

**SUPER PLASTICIZER USED TO ENHANCE THE CONCRETE
SUSTAINABILITY -A REVIEW**¹Aamir Shahzad Shafiq, ²Shabbir Ahmad, ³Hazrat Saeed Khan^{1,2,3} Department of Civil Engineering, Iqra National University Peshawar, Pakistan

Abstract: Throughout the world, sustainable development is one of key factor and challenge covering the needs of human begin such as energy, food, transportation, industrial and natural resource. More ever it is more important for future development to protect the natural resources and environmental qualities. It is known to everyone that 0.9 metric ton of carbon die oxide was produced by manufacturing of 1 metric ton of cement which is very harmful to health condition. In order to overcome this type of issue we must reduce use of mortar and concrete work. The best way to replace the cement is use of different admixture in concrete and mortar. In this review paper the admixture used in construction work is superplasticizers. The reduction in water cement ratio, high performance concrete and self-compacting concrete production is due to addition of admixture (superplasticizers) to the concrete. It is indeed know that by decreasing water cement ration the concrete strength increase with increase in stiffness of mixture. But in world most of construction companies having lack of knowledge to use the Plasticizers at right way and right time. Therefore it was recommended to use the Superplasticizer in concrete at right time and right procedure to achieve max effectiveness.

Key Words: Sustainable Development, Superplasticizers, environmental qualities, Industrial and natural resources

Introduction:

It was difficult to know the definition of sustainability in easy way. However it was defined in different ways and mainly based on four types of criteria.

- A system or process is said to be sustainable if it was not increase from its limits. It was mostly based on resources and not finished with in difficult time.
- The most complete definition of Sustainability was to continually define behavior independently, and to know the relationship between social, economic and environment sustainability.
- External or internal unexpected waste must not be produced with in sustainable process.
- A system or process was said to be sustainable if and even resources and opportunities was equally distributed.

Throughout the world, sustainable development is one of key factor and challenge covering the needs of human begin such as energy, food, transportation, industrial and natural resources. More ever it is more important for future development to protect the natural resources and environmental qualities. In the developing countries the demand of natural resources was the fast increasing supply. Furthermore the human being influenced the environment was important and increasing day by day.

The Independent and corresponding ideas were seen as economic, social, environmental and technological development, while improving the life quality with common goal ecological sustainability and economic competitiveness were corresponding features. As now the construction industries were moving so fast that in order to achieve targets and doing good performance in term of sustainability, the global energy consumption and generation of waste was observed as 40% and emission of carbon di oxide was found as 50%. In economical context the largest asset of any country was its building stock which also included infrastructure. The three pillars of sustainability such as environment, social and economic were most important factor that was considered in the construction and building sector because it was observed that most of people was interested to spend their 90% of time in building or in between building due to transportation. To meet the needs of present generation without killing and damaging of the environment was said to be sustainability. Sustainability also implies more ever if the needs of present generation was completed without compromising the capability of future generation needs to meet their needs. During the life time of new facility to be built in area and meet all the requirements and provide facilities to the society and peoples, the structure was said to be sustainable. Economic, environmental and social sustainability, (the three pillars of sustainability) was also taken in consideration while constructing the sustainable infrastructure.

As per Bruntland report (Our Common Future, World Commission on Environment and Development in 1987) the most used and original definition was as given below,

“The Development without compromising the need of future generation to meet while meets the present population”

To ensure the better quality of life for present and future generation was known as sustainable development. To achieve the better life quality following three elements were important such as

- To know and define the needs of every one such as social equity
- Establish level to be maintained of economic and employment growth
- To enhance and protect the usage of natural resources such as environment

