

SUSTAINABILITY OF CONCRETE AND STRUCTURES

Yash Agrawal^{1*},

Ar.Nishant Saxena²

Bhavesh Joshi³

Abstract-

Today sustainable development has become important issue for the engineers around the world due to non availability of natural resources. The approach of RRR (reuse, recycle and reduce) is the most significant approach towards the sustainable construction. In the construction sector, cement and steel consign massive energy claim for the production itself. That's why it is important to make the structures sustainable without compromising with the future need as national wealth is directly belongs to it. The most widely used material concrete facing the challenge and concern all over world. The sustainable construction requires both the concrete and structure would be design durable to meet the future need. This study concentrates on the introduction of sustainable concrete and structures. Also in this study general introduction is given about some modern method and techniques for achievement of sustainability in concrete and structures.

Key Words: Sustainable concrete ,structure, health mointoring

1. Introduction

Today a great challenge in the construction industry is to meet the requirement of present generation without wasting, polluting or damaging the environment and compromising with future generation needs.

The most widely used material concrete facing the challenge and concern all over world. In the construction sector, cement and steel consign massive energy claim for the production itself. Cement production generates total 7% of CO₂ emissions from all the other rest, which causes environmental pollution and in the conventional concrete the river sand and coarse aggregate are inadequate to the enormous utilization of natural resources.

Therefore it is essential for us to identify the new material and method for the production of cement and concrete without using natural resources.

In order to achieve this sustainability of concrete and structure, focus on the broad understanding of material and technical issues are need to rectify. For creating a sustainable construction world cement replacement material, industrial waste & by-product, other waste material, fibers/textiles and recycle aggregate are suitable options. Therefore selection of material plays a significant role in development of sustainable infrastructure.

1.1. Sustainability of Concrete

Following are the method and approaches for making concrete sustainable:-

1.1.1. By using high strength concrete:

Normal/conventional concrete is less sustainable than High strength concrete and ultra high strength concrete.

Yu *et al.*(2014) determined the properties of Ultra-High Performance Fibre Reinforced Concrete. The test results showed that, after 28 day of curing, large amount of unhydrated cement in the UHPFRC matrix is still available , which could replaced by fillers to improve the workability and cost efficiency of UHPFRC.

1.1.2. By making concrete with high durability:

Currently concrete mixtures are designed to achieve the strength, with the durability second concern. For sustainable concrete we have to design a concrete by using different admixture and lower w/c ratio for higher durability in effective way to increase its service life.

Melançon (2014) examined the effect of high-performance concrete and steel materials on the blast performance of reinforced concrete one-way slabs and also investigated the

implementation of innovative materials in reinforced concrete slabs and panels.

1.1.3. By using supplementary cementing material:

Today it is very important to reduce the environmental pollution for creating sustainable world. The most effective method for making sustainable concrete is to replace the cement partially by supplementary cementitious material for decreasing both energy consumption and production of green house gases.

Each kg of replacement of cement results in reduction in 1 kg of CO₂ emission and save several energy in production.

There are many supplementary cementing material such as fly ash, ground granulated blast furnace slag, silica fume, metakoline and calcined clay and rice husk ash.

Ramezianpour *et al.* (2018) examined effect of supplementary cementing materials on concrete resistance against sulfuric acid attack. The test results indicated that concretes containing supplementary cementing materials are more durable and significantly improve performance in acidic solution.

1.1.4. By using filler material:

The filler material is that material which cannot react chemically with the cement, but beneficial for physical action. Crusher dust, marble slurry and granite slurry are use as filler material.

Subaşı *et al.* (2017) determined the use of waste ceramic powder as filler material in concrete and also evaluated that 15% of waste ceramic powder as a filler material is effectively used without compromising with the strength and other parameter.

1.1.5. By using waste materials:

Sustainability of material depends basically on RRR i.e. recycle, reduce and reuse. By using different industrial waste sustainable concrete is made.

Lynch (2017) tested the results of adding plastic and glass into concrete mix. The results gave idea of cleaning up the environment by putting waste material into concrete in less quantity.

