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The Importance of Using Natural Admixture to Improve the Properties of Concrete

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ABSTRACT

Chemical admixtures are commonly used in concrete in modern construction. Although chemical admixtures increase the characteristics of concrete, they also cause leaching and contribute to environmental damage. The impact of chemical admixtures on the environment can occur when chemical admixtures are exposed to the environment, when dumping concrete granulate containing admixtures after the demolition of a structure, or when concrete granulate is used as gravel replacement in construction, and because the concrete admixtures are very readily soluble in water, thus creating an environmental problem due to leaching. This study provides a critical examination of numerous natural resources. Leaching causes an environmental issue. This paper provides a thorough analysis of numerous natural materials used in concrete as an additive that influences the mechanical and durability characteristics of concrete. When compared to chemical admixtures, this type of admixture is more environmentally friendly and less cost.

Keywords: natural admixture, chemical admixture, environment, Durability, Mechanical properties, Natural Admixtures.

1- GENERAL

Concrete is the mostly used man-made material used in construction industry and is the second after water as the most utilized thing on the Earth. Simply said, it is a four-ingredient combination is described as having coarse aggregates (size from 6.5 to 38 mm or larger), which make up the majority of the mix, fine aggregates (with a size range of 0.025 to 6.5 mm), like sand, which fill in the gaps, binding materials, like lime or Portland cement, which hold the components together, and water, which reacts with the binding materials. We get a paste known as matrix when we combine these four ingredients. This step of the process is known as fresh concrete or green concrete, and as the water reacts with the binding substance, it hardens into stone. This response is referred to as concrete hydration. Concrete can be cast into any desired shape while it is still in its fresh state by using forms. This characteristic of concrete enables the most effective use of the material. In typical structural concrete, the ratio of water to cement greatly influences the concrete's characteristics. All other factors being equal, stronger concrete results from reduced water content. An admixture is a component that is added to the concrete mix in quantities no greater than 5% by mass of cement. It can lead to savings in other areas, such as the cost of labor needed to effect compaction, the amount of cement that would otherwise be required, or the improvement of durability. To reduce the water/cement ratio while maintaining the desired workability, a water-reducing admixture is used in concrete mixes. However, properly used admixtures are not a fix for low-quality mix components, improper mix proportions, or poor workmanship in transporting placement, and compaction techniques. (neville,A.M, 1995)

An admixture, according to the (ASTM C-494) a standard is a material other than water, aggregates, and hydraulic cement that is used as an ingredient of concrete or mortar and is added to the batch immediately before or during mixing. The widespread use of admixture is due to the many benefits made possible by their application. The use of admixture into concrete mixes to alter or improve the properties of the fresh or hardened concrete or both. In general, these changes are affected through the influence of the admixture on hydration, the liberation of heat, formation of pores, and the development of the gel structure. Concrete admixtures should only be considered for use when the required modification cannot be made by varying the composition and proportions of the basic constituents' materials, or when the admixtures can produce the required effect more economically. Although the use of chemical admixtures in concrete provides better concrete properties, it also contributes to environmental pollution. Chemical admixtures serve a significant part in the creation of sustainable normal concrete with better mechanical properties and long service life; depending on their properties, they are used for a variety of reasons; (Patel, and Deo) Plasticizers, accelerators / retarding agents, waterproof additives, air-entraining agents, shrinkage reduction admixtures, and others such as corrosion inhibitors and coloring agents are examples of chemical admixtures that can be used (Gülçağ A.et all) . Chemical admixtures are used to modify concrete properties such as strength, flow behavior, frost and deicing salt resistance, sulphate resistance, setting characteristics, pump ability, and so on. Different chemical admixtures are widely utilized in the production of concrete with a very low water-cement ratio; common types and functions are listed in Table 1.

Table 1. *Types of chemical admixture and their functions:*

Types of chemical admixture	Function
Super plasticizer	To reduce the water requirement by 15% to 20% without affecting the workability leading to a high strength and dense concrete.
Accelerator	To reduce the setting time of concrete, it helps to remove the forms early and therefore is used in concreting in cold weather.
Retarder	To reduce the setting time by reducing the rate of cement hydration and therefore is preferred in high temperature concreting places
Water reducing admixture	To achieve a workability (slump) in the ratio of low-water cement to a certain strength and thus save cement.
Air entraining admixture	insert small air bubbles into concrete that act as rollers, they improve workability and therefore very effective in freeze-thaw cycles as they provide a cushioning effect on the expanding water in the concreting in cold climate.

2-HISTORY OF USING ADMIXTURE IN CONCRETE:

According to records, ancient constructions left by Egyptians, Greeks, Romans, and Indian civilizations were usually built with lime as a binding medium, and this substance was a versatile material that was used in traditional temples and monuments (Thirumalini, and Sekar). Furthermore, the builders used several bio admixtures in the manufacture of their lime stuccos. The exact objective of utilizing such admixtures is unknown (ACI Education Bulletin E4-12), but builders were led to believe that using plants and animal derivatives as natural admixtures in lime mortar would improve the strength and endurance of the mortar. Since the Roman Empire, admixtures have been utilized in concrete and mortar. The Romans discovered that organic materials such as molasses, eggs, and rice paste, as well as inorganic materials such as milk, blood, and lard, allow for increased workability in cementitious compositions. While the first patent for calcium chloride in concrete dates back to 1873 in Germany, contemporary additive technology began in the 1930s in North America with basic air-entraining agents, retarders, accelerators, and water reducers. However, these kinds of materials were not commonly employed in concrete until the 1950s. The ASTM C494 standard, now titled Historical Standard: Standard Specification for Chemical Admixtures for Concrete, was initially issued in 1962 and sets performance standards for five types of admixtures: A, B, C, D, and E. the high-range water-reducing admixtures Types F and G were not introduced to the C494 standard until 1980. The ACI 212 Committee published a report on "Chemical Admixtures in Concrete" that did not include a High Range Water Reduction (HRWR) until 1981. While the usage of admixtures in concrete increased dramatically in the 1970s, the first corrosion inhibitor was introduced in 1979 with the aim of the reduction of the impact of chloride salt attack (NaCl) on steel reinforcing. Shrinkage-reducing admixtures were used over 20 years later (1996) to help solve cracking problems connected with autogenous drying in high-performance concrete. The usage of admixtures in concrete increased in the 1980s and 1990s, with many projects using HRWRs as the placement benefits of higher slumps and enhanced durability of lower water-cementitious material (w/c) ratio concretes were realized.

Table 2. History of admixture use in concrete
(John Newman and B S Choo, (2003)

Brief history of admixture use		
Romans	Retarder	Urine
	Air entrainment	Blood
	fibers	Straw
Plasticizers	1932	Patent for sulphonated naphthalene formaldehyde plasticizers
	193?	Lignosulphonates used as plasticizers
	193?	Hydroxycarboxcilic acid salts used as plasticizers and retarders
Water proofers		Fatty acids, stearates and oleates
Air entrains	1941	Tallow and fatty acid soaps for frost resistance
Super plasticizers	1963	Sulphonated naphthalene formaldehyde commercially available
	1963	Sulphonated melamine formaldehyde patent and available
	1990-1999	Polycarboxylate ether development and production

3-CONCRETE ADMIXTURE TYPE

Mineral admixtures and chemical admixtures are the two types of admixtures used in concrete.

1-Mineral Admixture

These insoluble components are utilized in concrete to achieve particular technical properties. They consist of silica fume, fly ash, rice husk ash, furnace slag, and so on.

2-Chemical Admixture

Chemical admixtures are the elements in concrete other than Portland cement, water, and aggregate that are added to the mix just before or during mixing. Admixtures are largely used by producers to lower the cost of concrete construction, alter the qualities of hardened concrete, guarantee the quality of concrete while it is being mixed, transported, placed, and cured, and resolve specific crises that may arise during concrete operations, they are typically employed to lower casting costs and raise the caliber of concrete. The amount of cement used, the water content, the mixing time, the air temperature, the slump, and the batching processes all have a significant role in the efficiency of chemical admixtures (ACI 212, 2010) .

