. The use of this kind of concrete will considerably reduce the maintenance cost and will also increase safety. Therefore, it is highly recommended to use the SHC due to its many benefits.

VI. WEARABLE TECHNOLOGY

Wearable technology includes smart electronic devices (electronic device with micro-controllers) that can be incorporated into clothing or worn on the body as implants or accessories.

This technology is also called as wearables, fashionable technology, wearable devices, tech togs or fashion electronics

Wearable devices like activity trackers are an example of the web of Things, since "things" like sensors, software, electronics, and connectivity are effectors which allow objects to exchange information (including data quality) through the internet with a manufacturer, operator, and other different connected devices, without requiring human intervention.

While people may think that this is only a common sense, it shouldn't go unmentioned that wearable technology (e.g. Fitbit's, 3D glasses, Google Glass, armbands that can communicate with coaches on the sidelines) will become an emerging trend which is useful in keeping employees safe. This will facilitate keep employees from constantly looking down at their instructions because now they can talk to one another via this technology. Additionally, it will facilitate in tracking where workers are if they meet an accident.

Fig 4: Fitbit , a modern wearable device

VII. GPS

Eventhough drones deliver high-quality visual data on parts of a structure it is too difficult or unsafe for anyone to reach.

Another aspect of modern technology which offers real benefits to the construction industry is GPS tracking. This has proven itself to be a powerful tool across countless applications in diverse areas of everyday life.

GPS technology was originally utilised by the US military that launched a system of satellites into orbit round the Earth to assist set up the troop movements and procure precise locations for deployment of personnel and equipment. Today, GPS technology is often used in civilian applications, including the construction industry.

SURVEYING:
Construction crew can save time when surveying by using GPS units. Instead of having to coach the crew to use standard training equipment; construction companies can issue GPS devices to their employees, because it is easier to use GPS devices to collect data and information about an area which is under construction, such as a new road section. Construction crew can obtain accurate data more quickly with GPS units, freeing them up to begin construction earlier.

HANDHELD AND VEHICLE UNITS:
GPS units that are installed in vehicles will facilitate the drivers find the exact location at a job site wherever they have to deliver materials and machineries as well as wherever to drop off construction crew. Teams of construction workers who are working on a large and a difficult project can use GPS units to make sure they can meet in the middle. In addition, a handheld GPS unit is very useful in the case when construction workers must walk to a site that is not yet accessible to large GPS equipped vehicles.

REDUCE FUEL EXPENSES AND WASTED TIME:
Construction projects sometimes involve lots of driving. Transporting materials from one site to another, collecting equipment from warehouses, driving waste to a landfill or recycling centre, all consumes fuel

Some GPS tracking units monitor fuel consumption which inturn allows you to keep tracking of fuel used in real-time. Your GPS tracking might also have a facility of notifying you of engine idling times, which will drain fuel unnecessarily and essentially waste your money.

GPS tracking also helps you cut down on fuel expenditure by pinpointing the most efficient routes for journeys.

VIII. BUILDING INTEGRATED PHOTOVOLTAICS

BIPV are the photovoltaic materials which are replaced over old building materials in building parts such as the roof and skylights. Incorporation of these are being increased in the construction of new buildings as a principal or ancillary source of electrical power, eventhough present buildings can be retrofitted by similar technology.

The benefits of integrated photovoltaics over regular non-integrated systems is that the initial cost can be offset by reducing the material cost and labour cost. This would generally be used to develop a part of the building that the BIPV modules replace. BIPV can parallely serve as a building material and also a power generator,thus these systems can improve in saving the cost of materials and electricity.It can reduce use of fossil fuels and avoid emission of ozone depleting gases.BIPV can add architectural value to the building. These advantages make BIPV one of the rapid growing products of the photovoltaic industry.

There are four major classifications of BIPV products

- Crystalline silicon solar panels used for rooftop and ground-based power plant
- Amorphous crystalline silicon thin film solar pv modules which are light,hollow hollow, light, red as glass curtain wall and transparent skylight
- Copper Indium Gallium Selenide are thin film cells on flexible modules laminated to the building envelope element
- Double glass solar panels which contains square cells inside

Building Integrated Photovoltaics (BIPV) is the integration of photovoltaics (PV) into the building envelope. The Photovoltaic modules serves the dual function of building skin such as replacing usual building envelope materials and power generator. By reducing the use of conventional materials, the incremental cost of photovoltaics is reduced and its life-cycle cost is improved. These systems generally have reduces overall costs than photovoltaic systems requiring separate, dedicated, mounting systems.

An entire BIPV system includes:

- PV modules
- a charge controller,
- a power storage system
- power conversion equipment that includes an inverter to convert the PV modules' DC output to AC compatible with the utility grid;
- backup power supplies such as diesel generators

Photovoltaics may be integrated into various assemblies :

- Solar cells can be incorporated into the frontage of a building, replacing traditional view or spandrel glass. These installations are generally vertical, lowering access to available solar resources.

- Photovoltaics may be incorporated into awnings and saw-tooth designs on a building portico. These improves access to direct sunlight on the building.
- The use of PV in roofing systems can give a direct replacement for batten and seam metal roofing and traditional 3-tab asphalt shingles.
- PV for skylight systems are both an economical use of PV and an excellant design feature.