Thomas *et al.* (2016) investigated the comparatively the depth of chloride penetration, resistance to acid attack and macrocell corrosion of rubberized concrete and control mix concrete

1.1.6. By using recycle concrete:

Recycle concrete aggregate is a material which results from construction and demolition of building and structures. Recycled concrete aggregate are most commonly used as coarse aggregate. Density of these aggregate is estimate between 2100 to 2300 kg/m³.

Khan *et al.* (2016) determined the strength gain in low volume fly ash concrete (LVFAC) with stone dust and recycled aggregates. The best optimum dosage was found at 5% of stone dust and 5% of recycled aggregates to accelerate the rate of gain of strength.

1.1.7. By improving structural design and building codes:

For sustainable construction it is essential that the engineer will improve the structural design by making the structure more fit up to its design life period by using sustainable concrete so the structure withstand more safely than its design life.

Various building codes are should be revised so that the structural concrete shall have good compressive strength and durability for different exposure condition.

Cohn and Riva showed the suitability of design codes requirements for curvature ductility which were predominantly based on fixed targets.



Fig.1 Sustainable concrete

2. Sustainable Structures

The entire life cycle of structure is divided into five phases which is demonstrated in fig.2. So it is important to make the structures sustainable without compromising with the future need because national wealth is directly belongs to it.

Important challenge for developing sustainable world is to achieve the sustainable structures and the state of the existing infrastructure systems for making them sustainable. Many structures in India as well as in the world are showing the signs of damage/distress.

Sustainability of old structures can be achieved through by providing them proper strengthening via retrofiting. In case of the new and existing structure sustainability can be achieved by structure health monitoring system.

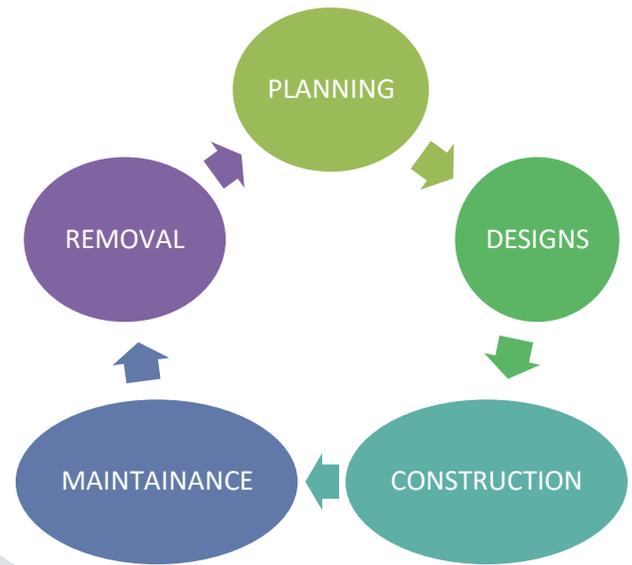


Fig.2 Life Cycle of Structure

Entire man-made structures cover restricted life spans and mortify after they place into service. Miscellaneous processes condition for example fatigue, erosion, wear, corrosion, and overloads degrade them until they are no more fit (Gharibnezhad *et al.*, 2014).

It is exceptionally hard to do maintenance and inspection of infrastructure, due to in service expense. The quality of infrastructure is directly interrelated to the wealth of nations.

With encroachment and modernization in the construction industry structures failures may be prevented by monitoring and prediction of their life span. By monitoring the structure, we discover options of those issues that enhance the life of the structure.

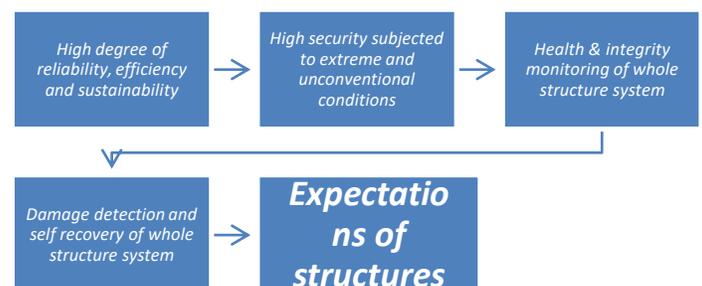


Fig.3 Flow diagram of expectations of structures in present and future

2.1. Main factors affecting structural health

Factors that mainly affect structural health are as follows:

1. Differential settlement
2. Earthquakes and vibrations
3. Structural distress
4. Reinforcement corrosion
5. Stresses development due to temperature

2.2. Structural health monitoring-

Modern, efficient monitoring systems are proficient in providing information regarding the behavioral condition and safety of the structure to the structure owner and operator thus assisting with the progress of operation and maintenance plans as outlined in Fig. 4.

From structures, different type of monitoring may be carried out (St Leger *et al.*, 2014):

- a. Meteorological Monitoring,
- b. Wind, Air Temperature and Humidity,
- c. Highway Live Load Monitoring,
- d. Seismic Load Monitoring,
- e. Position Monitoring,
- f. Hanger Load Monitoring,
- g. Tower Settlement Monitoring Strain

Monitoring

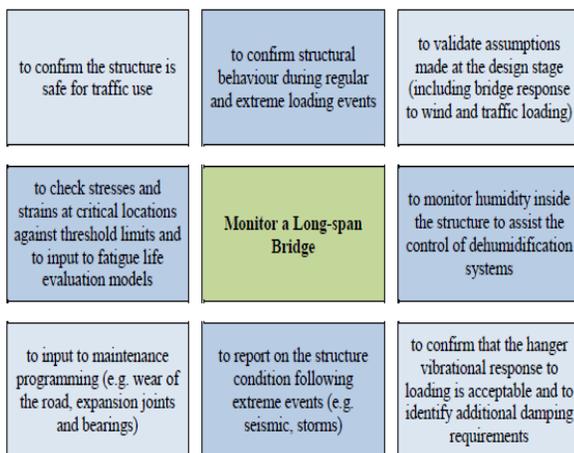


Fig. 4. Information of a structural health monitoring system (St Leger *et al.*, 2014)

Sustainability of the structure brings the following things in world of structures-

- Life cycle management
- In service inspection
- Repair and rehabilitation
- Use of energy efficient material
- Application for to ascertain the efficiency of building

3. Summary and Conclusion

The various method and approaches for sustainability of concrete and structures have been broadly investigated in the recent years. This paper presents need of sustainable structure, which could be summarized and concluded as follow:

- The method and techniques for making concrete sustainable is clearly demonstrated.
- Nevertheless, the field is still in its early phases, and further R&D investigation is need to be carry out in this area.
- In the majority of instances, the factors of structure failure would be traced, retrofitting and structure health monitoring of old structure will be done to achieve suitability of old and new structures.

4. About the author

1.



Yash Agrawal is an Assistant Professor in the Department of Civil Engineering, Geetanjali Institute of Technical Studies, Udaipur, India. He is Pursuing Ph.D. program from College of Technology and Engineering, MPUAT, Udaipur He received his Bachelor’s degree in 2012 from Pacific Institute of Technology (RTU) College, Udaipur. Master’s degree in 2016 from of College of Technology and Engineering, MPUAT, Udaipur. His research

interests include Sustainable construction, Earthquake resistant structures, durability of concrete and utilization of waste materials in concrete.

2.



Is a Jaipur (India) based architect and academician. Graduated in the year of 2005 from 'Aayojan School of Architecture', he has been practicing from over a decade now. He has been involved in design, project management & execution of numerous urban planning, housings, commercial and conservation related projects. Currently he is serving Amity School of Architecture And Planning, Amity University, Jaipur in the capacity of Associate Professor.

3.



Bhavesh Joshi is an Assistant Professor in the ASAP, Amity University, Jaipur, India. He received his Bachelor's degree in 2013 from Sir Padampat Singhania University, Udaipur. Master's degree in 2016 from of College of Technology and Engineering, MPUAT, Udaipur. His research interests include Structural engineering, Concrete technology and Earthquake resistant structures.

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