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EMERGING INNOVATIONS IN THE FUTURE OF CIVIL ENGINEERING: AN OVERVIEW

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Abstract— The world is developing and innovating new trends day by day. Every second we are experiencing new trends that make our life simple, easy and accurate. Similarly, in the field of Civil Engineering too, the new ideas are emerging which helps in more productivity and serviceability. Before construction, we have new trends like BIM, ANSYS, CANDY and etc. software which help in design, analyse with accurate results. When coming to the machinery, upcoming innovations like Internet of Things (IoT), Drones, Robots and Automations helped us a lot in achieving security and faster productivity. In the phase of Construction, Green Buildings, Smart concretes like Transparent concrete, Self-healing Concrete, and Active Football, modular construction, 3D Printing and also IoT applications paved way to much more new era in the field of civil Engineering.

Keywords— Transparent Concrete, Active Football, IoT, 3D Printing, Automation

I. INTRODUCTION

We are facing serious increase in population and Urbanisation. Everyone enjoys the resources that are provided by the nature. The question today is how these needs can be accomplished without compromising the ability of future generations to meet their needs. The rapid advancements in the field of technology have developed some concepts focusing on few challenges like delivering faster, managing data, save more and also to think Big, effective communication etc. In every phase of civil engineering there are these innovations. Recently, as the convergence between multi-disciplinary and dissimilar technologies has deepened, the social competition and the complexity of customer needs have increased, and the phenomenon where the boundaries between different disciplines, such as science and technology, engineering, humanities, and the social sciences, are destroyed has been highlighted. Now is the time to explore a framework for a new type of construction technology through the fusion of engineering and science based on innovation (discontinuous innovation) beyond the advancement of the conventional concrete technologies in the past. The convergent thinking approach is the process of deriving new ideas based on stereotyped knowledge in the existing passive learning, whereas the divergent thinking approach is the process of addressing the inhibition of creative thinking by stereotyped knowledge and thus of making new ideas and coming up with new creations through new thinking without boundaries, contrary to the network of knowledge. Creating new values through the existing convergent thinking approach is meaningless in the current fast-changing science and engineering world, and there is a need to create values through a new innovation process in the field of engineering by sharing different ideas and values, away from the stereotyped framework based on the existing knowledge.

II. INNOVATIONS IN DETAIL

The discoveries in the field of Civil engineering are coming up every second. The following are some of the trends that are developed:

- **Before Construction**:

  - **Software**:

Computer plays a significant role in all walks of our life. With the advancements and inventions of new software will reduce all that extra work. There are many types of software that are available in civil engineering field each for specific work. But the invent of IoT, Building Information Modelling(BIM) for virtual design and other softwares like CANDY for estimation, etc. have helped the engineers in a better way.

Building information modelling (BIM) is a data-led process that allows project teams to manage information from the design stage and throughout the construction lifecycle. The principles of the software, which always stands out as a valuable asset, are saving time, reducing the civil engineer's workload and manpower, lowering total cost and ensuring a high level of accuracy. Many programming companies are available today and interested in providing the global market with thousands of software as well as the supporting features needed to make them user-friendly, better suited, more flexible and effective. Software performance in multiple and complex calculations has successful contributions due to their principles. Software is an extremely powerful tool and can be adapted to specific needs in order to serve the intended purpose of any project.

- **During Construction**:

  - **Smart construction:**

a) Internet of Things:

Internet of Things (IoT) has triggered a new communication pattern that all the objects in our life and work could be possibly communicated in both a sensory and an intelligent manner. Two typical information exchange modes, i.e. human to thing (H2T) talk and thing to thing (T2T) talk, are thereby available anytime at anywhere to facilitate dissemination of information in a smart way2. Smart Appliances make way for a smart home and thereby also to a smart city, where all the Civil Infrastructures could be efficiently operated and other Public Service facilities could also be effectively administered. Just the way Money transactions are performed on the Internet, so too, Product Monitoring (Bridges, Buildings) and Project Management (Traffic Regulation, Water Supply, Sanitary disposal, Street Lighting, Weather Monitoring, Pollution control) could be done SMARTLY using IoT.

b) Modular construction:

With the aim of delivering faster productivity, the new concept of construction has been developed called modular construction. The project that has been taken up will be completed in just few days with more efficient results.

c) Smart roads and grounds:

The population is increasing day by day. The people are engaging with their works and we all lost that energy. ACTIVE FOOTBALL/KINETIC FOOTBALL or ACTIVE ROADS/KINETIC ROADS are the new innovations where the flooring is enabled to determine the energy of footsteps. This energy is used indoors or outdoors in high traffic areas, and generates electricity from pedestrian football using electromagnetic induction process and flywheel energy storage. The technology is best suited to transport hubs where a large flow of people will pass over it. The largest deployment the company has done so far is in a football pitch in Rio de Janeiro to help power the floodlights around the pitch. It also currently has a temporary installation outside London's Canary Wharf station powering street lights. This was developed by Pavegen.

In addition to this innovation, we have SOLAR ROADS, developed by Scott and Julie Brusaw and also concept of roads which can charge electric cars and many more.

d) 3D Printing:

3D printing is a cutting-edge technology that's changing the manufacturing landscape. It's well suited for rapid prototyping, quick turnaround end-use parts, or even tooling for traditional manufacturing techniques. Begin with the basics, and learn how to design objects and prepare them for 3D printing. Additive manufacturing and 3D printing have paved ways in civil engineering having ability to build any product of any scale and also real components.

- **Sustainable construction:**

e) Concrete materials:

i. Transparent concrete:

Hungarian architect, Aron Losonczi, first introduced the idea of light transmitting concrete in 2001 and then successfully produced the first transparent concrete block in 2003, named LiTraCon. Now a day there is drastic improvement in construction technology, the height of building are increased to great extent. Metropolitan cities are crowded by sky skyscrapers which in turn increase artificial light consumption for illumination and hence to reduce power consumption, light transmitting concrete is better alternative. Transparent concrete is a concrete based building material with light transmitting properties due to embedded light optical elements usually optical fibres. Light is conducted through the artificial stone from one end to the other. Therefore the fibres have to go through the whole object. Transparent concrete is also known as the translucent concrete and light transmitting concrete because of its properties. It is used in fine architecture as a facade material and for cladding of interior walls. The purpose is to derive sunlight in interior of structure as a light source to reduce the power consumption for illumination and also use this concrete as an architectural purpose for good aesthetical view of the building as well as for interior decoration.

ii. Other types:

Many types like Self-healing concrete, waterproof concrete, Anti-bacterial concrete, Thermal concrete, etc. have been developed providing us many advantages in their respective ways.

f) Green Buildings:

Green Building refers to the incorporation of environment friendly and resource efficient processes at each stage of construction, right from site selection and designing to construction, operation followed by maintenance, renovation or even demolition. The endeavour is to seek minimum impact on environment. The key components include sustainable site design, energy efficiency and renewable energy, water efficiency, material efficiency, indoor environment quality. A green building is also known as sustainable building, is an opportunity to use the resource efficiently while creating healthier buildings that improve human health, build a better environment and provide cost savings. All development projects lead to over consumption of natural resources which leads to serious environment problems. The organisations like United States Green Building Council (USGBC) and Indian Green Building Council (IGBC), etc. are raised setting up some standards to avoid this issue. Not all projects are aware of this, but these standards have to be included now and in near future.

- **Construction management:**

iii. Machinery:

g) Robots and automation:

Robots and automation are of multiple benefits providing faster and better performance, etc. Especially in high labour cost countries; automated and robotized construction technologies can compensate increasing demand on construction projects. The short- and long-term development of automation will take place step-by-step and will be oriented to the respective application and requirements. In the initial phase existing building machines will be automated step-by-step. In the medium term a mixed concept consisting on the one hand of manual operation with programmable partial processes and on the other hand of automatic operation with manual monitoring options including all controlling concepts lying in between will gain ground. Though the initial cost is high, there will be better outcome. This innovation is still under development in many regions and will be seen in full swing in forthcoming days.

h) Other types:

Not only robots, there are many other new trends like Virtual Reality (VR) and Augmented Reality(AR) for more realistic exposure, Drones for security and monitoring and also IoT based machines, etc. are coming up for us in next level. All these Computer Integrated Construction will be helping the construction field efficiently.

❖ **Afterconstruction:**

- **Smart management**:

Of course IoT based applications as discussed before will play major role in management after the project has been finished.

III. ADVANTAGES

Realising the advances of technology and forthcoming chances, we have major advantages. Some of them include:

- Reduce risks of accidents in sites while undergoing projects like under sea constructions, tunnels, etc.
- Completion of project soon and also with better productivity.
- Usage of softwares, one can be aware of data management and can proceed with accurate plan.
- Cost reduction.
- No limit for ideas.
- Sustainability and many more.

IV. DISADVANTAGES

Unlike advantages of the new emerging trends in civil engineering industry, there are some disadvantages that one has to note:

- High Initial cost.
- Lack of awareness
- Lack of resources for utilization like materials, funds, etc.
- Lack of effective communication between controlling officer and smart machinery to manage this computer integrated construction.
- Lack of knowledge resources like manpower, etc. for the project to implement all the above discussed innovations.
- Correct usage (when and where to use, is this innovation necessary for our project?) and many more.

V. CONCLUSION

Over 2000 years ago, the yet famous Great Wall of China took nearly 200 years to complete. In 1994, The English Channel built between UK and France, took 6 years to complete. In 2011, Qingdao Haiwan Bridge, China took 4 years to complete. In 2012, A 10 Storey Building in Mohali, India was constructed in just 2 days. In 2015, A 57 storey Building in China claims it was constructed in just 19 days. By this we can understand how well the technology is changing day by day. It is the duty of an engineer to know and adopt in their projects. Not all the discussed innovations are in use today. The high complexity of the construction process and the stagnating technological development a long-term preparation is necessary to adapt it to advanced construction methods. Knowing the merits and demerits of these advancements like making things easier, faster and lifesaving, the entire civil engineering field waiting for further innovations to welcome and inculcate effectively in their projects.

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