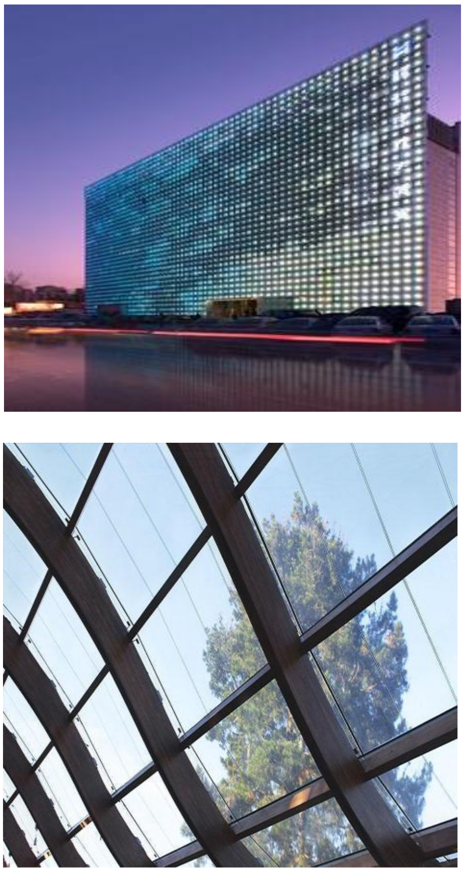

Fig 5: BIPV system

IX. ROBOTICS IN CONSTRUCTION

The construction industry is one of the least automated industries that use manual-intensive labour as a primary source of productivity. Whatever it's new a commercial construction, renovation or demolition, robots don't yet play a major role in any part of construction. However, machines having the ability to function on their own, without the human interaction actually has the potential to improve safety for all workers. In construction,robotics is now being used for machineries that operates on itself like cranes, bulldozers, and excavators, but the applications for such technology are not reached completely. When construction labours are relieved of the role of completing the routine tasks performing now by robots, their time can be used to do more skilled work.

Since these robots can develop even more precise and accurate, they'll become a authoritative force in the industry. Initially, the cost will be high, but it will still be well worth it to give attention to this technology. Eventually, we can witness that robots would be able to perform things like laying bricks and tieing rebar..etc.Even now we see them complete most of the current man-operated construction projects.

There are a various types of construction robots that are perched into the construction market to break at a large scale.

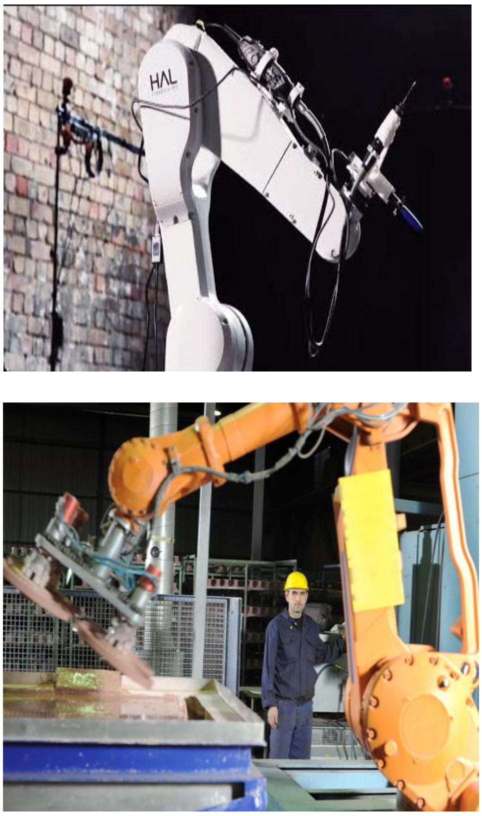

Fig 6: Robots for laying bricks

3D-printing robot is the first invention that can build large buildings on demand. It includes a mobile robotic arm controls a 3D-printer, and with a set of pre-programmed instructions, This invention prints an whole structurally-safe building in 3-Dimension. This combination of industrial robots and 3D printers is one of the most worthy automation technology in the construction field.

There are even robots for brick-laying and doing masonry works, and even robots that can lay an entire street at single time. These kinds of robots considerabely improve the speed and quality of construction work.

Demolition robots are the type of construction robot that's about to play an major role in mainstream applications. Even though they perform slower than demolition groups, they are more safer and cheaper during demolishing concrete and structural components of a building .

There are even other types of construction robots like remote controlled vehicle type robots, but the explained above are particularly manufactured to function in the present construction industry.

In addition to automatically working tasks, robotics also influence the safety level of construction workers in the construction field. These qualities pave the way for a safer job site, increase in production , and a reduced time consumption i to complete a job. The applications of robotics and its benefits in the industry ultimately reduces operations costs.

In this unautomated industry, these construction robots will create a major impact on the construction industry. As construction companies expect to perform tasks automatically for the matter of productivity and efficiency,the demand for construction robots will grow rapidly.

X. CONCLUSION

The change in the construction industry is certainly expected to increase presently such that major socio-economic changes will rule over the next decades. Practically incorporating these advanced construction techniques can increase efficiency,quality,safetyand make the project more worth for the money. Anyhow, there is a conflict between traditional industry methods and these advanced techniques, and this advanced techniques is often blamed for the relatively slow rate of technology transfer in the industial applications.But it is mandatory to improve the construction industry and take it to the next level of automation.It is not only about solving poverty and save money; it is also about improving the quality of the construction. Modularity would be the best method to achieve those goals.

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