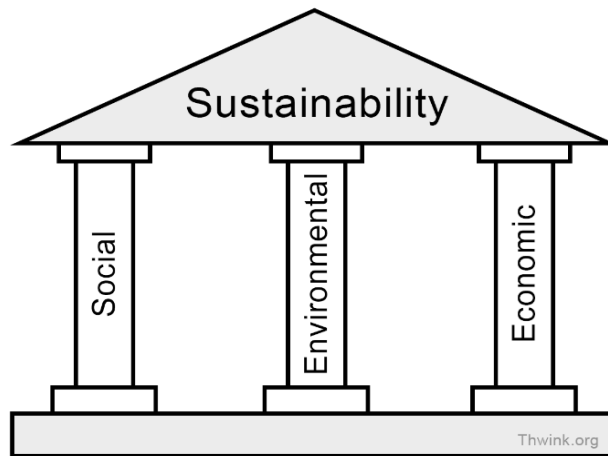


Fig: 01 Three Pillars of Sustainability

For Sustainability there must be even balance between all pillars. For instance, if we performed at the cost of community with positive economic growth this was not sustainability neither behind the unexpected mean protecting the environment. Perfect Solution was not the demand of Sustainability. All the organization were working together for the sustainable development as it was goal of all forward looking organization. Finally we said balance approach was a sustainable approach.

Super Plasticizers:

Super plasticizer are also known as high range water reducers. In 1968 Verbeck define the superplasticizers as polymers including sulphonic acid and at regular interval attached to the backbone of polymers. Also they were used in concrete applications in order to avoid or protect the segregation of particles and suspension properties of flow was improved. They were belong into four families of commercial formulation.

- Sulfonated melamine-formaldehyde condensates (SMF)
- Sulfonated naphthalene-formaldehyde condensates (SNF)
- Modified lignosulfonates (MLS)
- Polycarboxylate derivatives

It was a common practice of using the Superplasticizers (High range water reducers) in concrete applications. In 1960, this type of water reducers were developed in Japan and Germany and in mid of 1970's they were introduced in United States of America. According to types of superplasticizer's they were divided into four numbers such as

- sulfonated melamine Formaldehyde



Fig: 02 sulfonated melamine Formaldehyde

- sulfonated naphthalene Formaldehyde



Fig: 03 Sulfonated naphthalene Formaldehyde

- modified lignosulfonates and a combination of high dosages of water reducing
 - Accelerating admixtures.
- Melamine and Naphthalene based were commonly used superplasticizers. The naphthalene based superplasticizers were used to retard and affect the slump retention. This was due to hydration process by sulphonates.

Super Plasticizers Generations:

According to generation there are three types of Superplasticizers.

- 1st Generation – Lignosulphonates
- 2nd Generation – Polysulphonates
- 3rd Generation – Polycarboxylate

In 1960’s the first generation of Superplasticizers were introduced. After the introduction, for use of reinforcement with high density, low accessibility to areas and enhancing the ability of pump concrete, these superplasticizers were used important part of concrete placement. More ever these products included to concrete lead to high strength and durability because of lower water cement ratio. These superplasticizers were most common element of concrete with high quality and high performance. In addition, to achieve the desired properties, by the new developed concrete such as self-compacting concrete, presence of superplasticizers were required. The Superplasticizers supplied were consisted of liquid formulation along with 30-40% of active solid content.

The example of normal water reducers are carbohydrates and lignosulphonate salt of sodium and calcium hydroxycarboxylic acids. This review paper consisted generally of Superplasticizers and known as water soluble polymers. According to the properties of Polymers, the superplasticizers behavior was function of polymerization degree and its structure.

Table: 01 Generation of Super Plasticizers

S.No	Name of Superplasticizers	Generatio n
1	Lignosulphonates	1 st
2	sulphonates formaldehyde condensates	2 nd
3	Polycarboxylate and Polyacrylates	3 rd

Sulphonates formaldehydes condensates and polycaboxlates were most commonly and widely used superplasticizers. If we compare the cost of superplasticizers, the cost of sulphonated melamine formaldehyde and polycarboxylic ether were almost equal, sulphonated naphthalene formaldehyde cost was half of the Polycarboxylic ether. The cheapest superplasticizers was lignosulphonate. According to superplasticizers effectiveness, sulphonated naphthalene formaldehyde or lignosulphonate amount was more required as compared to polycarboxylic ether to achieve the Concrete workability. Therefore the unit cost of superplasticizer were not increases with the overall cost of plasticized concrete.

High Water reducer-Superplasticizers:

During construction work, concreting was one of most important activity to be done on site in building elements (Beam, columns and slab etc) for which strength was required as define in Specification. To achieve the specified strength of concrete water cement ration was a key factor to be known and used while using mixture of concrete. If we reduce the quantity of water or W/C ration in mix, it was observed that such type of mix having high density and higher paste quality. Higher compressive and flexural strength was observed in high quality paste with low permeability, Bond increased between steel and concrete, enhancement in weather resistance, dry and wetting volume was change and reduced along with reduction in shrinkage cracks (PCA-1988).

