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Contents

Development Of A Regional Park For Better Protection And Management Of Kerkennah's Archipelago Environment (Tunisia)

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A B S T R A C T

The engineering of regional Parks is an important approach for sustainable development and a new one in Tunisia. This article offers a management of a regional Park in the sabkha employed as a dump area and located in Kerkennah"s Archipelago. This proposal is used as the key intervening factor between public and local practice to reconciliate this area with his environment and it will create an integrated and interactive ecological and human habitat within an urban setting. Although, the idea of the proposed development involves the reconciliation of this space with its environment, taking into account the aspect of sustainable management of this particular site, four components are planned such us: an eco-museum, a sale exhibition and handicrafts center production, a halophilic garden and a water scene.

Keywords: Kerkennah"s Archipelago, sabkha, environment, landscape, regional Park.

1. INTRODUCTION

Urban development and human pressures can destroy in a few year landscapes that nature and man have shaped over time. Landscapes are changing and losing their characteristics [1]. To halt and reverse this process, sustainable development that ensures the protection of natural heritage and local development are needed. Among the adopted strategies, Parks are cited. In fact, Parks are positive elements of the urban space that add economic, social, historic, and esthetic value to our cities and environment. Well-planned Park can promote the local economy and educate citizens about the environment. Surrounding landscapes, it gives a sense to the city [2]. Morever, green spaces can facilitate sustainable urban environment by purifying air and water, filtering noise, and stabilizing the microclimate [3].

In recent years, the attention for regional Parks management projects has grown among national and regional governments in many countries. Thus, designing a Park from regional perspective is the subject

to discuss in this paper. However, a well managed regional Park has two main benefits: economic progress and sustainable development. We discusses a proposal for sustainable development, that allows, converting a sabkha used as a discharge zone by the local population into a regional Park integrating economic, environmental and social issues on the local level. It aims to combine urbanity and nature and to integrate the site to study the local landscape [4].

Looking to the current situation of the site, a recovering and managing integrity with the local environment is needed. In another terms, if the discharge zone is not properly managed, the accumulation of wastes can give rise to serious environmental damage, and increase safety problems and health-care costs. As the sabkha is an important native ecosystem, the establishment of the regional Park must be also as an ecosystem in order to protect and maintain the natural environment. The present proposal management will give to the studied locality a strong identification through the combination of the local culture with the Park design. Therefore, the primary goals of this landscape planning proposition for the discharge zone are to restore and sustain the ecological integrity of the region‟s ecosystems, to halt the loss and to restore populations of all rare and endangered plant species occurring within the sabkha [5].

The reason behind the developed reflection in this paper is that regional Parks are established for the purpose of providing recreational opportunities while protecting natural, cultural and landscape values (Office of environment & heritage). Parks aims to increase visitorship, attract the interest of potential clients and meet the needs of local residents. It should be noted that at the European level, the example of regional Parks has been selected by the French delegation in various international conferences in recent years. The philosophy of the creation of regional natural Parks in France was experienced in the Mediterranean basin, particularly in Morocco. Then at the "rendez-vous méditerranéen" on 17 and 18 May 2004 in Marseille, the creation of the regional Park Bouhachem in Morocco was decided as part of French-Moroccan cooperation [6].

2. MATERIAL AND METHODS

2.1. STUDY AREA

The Kerkennah‟s archipelago is composed of 5 small islands (between 0.5 and 100 km^2), the two biggest are Gharbi (48 km^2) and Chergui (99 km^2) where all population is located, and about 10 very small islands (less than 0.5 km^2) located on the north east of Chergui (Figure. 1). The islands are very flat: the

maximum altitude is only 13 m above the sea and the low land (less than 2.5m) represents more than 50 % of the islands. In the lower ground of the Kerkennah archipelago, salty and sterile areas called marine sabkha are growing [7]. The precipitations, that are intense and sudden in the region, can cause floods directly in the sabkha. Runoff can also bring salt and other mineral particles. The water can arrive in the sabkha from runoff bringing salt with it. During the rainy seasons, storms can bring on marine flooding [8]. The soils of the islands are generally light and poor in organic matter, characterized by a calcareous crust. The population of the Kerkennah Islands, are amounted to 14 400 in 2004. The working population is estimated at about 4880 people distributed according the following sectors: agriculture (47%, 90% for fishing), the industry and buildings (19%) and services (34%) (INS-RGPH 1994-2004). These natural hydrosystems are especially characterized by halophytic and succulent vegetation and by well-adapted perennial species, such as Chenopodiaceae: Atriplex spp., Suaeda spp., Salsola spp. and Salicornia spp. [9]. Sabkhas in Kerkennah‟s archipelago were developed under certain environmental factors. These factors may be linked to climate, slope, soil, geologic or to Anthropogenic interferences [10].

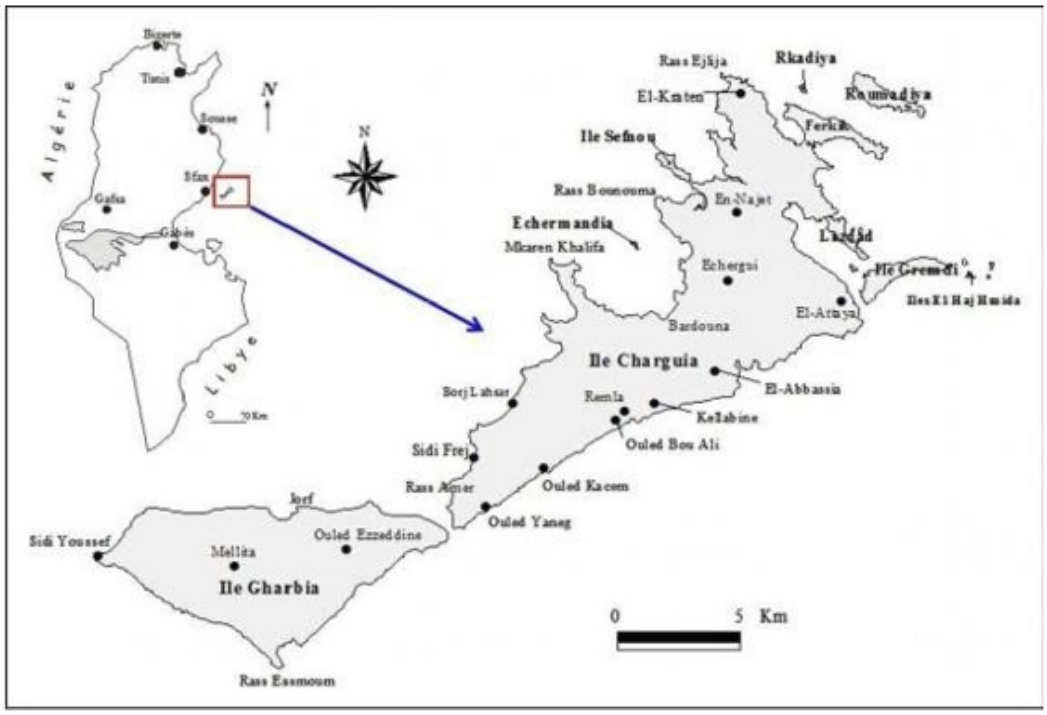

Figure 1 : Administratif location of Kerkennah Archipelago

The Study area belongs to the north-east of the kerkennah islands and belongs administratively to the Erramla locality. The site is a dried sabkha used as a discharge zone and exploited since 1984 by three localities: Kellebine, Erramla and Ouled Bouali. It is located about 1.5 km to the north of kellebine, 2.5 km to the northeast of Erramla and 2.8 km to the northwest of El-Abbassiya. It is accessible from the road RR 204 of kerkennah. The site covers an area of 3.5 ha and making a part of the state‟s fields. The

Sabkha‟s surface, sheltered by halophilic vegetation (Salicornia), is enriched in sodium derived from a groundwater saline with a marine origin and forming salt marshes which attracts migratory birds (Figure 2).

Figure 2: The halophilic vegetation of the study area

Therefore, the waste is collected daily and deposited in the sabkha by the local population and light wastes such as plastic bags and paper are scattered because of the wind and could be found outside of landfill area, from where the negative impact on the landscape region. Furthermore, the site is almost devoid of vegetation except the halophytic vegetation due to the high salinity, such as: Halocnemum strobilaceum, Salicornia Arabica, Atriplex inflata, Suaeda vera, Suaeda mollis, Arthrocnemum indicum, Juncus maritimus, etc. [11]. The below figure shows the salt deposition (white color) scattered in the study site.

2.2. CONCEPT OF "KERKENNAH REGIONAL PARK"

Regional Parks are areas of regional open space that are identified by planning procedures as having regionally significant conservation, landscape and recreation values. The concept of regional open space was first introduced in Western Australia by the Stephenson-Hepburn Report in 1955, which recommended that a statutory region plan be prepared for Perth which reserved private land required for future public purposes [12]. However, the approach of regional Parks differs from the one of national Parks at the protection level of nature. Regional Parks seek for the sustainable development of their territory while the purpose of national Parks is the protection of animal and plant species. There is a rural area with a rich and threatened heritage. It is the subject of a sustainable development project based on the protection and enhancement of the natural, cultural and landscape of its territory [13]. According to "la Maison du Parc naturel régional des Volcans d‟Auvergne", the main objectives of a regional Park are:

- To protect wealth and sustain the biodiversity of natural heritage;
- To control landscape evolution and improve the living environment;
- To preserve natural resources (including the water quality);
- To provide hospitality, education and information for the public;
- To contribute to the territory planning.

The Kerkennah regional Park will be a significant public open space located within an arid region of Sfax. It was originally designated. The design strategy for the Kerkennah Park proposes restoration on of an existing sabkha system. Using the environment as a tool of engagement, the Park will become a landscaped artery that connects the agglomerations, palms, wetland and sea. The proposed Kerkennah Park will create an integrated and interactive ecological and human habitat within an urban setting. This is why five main objects to design this are considered, such as: community, education, recreation, landscape and heritage.

Since our study area suffers from the negative impact produced by local population, then, it needs to reveal its nature and landscape identity lost and it must escape from its past as a discharge area. The lack of relationship with what surrounds the sabkha highlights the paradox: a natural rejected site in an urban center (Erramla) and in front of the sea. View this landscape disfiguration, it is necessary to seek an arrangement that allows the sabkha to communicate with the surroundings area and then to educate not only the local population but the entire archipelago‟s population about the richness of their heritage. Following this environmental situation analysis, we propose a project design capable to reconciliate the area with its environment, so the developed concept is called: “sabkha designed to protect the environment” that will restructure the denuded landscape and enhance the natural and traditional richness of the archipelago.

3. RESULTS AND DISCUSSION

A precaution must be taken by policies and public authorities for the good health of citizens and future generations. However, in order to integrate the area into the surrounding landscape, it is necessary to give it an added value by changing its vocation in terms of management [14]. So, the planning vision is based on the above regional Park objectives and contains four components: an eco-museum, a sale exhibition and handicrafts center production, a halophilic garden and a water scene (Figure 3). The design includes too, a paved walkway of 6 m width, which marks the heart of the plan. Around this central walkway, flowers, trees, secondary walkways and especially a halophilic garden are arranged. Therefore, it is necessary to mention that there are some technical issues that need to be taken into

account before starting the management such: the plant palette of the proposed development should be made by plants that tolerate salinity; physical soil amendments are needed to improve its structure and its pH; deep plowing is planning to eliminate weeds and it is essential to bring permanent and qualified workers in the Park.

Figure 3: Ground plan of the proposed regional Park in Erramla locality

To achieve an equilibrium with the surrounding landscape, it is necessary to provide the needed services by the local population. The proposed management will offer a variety of experiences that inform, inspire and involve visitors by providing access to nature, recreation and learning experiences. Moreover, provision of educational and recreational opportunities is one of the primary purposes of the Park that benefits to individuals and communities. In this sense, the proposed development plan includes a playground for children with a parental space and recreation areas for the whole family. An eco-museum covering 476 m2 is concepted and is located in a circular track. This cultural and ecological service will expose the rich fauna of Kerkennah islands. It will enhance the intellectual life of visitors by including a showroom which thematic panels introducing anatomy, lifestyle, and reproductive cycle of wintering, nesting, and sedentary birds. It includes also an audio-visual projection room of bird‟s life stories. The exhibition theme is also about aquatic ecosystems of the archipelago. Miniature ecosystem models and wildlife specimens are also proposed.

The regional Park will support the local economic activities and stimulate the socio-economic benefits that strengthen the local cultural and natural heritage [15]. A center for exhibition and sale of handicraft

products covering 773 km2 is proposed (Figure 4). With its circular shape, this place will expose the traditional practices of Kerkennah islands. The center is decorated with a water basin dressed with stones. The basin, with aquatic plants reflects the building as the surrounding vegetation. Street lights are also proposed to illuminate the space by night.

Figure 4: The exhibition center and sale of handicrafts products in 3 Dimension

Visitors can also enjoy a guided tour in the museum of the Park, to learn about birds and marine wealth of the archipelago. Visitors can also learn about the traditional business of the archipelago (the crafts). Among the well known costumes in Kerkennah, we find „Tarf‟ which is a native tapestry of the archipelago embroidered with brightly colored, predominantly the red color. And, we find also "Barnous", "Fouta" and "Melia". Furthermore, visitors can buy products on display which will help promote the local economy. Therefore, this management proposition will try to move towards better harmonization of environmental and recreational goals among the local landscape of Erramla. It will provide a wide range of values to the local community by contributing to the physical and an esthetic quality of urban settlements, to biodiversity, job opportunities, youth development, and public health.

The management will seek also for protecting and reminding the characteristic species of the studied area through the halophilic garden which highlights the natural environment and the ornamental potential of the site and exposes the characteristic vegetation of the sabkha (Figure 5). Nature in urban environment is source of positive feelings and beneficial services [16] and it can substantially improve the livability of land uses and city environment [17].

This component covering 2323.6 m^2 is recognized also for the beauty and diversity of its landscapes as we can contemplate the vegetation around the furnished walkways as well as the various components of the Park.

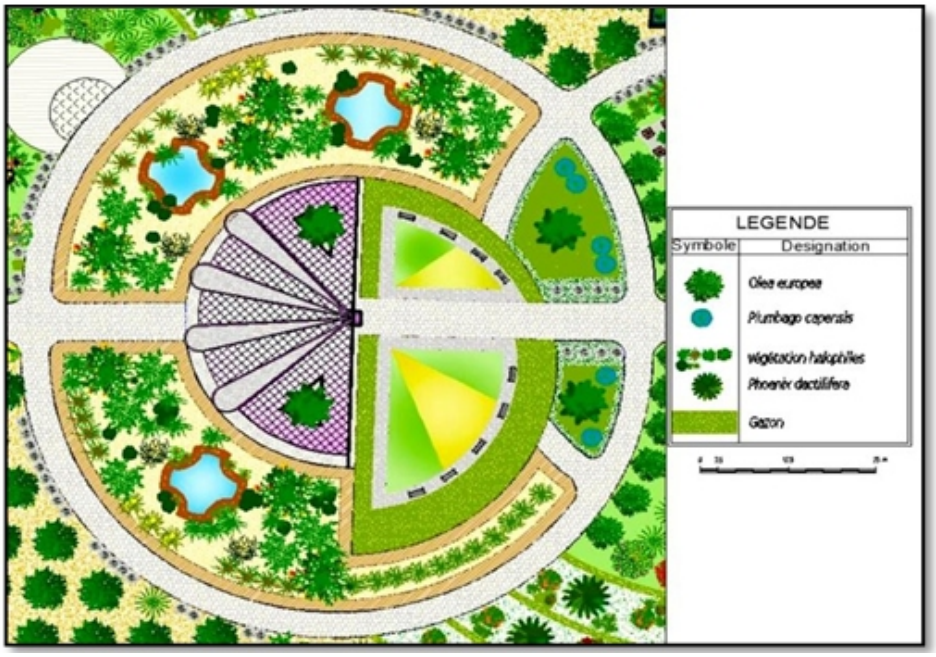

Figure 5: The halophilic garden in 2 Dimension

A relaxing place will be also a part of the plan: a scene of water with an area of 1256 m^2. Water is an element of identity. It adds life and color to the surrounding landscapes. The sound of water from a fountain could mask the street noise. It has a circular shape. The water scene will be designed as a fountain. It offers a spectacular view to the west of the site and it could be a source of relaxation for the visitor by hearing the sound of moving water.

Figure 3: The future scene of water in 3 Dimension

The Park will support a variety of healthy ecosystems that, in turn, support a diversity of flora and fauna. Biodiversity provides one of the defining values of the Park. It has the potential to be one of the primary attractions for visitors. That‟s why the plant palette used is varied and colorful while respecting climate and physicochemical soil conditions in the selection of plant species. Through the vegetation used in the proposed plan, we can find Olea europaea, Callistemon laevis, and Phoenix canariensis near the fountain; Albizia julibrissi and Punica granatum near the center for exhibition and sale of handicraft products; Eucalyptus camaldulensis, Acacia cyanophylla, and Artemisia near the eco-museum, etc.

individuals and communities. A Park must help people to improve their well being. The diversity Thus, the designed components of the regional Park will offer a variety of experiences that inform, involve and inspire visitors by providing access to nature, recreation and learning experiences. The Park is first and foremost a place of enjoyment; a resource for people to use and take pleasure from. It is also an area that can deliver positive benefits to a diverse range of the Park components will offer a high quality and regionally unique visitor destination to Erramla region. Visitors can make the visit enjoyable and memorable, invites return visits, and encourages a positive experience to be relayed to family and friends. Kerkennah regional Park will be a special place that offers visitors experiences they cannot find elsewhere. Moreover, the different landscape views of the Park are not just intended to users, but also to people living and working nearby, as well as those traveling through. Heritage assets, and places, located throughout the Park are a reminder of its rich history and industrial heritage.

4. CONCLUSION

A fact, as the population is increasing especially in urban regions, the volume of wastes also increasing. This factor contributes to the degradation of local environmental quality. Therefore, to protect the environment, a sustainable development management is required. In that sense, Erramla locality was chosen as a case study. The local population produces masses of waste per day which is usually disposed of in the sabkha (study site). When it is dumped, it makes the locality dirty and pollutes the air and groundwater [18]. In similarly cases, regional Parks are a successful example of integrative and active management strategies. It is true that this management proposition is based on theoretical considerations, but it integrates the three components of sustainable development concept: economic development, social development, and environmental protection. The proposed regional Park will provide jobs and opportunities to generate revenue for local people (exhibition and sale center of handicrafts products). It will provide recreational (water scene) and educational (eco-museum) experiences for visitors. And, it will respect and recall the origin identify of the site (halophilic garden).

5. REFERENCES

[1] Liu. S., 2012, Research on Landscape Design of Urban Park, 4th International Conference on Computer Modeling and Simulation (ICCMS 2012), Hubei University of Technology, Wuhan, China.

[2] Su. Z., 2003, Development of GIS as an information management system: a case study for the Burden Center. B. S., Tongji University.

[3] Neema. M. N., and Ohgai. A., 2013. "Multitype green-space modeling for urban planning using GA and GIS" Environment and Planning B: Planning and Design 40(3), pp 447-473.

[4] Jean-Louis Joseph., 2008, Fédération des Parcs naturels régionaux de France. La construction des politiques du paysage dans les Parcs naturels régionaux, n°15. http://www.parcs-naturels-regionaux.fr

[5] Agence de Protection et d'Aménagement du Littoral. 2002. Etude de gestion de la zone sensible des îlots Nord-Est de Kerkennah, Phase I, Caractérisation du milieu naturel, Rapport définitif. 53 p.

[6] Clain. J., 2005, Les parcs naturels régionaux : environnement et aménagement du territoire.. Mémoire de fin d'études, IEP de Lyon.

[7] Etienne, L. Dahech, S., Beltrando, G. and Daoud, A., 2012. Dynamiques récentes des sebkhas de l'archipel des Kerkennah (Tunisie Centro-méridionale): apport de la télédétection. Revue Télédétection, 11 (1), pp 273-281.

[8] Etienne. L, Beltrando. G and Daoud. A., 2013. Human Influences on Environmental Changes in The Kerkennah Archipelago (Tunisia) Since the 60's. 3rd International Geography Symposium - GEOMED. Symposium Proceedings, ISBN: 978-605-62253-8-3. pp 64-70.

[9] Brown. G., 2006. The Sabkha vegetation of the United Arab Emirates. In: M. Ajmal Khan et al. (eds). Sabkha Ecosystems: Volume II: West and Central Asia.

[10] Ashour. M.M., 2013. Sabkhas in Qatar peninsula: Landscape and Geodiversity. Studies of integrated geography. ISSN 2286-0177. ICCS, Spiru Haret University. Issue 1/2013, pp 10-35.

[11] Achouri. E and Benbelgacem. W., 2011, Proposition d'un circuit écotouristique dans l'Archipel de Kerkennah. Projet fin d'étude, ISA CM, 78p.

[12] Dooley. B., Bowra. T., Cluning. D., and Thompson. P, 2000, Yellagonga Regional Park management plan 2003 – 2013. Department of Conservation and Land Management, City of Joondalup and City of Wanneroo.

[13] Direction régionale de l'environnement Picardie, 2005, Park naturel régional. Code de l'Environnement : art. L.333.1 à L.333-4 ; art. R.244-1 à R.244-16.

[14] Djamel. B, 2014, Le site de l'ex décharge d'El Kerma sera transformé en parc d'attractions. Publié dans Le Quotidien d'Oran le 09/04/2014. Dordrecht: Springer. pp. 37- 51. http://www.lequotidien-oran.com/index.php?news=5196750.

[15] Janssen. J. 2009. Sustainable development and protected landscapes: the case of The Netherlands, International Journal of Sustainable Development & World Ecology, 16:1, pp 37-47, http://dx.doi.org/10.1080/13504500902757981

[16] Chiesura. A., 2004, The role of urban Parks for the sustainable city. Landscape and Urban Planning. Volume 68, Issue 1, 15 May 2004, pp 129-138.

[17] Neema. M. N., Khandoker. M. , Maniruzzaman, and Ohgai. A., 2013, Urban Greening Using an Intelligent Multi-Objective Location Modelling with Real Barriers: Towards a Sustainable City Planning. Current Urban Studies 2013. Vol.1, No.4, pp 75-86.

[18] Abdul Jalil. M. , 2010, Sustainable Development in Malaysia: A Case Study on Household Waste Management. Journal of Sustainable Development Vol. 3, No. 3.

Estimation Of Percentage Cost Overruns Of Tamil Nadu Construction Projects-A Regression Based Model

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ABSTRACT

A successful project is mainly associated with cost and time control. For the purpose of project management and control, it is not sufficient to consider only the past record of costs and revenues incurred in a project. This study focus on investigating the factors influencing Tamil Nadu large construction projects A questionnaire survey has been made amongst Government and Private Engineers to examine the various factors affecting construction cost performance. The collected Data was analyzed with statistical tools to determine the ranking of factors. The topmost twelve factors were selected and the percentage of cost overruns was calculated based on regression model. The important two parameters which influences the top most factor escalation of cost of Construction materials were forecasted for the three more subsequent years (2015,2016 and 2017) using the available data .

Keywords: Cost overruns, construction Industries, Influencing factors, Questionairre Survey, Tamil Nadu,

1. INTRODUCTION

Good project managers should focus upon the techniques to be adopted to control the cost and time overruns in the construction projects. If the accurate cost predictions is made then the project becomes successful. Several techniques have been adopted in different countries and states to reduce the impact of cost overruns in the various construction industries. The critical and a very frequent problem is cost overrun which is almost associated with nearly all construction projects.

There are several factors that affect the construction cost and various studies have been conducted to address these factors [1-20]. A study of delays and cost increase in the construction of private residential projects in Kuwait showed that the amount of time-delays and cost increases was greater when the total

cost of a residential project was higher. A major factor contributing to the time-delay and cost-increase was the inadequacy of money and time allocated to the design phase. The three main causes of time-delays were, in order, the number of change orders, financial constraints and owners' lack of experience in construction. The three main causes of cost overruns on the other hand were, in order, contractor and material-related problems and, again, owners' financial constraints [Koushki et al., 2005].

In Ghana study, 26 factors that cause cost overruns in construction of ground water projects in Ghana. According to the contractors and consultants, monthly payments difficulties was the most important cost overruns factor, while owners ranked poor contractor management as the most important factor. Despite some difference in viewpoints among the three groups surveyed, there is a high degree of agreement among them with respect to their ranking of the factors. The overall ranking results indicate that the three groups felt that the major factors that can cause excessive groundwater project cost overruns in developing countries are poor contractor management, monthly payment difficulties, material procurement, poor technical performances, and escalation of materials [Frimpong et al.,2003].

Kaming et al. (1997), examined factors influencing constriction delays (time overrun) and cost escalations, in Indonesian cities. They identified project cost underestimation and project complexity as the main causes of project delays and cost overruns. Chan et al. (1997), examined the principal and common causes of delays which leads to cost overrun in Hong Kong construction projects. The study identified the following factors (1) Poor site management andsupervision, (2) unforeseen ground conditions, (3) low speed of decision making by project teams, (4) client-initiated variations and (5)necessary variations of work, as major cause of delay. Akinci and Fischer (1998) attributed cost overruns in the construction phase of a project to uncontrollable risk factors. These factors must be identified and how they affect project activities must be understood.

Karla Knight and Aminah Robinson Fayek (2000) proposed method of modeling the identified factors using fuzzy membership functions, which capture the imprecision and subjectivity associated with the measurement of the cost affecting factors. He identified Impact labour productivity is a major source of cost overruns. According Flyvbjerg (2002), the under estimation of costs in construction were almost 9 out 10 projects. For randomly selected projects, the likelihood of actual costs being larger than estimated cost is 86%. The likelihood of the actual costs for the construction projects is being lower than or equal to estimated cost is 14%. The actual cost of the projects on average is 28% higher than the estimated cost. The best example for the above case is Suez Canal which was constructed at costs three times of the estimated cost.

There are several factors that are responsible for these cost overruns. This paper attempts to identify the major factors of cost overrun in construction sector of Tamil Nadu and can serve as the way forward for future work in coping with these overruns.

RESEARCH METHODOLOGY

The following steps were involved in the research methodology

1. A vast literature survey was carried out to understand the issues of cost overruns in different states and countries.

2. A questionnaire was developed by selecting top ranked 54 factors involved in the preliminary study.

3. A structured questionnaire survey was conducted amongst Government Engineers and Private Engineers of Tamil Nadu construction projects. Questionnaire was made with kind of questions to obtain what are the factors that are affecting the cost of the construction project.

4. Then the collected Data were analyzed with SPSS, a statistical software and the factors were ranked.

5. The data of the escalation of construction materials (Which leads top among all twelve factors) from 2011 to 2014 were collected and the material cost for the forthcoming years 2015,2016 and 2017 were predicted using Microsoft Excel sheet.

6. The formula for the prediction of the percentage of cost overruns in Tamil Nadu construction industries was obtained by Regression analysis.

QUESTIONNAIRE SURVEY

This study was conducted to identify the issues involved in cost overruns in construction projects in Tamil Nadu. In this regard certain factors were identified through the study and their importance and impacts were discussed. The factors were identified through a questionnaire survey from construction firms (Government Engineers and Private Engineers). Table 1 shows the factors affecting the construction cost. Table 2 presents the topmost influencing factors with their RII (Relative Importance Index).

Table .1.Factors affecting Construction Cost

Sl.No	Factors affecting Construction Cost
1	Complexity of project design
2	Incompetent Project team (designers and contractors)
3	Incomplete design at the time of tender
4	Lack of coordination at design phase
5	Improvements to standard drawings during construction stage
6	Incorrect planning and scheduling by contractors
7	Lack of cost planning/monitoring during pre and post contract stages
8	Lack of experience of local regulation
9	Lack of experience of project type
10	Underestimate project duration
11	Absenteeism of labour
12	Personal conflicts among labor
13	Low motivation and morale of labor
14	Works postponed due to Strike
15	Unqualified / inadequate experienced labor
16	Frequent equipment breakdowns
17	Inadequate modern equipment
18	Low efficiency of equipment
19	Shortage of equipment
20	Slow mobilization of equipment
21	Accidents during construction
22	Delay in obtaining permits from municipality
23	Natural disasters (flood, hurricane, earthquake)
24	Slow site clearance
25	Delay in providing services from utilities (such as water, electricity)
26	Change orders
27	Delay in progress payments
28	Lack of experience of owner in construction projects
29	Slowness in decision making
30	Suspension of work by owner
31	Complexity of the project
32	Legal disputes between project participants
33	Unfavorable contract clauses
34	Original contract duration is short
35	Ineffective delay penalties
36	Changes in material types and specifications during construction
37	Damage of sorted materials
38	Escalation of material prices
39	Poor quality of construction materials
40	Unreliable suppliers

41	Lack of experience of consultant in construction projects
42	Conflicts between consultant and design engineer
43	Inaccurate site investigation
44	Late in reviewing and approving design documents
45	Delay in approving major changes in the scope of work by consultant
46	Frequent change of subcontractors
47	Inadequate contractor experience
48	Inappropriate construction methods
49	Poor site management and supervision
50	Rework due to errors
51	Unreliable subcontractors
52	Obsolete technology
53	Ineffective project planning and scheduling
54	Poor communication and coordination with other parties

Table.2. Topmost Twelve factors affecting construction cost

Sl. No	Factors of cost overruns	Government Engineers		Private Engineers	
		RII	RANK	RII	RANK
1	Escalation of material prices	0.95	1	0.98	1
2	Poor quality of materials and unreliable suppliers	0.901	2	0.96	2
3	Poor site management and supervision	0.89	3	0.939	4
4	Unqualified/ inexperienced labour	0.881	4	0.941	3
5	Shortage and slow mobilization of equipment	0.864	5	0.937	5
6	Suspension of work by owner and delay in payment	0.85	6	0.932	7
7	Delay due to Natural Disasters like flood,rain	0.849	7	0.934	6
8	Incorrect planning and scheduling by contractors	0.838	8	0.93	8
9	Improvements to standard drawings during construction stage	0.821	9	0.928	9
10	Inappropriate construction methods adopted by contractor	0.812	10	0.926	10
11	Conflicts between consultant and engineers	0.8	11	0.923	12
12	Delay in obtaining permits from municipality	0.791	12	0.925	11

Based on the experience of Engineers who participated in this survey agreed with the 54 factors collected from the literature survey and among the 54 factors ,the top twelve factors were selected based on their RII.Regression Analysis

The questionnaire forms were also distributed to ten construction projects (5 government projects and 5 private projects) for the validation purpose. Forward stepping and backward stepping were carried out using SPSS software. Forward stepping begins with most significant variables at the first step and continues adding and deleting variables until none can improve the fit. Backward stepping begins with all candidate variables then remove the least significant variableza at the first step and continues until

no insignificant variable remains. This Forward stepping and backward stepping technique gave the model for predicting the percentage of cost overrun depending on twelve variables .Table 2 presents the regression based model with a squared multiple R=0.852.This indicates that the model is able to predict 85.2% of the validity of the collected data, which is an excellent indicator of the expected performance of the model. Only one variable has been excluded from the listed twelve variables on using this technique i.e., Delay due to Natural Disasters like flood, rain.

Table.3. Regression model

S.No	Variables	Coefficient
1	Constant	0.52
2	Escalation of material prices	0.24
3	Poor quality of materials and unreliable suppliers	0.17
4	Poor site management and supervision	0.11
5	Unqualified/ inexperienced labour	0.17
6	Shortage and slow mobilization of equipment	0.15
7	Suspension of work by owner and delay in payment	0.36
8	Incorrect planning and scheduling by contractors	0.17
9	Improvements to standard drawings during construction stage	0.1
10	Inappropriate construction methods adopted by contractor	0.1
11	Conflicts between consultant and engineers	0.1
12	Delay in obtaining permits from municipality	0.1

The predicted cost overrun percentage can be obtained as follows:

% Cost overrun = 0.52 + 0.24 (Escalation of material prices) + 0.17 (Poor quality of materials and unreliable suppliers) + 0.11 (Poor site management and supervision) + 0.17 (Unqualified/inexperienced labour) + 0.15 (Shortage and slow mobilization of equipment) + 0.36 (Suspension of work by owner and delay in payment) + 0.17 (Incorrect planning and scheduling by contractors) + 0.10 (Improvements to standard drawings during construction stage) + 0.10 (Inappropriate construction methods adopted by contractor) + 0.10 (Conflicts between consultant and engineers) + 0.10 (Delay in obtaining permits from municipality).+

For any Tamil Nadu construction project, by substituting 1 and 0 for used and unused variables respectively in this given model, the percentage of cost overrun can be predicted.

IMPACT OF ESCALATION OF CONSTRUCTION MATERIALS

Over the past few years the construction industry suffers several problems because of the escalation of construction materials. Construction cost indices have been used to measure the cost trends in the construction industry. Estimating the increase in price over the long term is almost impossible because of the many uncertainties beyond the control of all parties. The same is true of long term construction projects with multiyear schedules and start dates in the future. Despite this difficulty, the owners of large long-term projects need to come up with the estimated cost of these projects. The more prudent way to approach these problems is to calculate a range of possible costs. In the present study, it has been found from the statistical analysis, that the leading factor is the escalation of construction material prices.

The basic inputs include simple materials such as cement, sand, and reinforcement steel. This category may also include composite products such as wood (doors and windows), Aluminum (frames for glazing) and Brass (hinges and locks) .The forecasting of bulk construction materials and composite construction materials for the years 2015,2016 and 2017 along with the collected Data of the years 2011 to 2014 have been shown in Table 3 and 4.

Table 4. Escalation of construction materials

Item No	Description of item	Unit	Rate Analysis						
			2011	2012	2013	2014	2015	2016	2017
1	Cement	Bag	260	280	300	340	390	445	515
2	Reinforcement Steel	Kg	38	40	45	54	57.5	62.8	68.1
3	Structural steel	Cu ft	45	55	65	75	85	95	120
4	River sand	Cu ft	20	23	25	30	32.5	35.7	38.9
5	40 mm coarse agg	Cu ft	20	22	25	33	35.5	39.7	43.9
6	20 mm coarse agg	Cu ft	21	24	32	38	43.5	49.4	55.3
7	12 mm agg	cu ft	20	21	27	35	38.5	43.6	48.7
8	6 mm Agg	cu ft	13	13	25	30	36	42.3	48.6
9	Bricks	1 no	4	4.5	5	5.5	6	6.5	7
10	Fly ash bricks	1 no	4.5	5.5	6	6.5	7.25	7.9	8.55

Table. 5. Escalation of composite construction materials

Item No	Description of item	Unit	Rate Analysis						
			2011	2012	2013	2014	2015	2016	2017
1	1st class Padauk wood	Cu ft	2340	2464	2450	2600	2641	2708.7	2776.7
2	2nd class teak	Cu ft	2600	2800	2800	3400	3600	3900	4200
3	1st class Burma Teak wood	Cu ft	3700	4000	4000	5400	5867	6566.7	7266.7
6	SS Butt hinges	1 no	140	140	160	180	200	220	240
7	Brass handle - 125mm size	1 no	250	250	300	350	400	450	500
8	Brass hanging type floor door stopper	1 no	185	190	210	250	277	306.7	336. 7
9	Aluminum handle -100mm with screws	1 no	66	70	85	100	115	130	145
10	Aluminum tower bolt 250x10mm	1 no	80	86	95	100	108	114.7	121.7

Through forecasting technique, it was found that the cost of cement which is the major construction material from 2013-2014, 2014-2015, 2015-2016 and 2016-2017 would increase by 13%,14%,14.5% and 15% .

CONCLUSIONS

This paper investigated the causes of cost overruns of major construction projects of Tamil Nadu. The needed information was gathered through a vast literature survey and a detailed questionnaire survey. The questionnaire were distributed among the Government Engineers and Private engineers who are working in various construction projects of Tamil Nadu. Based on their experience, a total of 54 causes of cost overruns were observed. The Relative Importance Indices of all the factors were found out using SPSS software and the factors were ranked. Among the factors, the top leading twelve factors were selected. Among the top twelve factors , 11 variables were used to predict the model. The best regression model was thus created to calculate the percentage of cost overruns of construction projects. The topmost factor was taken for forecasting purpose. Escalation of construction material greatly influences the cost overrun. Therefore a rate analysis was also carried out for the construction and other important composite materials and the inflation of prices of them in the forth coming 2016, 2017 and 2017 years were also predicted with the help of Microsoft excel. The present study contributes an excellent regression model for the practitioners of Tamil Nadu construction industries.

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REFERENCES

[1] Ade Asmi Abdul Azis .,2013, Controlling Cost Overrun Factors in Construction Projects in Malaysia, Research Journal of Applied Sciences, Engineering and Technology 5(8),pp 2621- 2629.

[2] Aftab Hameed Memon et al., 2010 Factors Affecting Construction Cost in Mara Large Construction Project International Journal of Sustainable Construction Engineering & Technology,1(2).

[3] Akinci, B., and Fischer, M., 1998, Factors affecting contractor's risk of cost overburden. Journal of Management in Engineering, 14(1) ,pp 67–76.

[4] Anu V.Thomas and Sudhakumar., 2013, Critical analysis of the key factors affecting construction labour productivity –an indian perspective, The International Journal of Construction Management, 13(4), pp 103-125.

[5] Ashworth, A. (1994). Cost Studies of Buildings, 2nd Edition, Longman Group Limited.

[6] Assaf, S.A., Al-Khalil, M., and Al-Hazmi. M., 1995, Causes of delay in large building construction projects, Journal of Management in Engineering 11, pp 45-50.

[7] Ayman A. Abu Hammad., 2008, Prediction Model for Construction Cost and Duration in Jordan, Jordan Journal of Civil Engineering, 2(3).

[8] Chan, D. W. M., and Kumaraswamy, M. M., 1997. A Comparative Study of Cause of Time Overruns in Hong Kong Construction Projects, International Journal of Project Management, Pergamon, pp 55-63.

[9] Chimwaso, K.D., 2001, An Evaluation of cost performance of public projects; case of Botswana. Department of Architecture and Building Services, Private Bag 0025, Gaborone, Botswana.

[10] Creedy, G.D., Skitmore, M., and Wong, J.K.W., 2010,Evaluation of risk factors leading to cost overrun in delivery of highway construction projects, