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Investigating the Effect of Chemical Admixtures on the Quality of Concrete in the Construction Industry in Kenya

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Abstract: Quality of concrete has been the focus of key stakeholders of the construction industry in Kenya for sometimes now after several storey buildings have collapsed. The question has been what really leads to concrete failure; quality of material used; design mix adopted; method of batching concrete; method of handling and placing. This study has set out to find whether chemical admixtures are being used in the construction industry in Kenya and their influence on quality of concrete in a bid to solve the problem. The study adopted a mixed design approach which incorporates both qualitative and quantitative elements of research. The study came to several conclusions key among them; that chemical admixture are used in the construction sector with good effect on the quality of concrete; chemical admixtures enable projects to be managed easily. The study recommended formulation of legislation to guide the use of admixtures which will lead to solving of the current challenges of counterfeit chemical admixtures, lack of proper training by contractors and lack of interest from building statutory bodies on its use.

Keywords: Quality of Concrete, Construction Chemicals, Construction Industry.

I. INTRODUCTION

Construction in Kenya mainly depends on concrete due to knowledge of its use, availability of constituent material and the specification in the building code. However, this material has not been properly utilised to derive the maximum benefit. There has been several cases of collapsing buildings some while still under construction and others with people living inside, among many cases. In general the problem of substandard construction can be summarized as being due low quality construction materials and poor workmanship (Kuta and Nyaanga, 2014). The major material for most being concrete which if wrongly used will lead to disaster. Failure of concrete can emanates right from the mix design, quality of the materials used, method of mixing, placing and transportation and lastly innovation of the same to give better result in different construction scenarios. Past researches identify the major causes of buildings failure as dependent on the quality of building materials used (sand, coarse aggregates, steel reinforcement, water), workmanship employed in the concrete mix proportioning and construction methodology, defective designs and non-compliance with specifications or standards (Nyambura, Mutuku & Abiero, 2014).

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Before a concrete mixture can be proportioned, mixture characteristics are selected based on the intended use of the concrete, the exposure conditions, the size and shape of building elements, and the physical properties of the concrete (such as frost resistance and strength) required for the structure. Once the characteristics are selected, the mixture can be proportioned from field or laboratory data.

All these challenges coupled with demand for better and complex structures leads us to explore the use of chemical admixtures in the Kenyan Construction industry. Additives or extra materials considered as the fourth substance of concrete are used to improve some of its characteristics (Abidollah & Hojjati, 2013). Today, the application of different additives has become wide spread so that you can barely find a concrete mix without any additives. In general, using admixtures in concrete improve its workability, accelerating or retarding setting time, controlling development of concrete strength and enhancing durability to deterioration process. However, usage of admixture is not remedy for poor quality of concrete due to the use of incorrect mix proportion, poor workmanship in concrete mixing and the problems caused by low quality raw materials selection concrete (Alsadey, 2012). According to Juran (1988), quality can be defined in terms of (1) conformance to the agreed requirements of the customer and (2) a product or service free of deficiencies. In the building construction industry, quality can be defined as meeting the requirements of the designer, constructor, and regulatory agencies as well as the owner (Arditi & Gunaydin, 1997). The objectives of the study are; to establish the type of chemical admixtures being used in concrete; to establish the effect of chemical admixture on concrete quality; to establish the contribution of chemical admixture in construction project management; outline recommendations that may support the use of chemical admixtures in the construction industry.

II. TYPE OF CHEMICAL ADMIXTURES

A. Accelerating Admixtures

This are the kind of admixtures that are used to fast track the setting of cement paste in concrete to bring about certain desired effects required by a specific project. Accelerators are primarily comprised of inorganic materials and can be subdivided into two general categories based on their desired application. Hardening accelerators which are used to achieve a higher initial strength will usually achieve strength greater than 120 percent at 24 hours compared to an equivalent concrete without the accelerator added (UK Cement Admixtures Association 2006). The second type of accelerators is set accelerating admixtures. These set accelerating admixtures reduce the time for the mix to transform from the plastic to the hardened state. Generally an admixture will fulfil only one of the two primary categories. These admixtures are used for concrete repair mix designs and in prestressed or precast applications, where time delays cost customers or precasters significant amounts of money and inconvenience. The most common material used in this admixture is calcium chloride ($Cacl_2$) which accelerates primarily the early strength development of concrete (Neville and brooks, 2010). Acceleration without the risk of corrosion can be achieved by the use of very rapid hardening cement or of chloride free admixtures. Most of the latter are based on calcium formate, which being slightly acidic accelerates the hydration of cement.

The effects of accelerators on hardened concrete are as important as they are for the fresh mix. Benefits of their use include accelerated strength development in both compression and in flexural modes, although less so in the latter. Modulus of elasticity, too, increases at a faster rate. Abrasion resistance and erosion resistance are improved with the use of accelerating admixtures, as is pore structure, due to reduced porosity. Frost resistance in concrete is better at early ages when calcium chloride accelerators are used, but performance declines with time, and resistance is actually worse at later ages.

B. Retarding Admixtures

Retarding admixtures are used to slow down the initial set of concrete by the users so as to allow for the concrete to be transported or placed either by pumping or cranes a process which might take time. This eliminates the risk of the concrete setting prematurely on the concrete truck, mixer, buckets or pump line. Retarders are specified in ASTM C 494 as Type B admixtures and are used in varying proportions, often in combination with other admixtures, so that, as working temperatures increase, higher doses of the admixture may be used to obtain a uniform setting time (ACI 305R, 1999).

Simple retarders typically consist of one of four relatively inexpensive materials: lignin, borax, sugars, or tartaric acids or salts. Retarders serve best to compensate for unwanted accelerations of working times due to changes in temperature or cement or due to other admixture side effects. They also are used to extend the working time required for complicated or high-volume placements and for retarding the set of concrete at a surface where an exposed aggregate finish is desired. Retarding admixtures interfere with the critical chemical reactions of the fastest hydrating cement reactant groups, (Tricalcium aluminate) C_3A and (Tricalcium silicate) C_3S (Collepardi, 2005). These reactants normally initiate the hydration process in the early stages. Eventually, the hydration process accelerates due to another initially slower reaction group, and the heat of reaction allows the hydration to continue at a normal rate until completion.

C. Air-Entrainment Admixture

Air-entrained concrete was developed in the 1930s, and it is still recommended today for nearly every commercial application. Air-entraining agents are provided already ground into the cement (air-entrained cement) or as an admixture whose addition can be adjusted for individual batch design needs (Neville & Brooks, 1987). Because air-entraining agents provide extremely small and well-dispersed air bubbles in the paste, they act as localized stress reducers in the cured matrix. Entrained air has a significant influence on many of the properties of both fresh and cured concrete. In fresh concrete, it is known to reduce water demand and the tendency toward bleeding, as well as plastic shrinkage. It increases slump and workability. In hardened concrete, entrained air improves deicer scaling resistance and resistance to freezing and thawing degradation, although small and predictable reductions in compressive, flexural, and bond strengths are to be expected.

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D. Waterproofing Admixtures

Many buildings incorporates basement floors for parking which are mostly below ground with high water table. Other structures are also constructed under water such as bridges, ports and jetties. All these structures requires concrete that is either insulated from water ingress or highly impermeable to water. Concrete absorbs water because surface tension in capillary pores in the hydrated cement paste absorbs water by capillary suction. Waterproofing admixtures aim at preventing this penetration of water in to concrete (Neville & Brooks, 1987). One action of waterproofing admixtures is through reaction with the calcium hydroxide in hydrated cement paste; examples of products used are stearic acid and some vegetable and animal fats. The effect is to make the concrete hydrophobic. Another action of waterproofing admixtures is through coalescence on contact with the hydrated cement paste which, because of its alkalinity, breaks down the 'waterproofing' emulsion; an example is an emulsion of very finely divided wax. The effect here, too, is to make the concrete hydrophobic. The third type of waterproofing admixture is in the form of very fine material containing calcium stearate or some hydrocarbon resins or coal tar pitches which produce hydrophobic surfaces. While imparting hydrophobic properties to concrete is valuable, in practice, complete coating of all surfaces of capillary pores is difficult to attain, with the consequence that full waterproofing is unlikely to be achieved. Some waterproofing admixtures, in addition to their hydrophobic action, also effect pore blocking through a coalescent component.

An experimental research was done in Singapore, Hong Kong and China which achieved the following results on the beneficial properties of waterproofing admixture; (1) Significant reduction in water permeability and water absorption at the same water-to-cementitious ratio as the control; (2)

Significant reduction in drying shrinkage that corresponds to improved resistance to cracking under drying conditions; (3) Reductions in water absorption, shrinkage, and water permeability were observed with typical OPC, fly ash or GGBFS concretes. (4) No adverse effect to concrete's air content and setting time; (5) Highly dosage-effective and show good compressive strength development. (Zhang Qiang, Chen Fang, Zhong Hua, Leung Ming and Nick Peng, 2008). The waterproofing admixture used was (Adprufe® 100 and Adprufe AP1 and AP3 – produced by Grace Waterproofing Company) based upon a glycol ether shrinkage reducing admixture (SRA) and additional hydrophobic elements providing enhanced hydrophobic action

III. RESEARCH METHODOLOGY

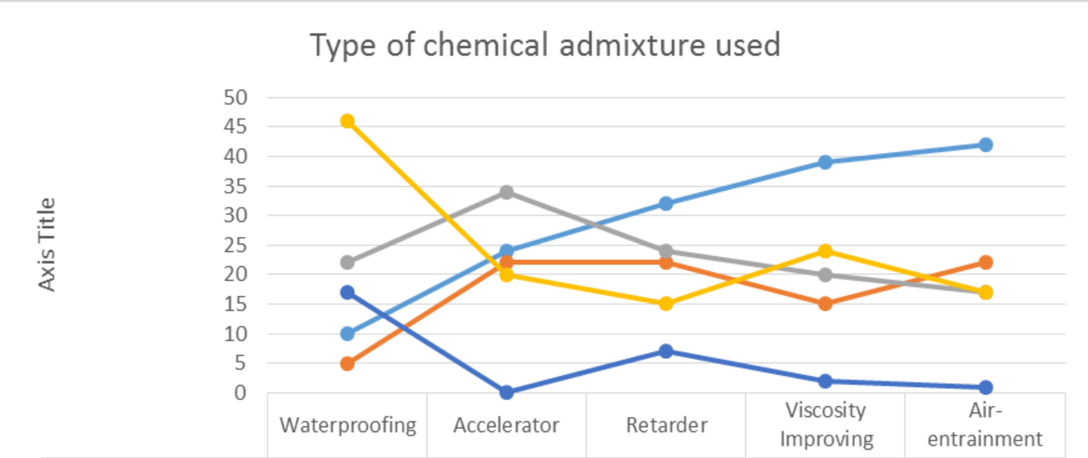
This research adopted both qualitative and quantitative method in order to effectively collect information on the types of chemical admixtures used and in detail elaborate the benefits to construction project management and recommendation for further use. The target population was building contractors in Nairobi County in Kenya who were identified from the National Construction Authority Contractors Category One. These are the most qualified contractors in the country to undertake building works. The researcher used questionnaires to collect numerical and measurable data. Data presentation was done using graphs, and tables. The data analysis was done using statistical software (SPSS). The sampling procedure used for this research was purposive sampling. This was done to ensure success in getting the listed contractors since a majority were international contractors with offices in Suburban centres within Nairobi City with no formal listed address. Majority were found on sites. Data from contractors was collected through in-depth questionnaires comprising of both Likert Scale and open ended questions. Questionnaires were administered by hand to the various contractors both in their offices and sites and for others through email as requested by them. Data analysis involved preparation of the collected data, coding, editing and cleaning of data that was processed using Statistical Package for Social Sciences (SPSS).

IV. RESEARCH FINDINGS

A total of 62 questionnaires were issued out to contractors around Nairobi County. 41 questionnaires were returned and analysed. The response rate was 66%.The response rate was deemed sufficient to be used to make conclusions about the research problem.

A. Types of Chemical Admixtures Used in Kenya

The contractors were requested to give their factual information on the types of chemical admixtures that they have used in their projects in Kenya using the questionnaires provided. The response for the questions was rated in Likert Scale of 5, where 1 = Not used, 2= Slightly used, 3= Moderately used, 4= Highly used, and 5= Extremely used. The percentage for each response and their respective Likert Mean was computed and the results presented using line graph. The results of the analysis of data from the questionnaires presented to the contractors with respect to chemical admixture used by contractors are shown in figure 5.



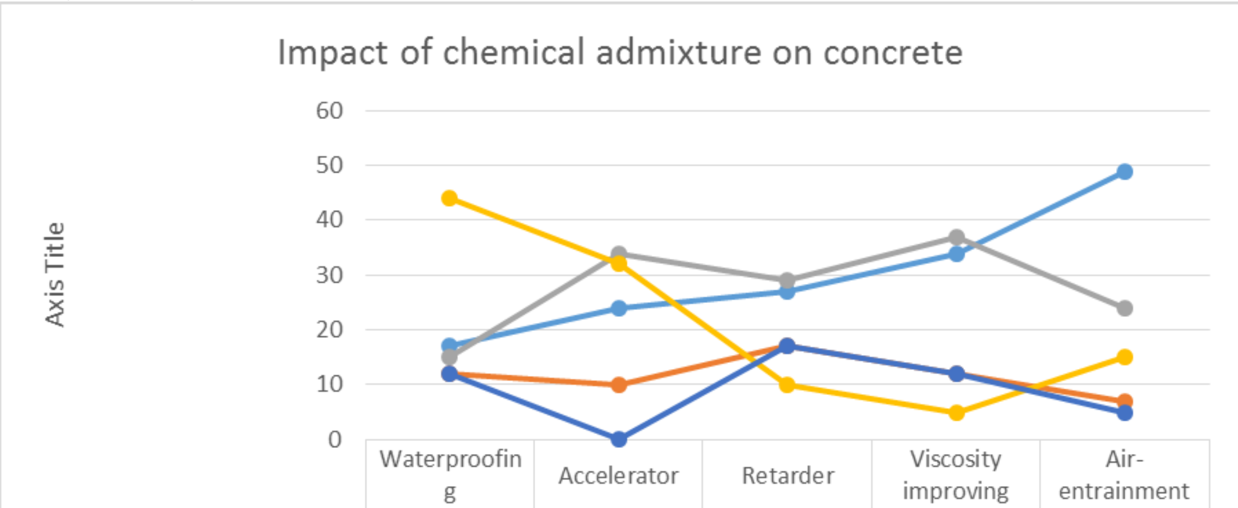
	Waterproofing	Accelerator	Retarder	Viscosity Improving	Air-entrainment
Not used	10	24	32	39	42
Slightly used	5	22	22	15	22
Moderately used	22	34	24	20	17
Highly used	46	20	15	24	17
Extremely used	17	0	7	2	1

Figure 5: Types of chemical admixture used.

The study revealed that waterproofing admixture is the most used in the industry with 17% using it extremely and 46% highly. This truly reflect the fact that most building waterproof their basement floors and also water retaining structures such as water, septic and fuel tanks. Only 5% of the contractors do not use this type of admixture which leads to the conclusion that it is a very essential product in the industry. The interviewed contractors claimed that Nairobi is rocky and contain underground water which affects the substructure. On the use of set accelerating admixture, none of the contractors depend on it as we recorded 0% for the extremely used part. However, 20% highly uses this type of admixture, 34% moderately and 22% slightly. This were contractors who carry out pre-casting of concrete elements offsite and transport to site. An example being the beams used for the overhead roads and other small products such as waste water pipes, road culverts, wall copings and paving slabs. This was mainly observed from international contractors under this category undertaking big projects. The main reason is to remove formwork quickly for re-use which allows for minimum purchase or fabrication of formwork. Lastly to speed projects by having such products ready on a very short span of time. This finding can be corroborated by the large number of foreign contractors who are taking the sector to a new height with the work methods used. 7% of contractors indicated that they highly depend on retarding admixtures and 15% depend on it highly. Further 24% moderately use it making a total of 46%. This represent a huge number indicating the growing demand for retarding admixture. The deduction from this is a reflection of the many projects that utilizes pre-mix concrete whose setting needs to be delayed as the concrete is being transported. The study noted in the course of visiting the contractors that a good number had fixed concrete batching plant on their yards whereas others indicated that they purchase concrete periodically depending with the nature and location of their projects. Due to the location of projects in the congested areas of the Nairobi city, it has become difficult to cast concrete on site. In particular the contractors working as developers have noted the increased quantity of concrete pour that cannot be mixed on site.

On the use of viscosity improving admixture, 2% of the contractors used it entirely for all their operations 24% depend on it highly and 20% moderately. This is a fairly used admixture based on this percentages which represent 46%. However of interest to note is the huge number of contractors, 39% who do not use it. Lastly, we had the air-entrainment admixture with a majority of the contractors 58% having used it somehow. 42 % have not used it at all indicating the huge gap of knowledge in the same class of contractors. The contractors preferred this admixture to make concrete workable and durable. The literature for this study points out to the establishment of bubbles in the concrete that acts as lubricant to concrete constituents materials that makes it more workable. It also blocks the pores left behind by free water which creates them when it evaporates. This leads to an impervious concrete structure that is more durable.

B. Impact of Chemical Admixture in handling Concrete in construction



	Waterproofing	Accelerator	Retarder	Viscosity improving	Air-entrainment
Did not influenced	17	24	27	34	49
Slightly influenced	12	10	17	12	7
Moderately influenced	15	34	29	37	24
Highly influenced	44	32	10	5	15
Extremely influenced	12	0	17	12	5

Figure 6: Impact of chemical admixture on concrete.

The study set out to identify the impact of chemical admixture on concrete which will reflect on its quality figure 6. The respondents viewed waterproofing as having a great influence on the handling of concrete at 44% and 12% thinking that it extremely influence concrete handling. In actual sense from the literature, waterproofing has little impact on the concrete mix. 76% in total of the contractors polled that set accelerating admixture has a big influence on the handling of concrete the highest being 32% of whom highly believed so. 24% of them felt otherwise may be due to their lack of experience with these admixtures. This is corroborated with the actual percentage of contractors who have never used admixtures at 24%. The fact of the matter is set acceleration as in the literature affects the set time of concrete and allow it to set much earlier for the determined benefit of the contractor.

A majority of the contractors agreed with the question concerning the effect of viscosity improving admixture on the handling of concrete. Indeed 73% in general agreed with 17% and 10% agreeing extremely and highly. The lack of an overwhelming majority who strongly agrees points out to the actual information given out by the contractors on their actual experience on usage rather than what they have heard or read. This can partly be explained by 32% of the respondent in above figure who have not used admixture before. 34% of the contractors have never used viscosity improving admixture but at least 66% of them have used either once or always. This reflect the actual use of admixture since most of the time the set accelerating and retarding admixtures requires a water reducing admixture to enable the concrete to be user friendly during mixing, transportation, placing and vibrating. Air-entrainment admixture is the least used with 49% believing that it has no influence on the handling of concrete. 20% strongly reported their position which suggest great influence on the handling of concrete. The facts from literature suggest otherwise and disagree with the 49% of the respondents. Indeed air-entrainment admixtures assist to improve the workability of concrete which greatly affects its handling. It allows for easier pumping and compaction.

C. The extent to which Chemical Admixture influence the quality of concrete

The response to determine the above subject matter was rated in Likert scale of 5 where 1 = not at all influenced, 2= slightly influenced, 3= moderately influenced, 4=highly influenced, 5= extremely influenced. The mean and standard deviations were computed and the results were as illustrated in table below. The responses with mean of 1 and below indicated ‘ did not influenced at all’, 1.1 to values less than 2.0 indicated ‘slightly influenced’, mean from 2.0 to values less than 3.0 indicated ‘moderately influenced, mean from 3.0 to values less than 4.0 indicated ‘highly influenced’ and means from 4.0 to 5.0 indicated ‘extremely influenced’. The standard deviation indicates how divergent the responses were from the mean response. A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data is spread out over a large range of values. A standard deviation more than 1 is significant and shows a great divergence of responses from the mean response.

Table 1: Extent of chemical admixture on the quality of concrete.

Descriptive Statistics		
	Mean	**Standard Deviation**
Extent to which chemical admixtures solved segregation of concrete.	2.46	1.16
Extent to which chemical admixtures solved loss of slump in concrete.	2.07	1.21
Extent to which chemical admixtures solved bleeding of concrete.	2.85	1.35
Extent to which chemical admixtures solved uniformity in concrete.	2.90	1.22
Extent to which chemical admixtures solved setting of concrete.	3.65	1.24
Extent to which chemical admixtures allowed for strength gain in concrete.	3.24	1.37

The study identified several failure characteristics of concrete that forms the basis of poor quality. One of the objectives of this study was to find out the perceived users who are the contractors on the actual effects of admixtures on this quality factors of concrete. From the above table 1, we note that the mean response on segregation of concrete is 2.46. This suggest that less than half of the contractors actually believe that admixtures will solve this challenge.

Slump value is of great importance when concrete is in its fresh state. Slump value represents the workability property of concrete. Due to its importance, the value of slump is generally specified by the designer. And while working on site, the engineer’s responsibility is to make sure that the concrete should show the same slump value as specified. It is therefore required to check slump before placing concrete. But due to several reasons, the slump value gradually decreases as time elapsed. This reduction in value of slump with time is called slump loss in concrete. The above table indicates a mean of 2.07 in regards to their perception on the loss of slump. This indicates that the majority of them manages slump without admixtures and therefore have no idea the effect of admixtures to manage the slump as prescribed to them by the mix design.

The standard deviation for this is 1.21 which shows a small variation in the response. Bleeding is one form of segregation, where water comes out to the surface of the concrete, being lowest specific gravity among all the ingredients of concrete. The study indicates a mean of 2.85 with majority of the contractors agreeing that admixtures will solve this problem. This is true from the literature survey which indicates that air-entrainment admixture is used to arrest this problem. Air-entrainment adds air bubbles to concrete which act as additional fines. A majority believed that admixture will improve the uniformity of concrete. This is true from the literature since air-entrainment and viscosity improving admixtures indeed help concrete to be more workable which leads to uniformity. This property is important for concrete that is mixed in trucks by avoiding the formation of concrete lumps that damages the mixing blade and also pumped concrete whose consistency must be smooth to avoid clogging of pipes.

Setting of concrete is the change of concrete from fresh state to a hardened state. The mean form the study indicates 3.65 the highest of all scores in this category. This shows the significance effect of using admixtures in altering the set of concrete either by delaying or accelerating it. Finally a good number of contractors believed that admixtures also help concrete to gain strength. The mean for this being 3.24 well above the average.

D. Percentage of Concrete that utilizes Chemical Admixture

Table 1: Results for the percentage of concrete which uses admixtures.

Descriptive Statistics		
Percentage of concrete that used admixture	**Mean**	**Standard Deviation**
Percentage of concrete that used admixture	49.37	28.95

The mean result from the above table 5 indicates 49.37. This show that an average of 49.37% of concrete produced by NCA 1 contractors utilizes chemical admixture. This finding is very important and eliminates the notion that these admixtures are not used at all. In fact from the literature, chemical admixture is a wide spread material that is used extensively in particular for major infrastructural projects.

E. The Opinions of Contractors on the influence of Chemical Admixtures

These findings are addressed by forming themes based on the returned opinions from the questionnaires. This will make work easier and allow for in depth analysis of each opinion. According to Mugenda and Mugenda (2003), qualitative studies obtain detailed information about the phenomenon being studied and then try to establish patterns, trends and relationships from the information gathered.

- ***Improves quality of concrete***

Most of the contractors strongly believed that chemical admixture assist in project management by helping in delivering quality concrete by improving workmanship and durability. The comments from contractors were as follows;

> *'Admixtures help us to achieve the recommended water cement ratio from the design mix, greatly improves workability, save time and improves workmanship on site'* **(Q-26)**

> *'Improve the strength of concrete and quality of building structures. Makes concrete workable and provide good slump'* **(Q-24)**

> *'The use of these chemical admixtures should be encouraged and embraced in the construction industry since they increase the strength and improve the properties of concrete and enhances and increase the life span of structures'* **(Q-07)**

The contractors note that most plain mix design requires less water to cement content in order to achieve a dense concrete that will allow the achievement of the desired class of concrete. Unfortunately this same concrete cannot be pumped due to its thick mix consistency or low slump around 50mm. Thus they reckon that the use of admixture allows them to achieve a highly fluid mix with high slump about 150 to 200mm that enable them to pump without adding more water and consequently achieve the desired strength in line with the mix design.

- ***Facilitates Transportation of concrete***

With the use of retarder admixtures, concrete is transported through the heavy traffic currently in almost all roads in Nairobi. This assist in project management especially of buildings in the central business district, Upperhill and Westland where space is really constraint. Client comments on the same found below;

> *'Since construction industry is moving away from the small mixes to large batching mixes, admixtures should be emphasized. This is also important to counter traffic and lack of space to stockpile aggregates'* **(Q-09).**

> *'Use of admixtures makes transport of concrete (ready mix) easier'* **(Q-24)**

The contractors pointed out that the volume of concrete being undertaken in Nairobi for office blocks and apartments is large. This means for any concrete mix to be done on site, huge stockpile of sand and ballast need to be kept aside from other building materials like building stones, cement and water. This kind of spaces are not available and that means concrete will require offsite mixing and pumping when it arrives on site. Concrete sets within one hour after mixing. To move through the traffic in Nairobi one requires more than two hours depending with the destination and occurrences on the road like accidents or the president moving on the road. With retarders, concrete can be allowed between 3-4 hours before setting commence. This gives enough time for transportation and placing by pumping on site.

- ***Deliver projects on time***

It reduces large concrete pour to one day and even hours due to premixed concrete which is done offsite. On the other hand it enable precast units of a project to be prepared well in advance of the task and finally takes just a few hours to install thus save a lot of time in particular for roads concrete work.

> *'Admixtures use reduces the number of days required by concrete to achieve sufficient strength to allow for construction work to continue with formwork still erected'* ***(Q-15)***
>
> *'Admixtures speeds-up project i.e strength gain and setting'* ***(Q-33)***

Further the cost of formwork is cut down by the early removal and reuse.

- ***Act as a marketing tool for contractors***

Contractors with batching plants and knowledge of premix concrete are having an advantage over the rest. This assist in the component of marketing which spreads itself especially to developers and huge infrastructure projects.

F. Suggestions for the use of Chemical Admixture

The study has established that chemical admixtures are being used in the construction industry. The various contractors interviewed had different suggestions on the way forward in terms of this admixtures. These are;

- ***Training needs to be undertaken***

Most of the contractors felt that the use of chemical admixtures in the industry is important but a lot of information needs to be brought to their attention through training. This they said should be accompanied with marketing from the sellers of these chemicals to create more awareness of where they can be purchased and used. Others suggests that NCA should carry this awareness even to the sites that they visit.

- ***Enactment of legislation to govern its use***

Some contractors felt that proper procedures in ways of legislation should be formed to guide the use of the admixtures. They felt this will maximize on the benefit of these admixtures and at the same time eliminate abuse of the same due to trial and error method that is currently the *norm.*

- ***Amendment of the building code***

The contractors would wish to have the use of admixtures incorporated in the bill of quantities and technical specifications of projects. This can only happen by introducing it in the building code. Thus this is a call for the building code to be reviewed to incorporate the many products that are currently being used in the construction industry in an ad hoc manner.

- ***Counterfeit chemical admixtures***

Due to a lack of proper guidance on their use and lack of official information, many counterfeit products have emerged that mislead contractors. Such products are a threat to quality of structures and present losses to contractors whenever they use them.

- ***Costly chemical admixtures***

Majority of the contractors expressed the extra cost of using admixtures which is expensive at present since they are not factored in the standard rates for the cost of concrete.

- ***Lack of interest from relevant statutory bodies in charge of construction sector***

Contractors felt that the bodies in charge of construction like National Construction authority, Board of Architects and Quality Surveyors and Engineers Registration Board of Kenya are not interested in knowing the admixtures used by contractors and their benefits. This will eventually lead to a drafting of procedures and standards that can only be led and guided by the same bodies.

V. CONCLUSIONS

The study came to several conclusions based on the objectives set out. The study established that indeed chemical admixtures are being used in the construction industry. These are waterproofing, set acceleration, retarders, viscosity improving and air-entrainment admixtures. Nearly half of the concrete used by category one contractors contains admixtures. Admixtures improves the quality of concrete positively by altering the set time of concrete according the desire of the user, improves uniformity of concrete, increase strength and resolve bleeding challenges. Further the study note that the admixtures have less influence on segregation of concrete and loss of slum.

Contractors in this study believed that admixtures help to improves quality of concrete which enable easier project delivery. It also helps in the transportation of concrete, delivers projects on time and act as a marketing tools for contractors who use them. The study notes that training is required and enactment of laws to regulate the use of admixture. The amendment of the building code to be undertaken. Counterfeit products are also in the market. Lastly, the study concludes that the regulatory bodies in the construction industry are not interested in studying to understand and then promote the use of admixtures.

RECOMMENDATION

The research has come to the conclusion that admixtures are being used in the industry and they improve the quality of concrete, assist in transportation of concrete, help to deliver projects faster and also act as a marketing tool for the contractors. The study thus recommends the following measures to be taken to further foster the development of the construction industry;

a. The regulating bodies in the construction industry to take a leading role in understanding the role and benefits of admixtures so as to guide on how it can be incorporated in the sector.
b. The building code should be amended to incorporate chemical admixtures.
c. Laws should be formulated to formally guide the use of chemical admixtures.
d. Training to be undertaken in the industry to equip both the contractors and the consultants on the use of admixtures.

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