Collepradi in 2006 stated that Superplasticizers were used to ensure the good workability at low water cement ratio. When superplasticizers were added to the concrete mixture, it required less water as compared to mixture without admixtures addition. Therefore they were called as high range water reducer. There are some superplasticizers which introduce air due to their amphiphilic nature. As per (Sakai et.al (2003), Plank (2004) Comb type copolymers consisting uncharged side chains and anionic back bone were most effective superplasticizers. According to the water reduction level the Superplasticizers were divided into two types such as normal range water reducer and high range water reducer by addition to concrete mixture. The percentage value of high range water reducer was found 15-30% water reduction in mixture of concrete while for normal range of water reducer the percentage value was noted as 5-10%. The High range water reducer were added to the mixture of concrete at reduced water cement ratio to maintain the same workability or by maintaining the constant water cement ratio to enhance the workability of concrete. The Superplasticizers which were used to reduce the water content in mix are retarding admixtures or High range water reducers. Those admixtures retained the workability and consistency of mix and reduce 12 to 30% of water in the concrete mix.

Procedure for water Reduction in Concrete Mix:

Water cement ratio in mix of concrete was done in such a way that process of cement hydration was complete along with retained workability to place and compact the concrete easily and smoothly during the construction work at site. The process of hydration of cement was completed within range of 0.22 to 0.25 water cement ratio. For best workability of concrete during its placing and compacting existing additional water was required. When the less quantity of water was added to mixture, the mixture become stiff and less workable which lead towards the issue of placing and unsmooth finished surfaces. To decrease the addition of water to mix or mix with slow setting rate was due to addition of superplasticizers. In addition this was retained the concrete flowing properties.

Self-compacting concrete and super plasticizers:

Concrete having compacted under its own weight due to highly nature of flow and with better viscosity control was known as self-compacting Concrete. According to (Johnson and Anderson in 1991) for a mixture composition the optimal flow properties were achieved close to the maximum packing density. Based on theory it was found that the flow properties of concrete was observed form the excess paste after filling the aggregates in the concrete mix. So in this regard the low paste content or fixed paste content a given workability could be achieved and mixture was of high density and lead to better workability. So we applied this rule to the cementitious materials the nature of flow was improved by increasing the high density package.

Mix design Method:

The mix proportion of concrete and Materials used in mixing was largely influence by self-compacting. In 1995 Okamura and Ozawa assumed ready mixed Concrete plants by proposing the simple mixing proportion system. By getting the self-compatibility water powder ratio and superplasticizers were adjusted while fine and course aggregate were found fixed.

- Content of course aggregate of solid volume was fixed
- 40% of fine aggregate with respect to mortar was adjusted.
- Based on the characteristic of powder 0.9-1.0 water powder ration by volume was assumed
- To verify the self-compatibility final Water cement ratio and dosage of super plasticizers were determined. High viscosity and deformability was required for mortar and paste in self-compacting Concrete.

Conclusion:

It was observed that greenhouse gases having linkage with use of cement and concrete in construction industry. Therefore it was a huge problem for civil engineer to control greenhouse gases to atmosphere during construction of sustainable structure. So for this purpose to reduce the greenhouse gases engineer used different advance concrete composite and cement such as superplasticizers as reviewed in this paper. It was well known that workability and durability of concrete was increased due to addition of superplasticizers to the mix. If we used durable materials, the concrete constructed from this materials was also durable and more sustainable because of following

- The concrete was of economic value
- Having good impact on environment
- Structure used for long time

With close coordination between client, consultant, contractor, architecture and structure design we can construct sustainable structures in our country within available facilities or resources. More ever due to our education matter we

cannot assumed it as large financial investment or loss for any country. Ordinary concrete (without addition of Plasticizers) are more shrink as compared to concrete with superplasticizers addition. Water Molecules are hundred times lesser than macromolecule and superplasticizers are soluble macromolecules (Gani -1997). Workability of Concrete was reduce when superplasticizers were fixed with C3A in cement Particles, therefore it should be ensured.

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