4-THE PURPOSES OF USING ADMIXTURE IN CONCRETE "

1. To accelerate the initial setting and hardening of concrete.

2. To retard the initial setting of concrete.

3. To increase the strength of concrete.

4. To improve the workability of fresh concrete.

5. To improve the durability of concrete.

6. To reduce the heat of evaluation.

7. To control the alkali aggregate expansion.

8. To promote pozzolanic properties in concrete.

9. To aid in curing of concrete.

10. To improve wear resistance to concrete.

11. To reduce shrinkage during setting of concrete.

12. To reduce bleeding of concrete.

13. To impart color to concrete.

14. To aerate concrete or mortar to produce light weight concrete.

15. To reduce segregation in grout mixes.

16. To increase the bond between old and new concrete surfaces and also between concrete and reinforcement.

17. To produce fungal, insects etc. resistant concrete.

18. To produce nonskid surface of concrete.

19. To increase the resistance to chemical attack.

20. To decrease the permeability of concrete.

21. To check the corrosion of concrete reinforcement. (Shetty, M.S. and Jain, & A.K., 2019).

5-KINDS OF CHEMICAL ADMIXTURES USED IN CONCRETE:

5.1-SET RETARDING ADMIXTURE

Water soluble additives called set retarding admixtures slow down the cement's setting. They do not appreciably plasticize and have little to no impact on the water demand or the concrete's other qualities. (Zhang, 2011)To offset the acceleration of concrete setting caused by hot weather, used to delay the setting rate of concrete. High temperatures frequently speed up the process of hardening, making it challenging to place and finish materials. Retarders delay the early setting of concrete while keeping it workable during installation. (Gan & M.S.J, 1997)

5.2-RETARD RESOURCES

1. Lignosulphonates salts and variants.

2. Salts and hydroxycarboxylic acid compounds.

3. Sugars and their derivatives (a truck of concrete can be stopped from setting by adding a sack of sugar to it (Ramachandran & V.S, 1996)

5.3-AIR-ENTRAINING ADMIXTURE

The purpose of an air entraining additive is to minimize concrete mixture segregation, improve workability, and increase the anti-freeze and durability of concrete by entraining a high number of small, homogenous, stable, and closed bubbles during the mixing process. (Gan & M.S.J, 1997).

5.4-WATER -REDUCING ADMIXTURE

Often cut the amount of water used for a concrete mixture by 5 to 10%. As a result, concrete treated with a water-reducing additive requires less water to achieve the desired slump. The water-cement ratio of the treated concrete may be lower. This often means that more cement may be used to build concrete with a higher strength. (Ramachandran & V.S, 1996).

Water reducers can be applied in three different methods, as follows:

1. They can lower the water demand for a particular workability, resulting in higher strength and toughness.

2. They can make a particular w/c and strength more workable.

3. The amount of cement can be decreased while maintaining the same w/c, sturdiness, and workability (Ramachandran & V.S, 1996)

5.5-ACCELERATING ADMIXTURE

Accelerating admixtures can be used to speed up the concrete's stiffening or setting or its hardening and early strength acquisition to enable quicker formwork striking and remolding (Zhang, 2011) The majority of accelerators are built on one of the chemicals listed below: Organic ions that are soluble (CaCl, carbonates, aluminates, fluorides, and ferric salts). Liquid chemical substances (triethanolamine, calcium formate, calcium acetate). Due to its cheap cost and high rate of acceleration, calcium chloride is the most widely used option for a provided dose. (Ramachandran & V.S, 1996) .Speed up the beginning of finishing processes and shorten the time needed for adequate curing and protection. In cold climates, accelerating admixtures are particularly helpful for changing the characteristics of concrete. (Gan & M.S.J, 1997)

5.6-SUPERPLASTICSIZER

sometimes referred to as plasticizers, high-range water reducers (HRWR) can be used to create high-slump flowing concrete by reducing the water content of concrete with a low to normal slump and water-cement ratio by 12 to 30 percent. The installation of very fluid yet workable flowing concrete requires little to no vibration or compaction. Depending on the type and dose rate, the impact of superplasticizers lasts just 30 to 60 minutes before rapidly losing its workability. Superplasticizers are often added to concrete on the worksite to compensate for the slump loss. (Gan & M.S.J, 1997).

Super-plasticizer materials there are four different kinds of super plasticizers that are frequently used for concrete.

1. Condensates of sulphonated melamine formaldehyde the dose of 0.5 to 3% by weight of cement is appropriate for low-temperature locations.

2. Sulphonated naphthalene formaldehyde condensates: Use 0.5 to 3% by weight of cement in high-temperature locations.

3. Modified Ligno Sulphate - This substance should not be used in dosages that exceed 0.25 percent by weight of cement since it is ideal for Indian settings where temperature variation is significant.

4. Admixture that is carboxylate. When workability must be maintained for a long time, it is appropriate

5.7-CORROSION INHIBITING ADMIXTURE

Increased passivation of reinforcement and other embedded steel due to corrosion preventing additive. When passivation would have otherwise been lost due to chloride intrusion or carbonation, this can prevent corrosion. They are referred to as "integral" corrosion-inhibitors and are added to concrete during manufacture. Admixtures are not the so-called "migratory corrosion-inhibitors" used on hardened concrete. (Zhang, 2011)Concrete constructions that will be subjected to high chloride concentrations, such as maritime facilities, highway bridges, and parking garages, might utilize corrosion inhibitors as a defensive measure. (Gan & M.S.J, 1997)

Shrinkage-reducing admixtures and alkali-silica reactivity inhibitors are examples of other specialty admixtures. Although ASR inhibitors manage durability issues brought on by alkali-silica reactivity, shrinkage reducers are utilized to decrease drying shrinkage and prevent cracking. (Gan & M.S.J, 1997).

6-CHEMICAL ADMIXTURES AND ENVIRONMENT

Chemical admixtures are commonly used to modify the properties of concrete, which is typically constructed of polymer; these are oil-based and non-renewable. Chemical admixture can pollute the environment during production, transportation, storage, or handling, use in concrete, service life of concrete structures, demolition concrete recycling, and disposal of building materials and residues. Figure 1 depicts a simplified life cycle of a concrete admixture.

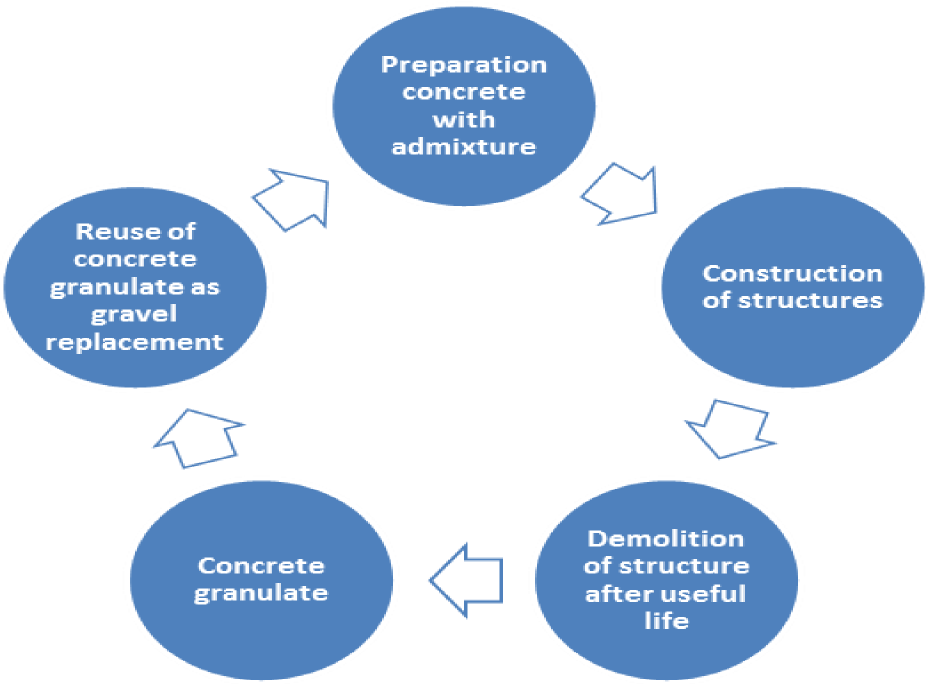

Figure 1. Simplified life- cycle of concrete admixture

These chemicals in admixture are found in highly water soluble compounds, and their leaching is an environmental hazard. When they are exposed during concreting or after the destruction of concrete structures, or as a result of leaching if concrete is granulated to be used as coarse aggregate replacement by so affecting the environment (Faqe et all).Figure 2 depicts the leaching process of concrete demolition when stored and utilized to replace coarse aggregate.

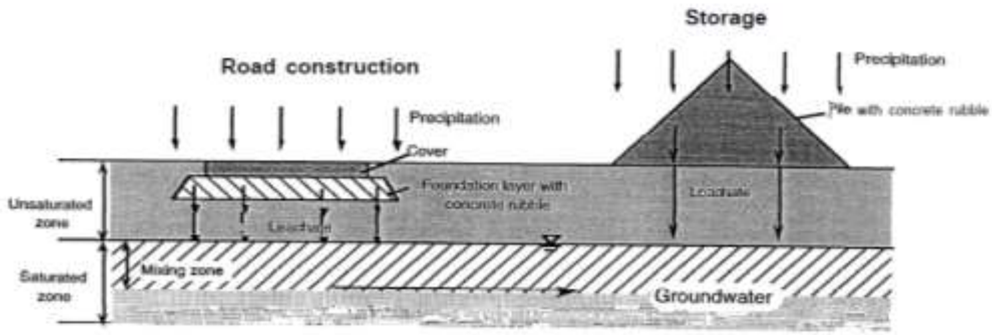

Figure 2. Leaching process after demolition of concrete structures.

7- NATURAL ADMIXTURES THAT USED IN CONCRETE AND EFFECTS:

Nowadays, concrete construction assessment techniques have moved towards a methodology known as eco-efficiency, which is a technique for producing highly durable and environmentally friendly concrete while minimizing both the environmental impact and manufacturing cost (Kim, and Chae) although the use of chemical admixtures improves the qualities of concrete, it is also responsible for harm to the environment. (Mehta et all.) As a result, finding alternative admixtures is important in producing environmentally friendly concretes. Concrete scientists and researchers around the world are attempting to develop non-chemical admixtures that are considered eco-friendly and environmentally acceptable building materials. These admixtures are produced from herbs, fruits, and animal products. Biopolymers and organic admixtures created by biotechnological techniques are commonly referred to as bio-admixtures. Natural admixture based on herbs or fruit extracts appears to be a good option, however, research on this area is limited. Herb extract has been used in construction with lime, according to research on historical structures (Thirumalini, and Sekar). Still, some of the constructions have stood for centuries and have shown to be durable, indicating that plant extract has a good effect on the durability of concrete (Woldemariam et all).There are several natural admixture used in concrete and have influenced on the properties of concrete such as black gram by (Chandra and Aavik) Black gram worked as air-entraining admixture, water absorption is reduced, while compressive strength is increased. Other research by (Otoko and Ephraim) on Palm liquor (PL), the result showed Slump, compressive strength, tensile strength were increased up to 15% PL then decreased, initial and final setting times are increased with increasing PL. Other research by (Woldemariam et al) on Blue gum (BG), the result showed Shrinkage is reduced, OD is between 10% and 15%. Using BG will reduce shrinkage cracking even the concrete is subjected to direct heat from the sun. (Amaran and Ravi)on their research on Cactus the results improves the standard consistency, initial and final setting times, workability, compressive strength are increased with increasing cactus up to 20%.(Pathan and Singh) improve the properties of concrete by using Molasses which increases a slump increase, setting time, compressive, and splitting tensile, flexural strengths with increasing molasses up to 0.8%.According to the findings, the most desired natural additive type influences the fresh properties of concrete and mortar, such as workability and setting time. Some of them act as retarders, delaying the hydration of the cement and increasing the setting time of concrete and mortar. Furthermore, with the appropriate dosage used by the researchers, these natural admixtures increased the mechanical and durability of concrete and mortar.

8-SUMMARY

Nowadays, concrete construction methods are focused on a technique known as eco-efficiency, which aims to produce environmentally friendly and highly durable concrete while minimizing both production costs and environmental load. The paper attempts to bring forward the importance of understanding natural Materials taking guidance from the studies that used natural materials in construction. Based on the review of the studies mentioned above, it has been concluded that these studies showed the significance and validity of focusing on environmentally friendly natural admixtures, and these natural admixtures are available in nature. Some are environmental issues, so using them as admixture improves the environmental problem. The data indicate that organic (natural) admixtures are acceptable options. The concrete industry should start moving in this direction because of its nature, which can improve the fresh, mechanical and durability properties of concrete, natural admixtures become less expensive than chemical admixtures, and the use of natural admixtures with the environment is environmentally friendly. At the same time, admixture from nature can be made. The behavior of natural admixture is highly dependent on the source of the plant or resources; concrete with natural admixture produces green concrete that is environmentally friendly; the production of natural admixture does not require more advanced technology. However, many of them are wastes that cause environmental issues. Also, using natural admixture in concrete construction must be tested and approved because the behavior of natural admixture depends on the origin of the plant or re-sources, with the situation of the natural materials.

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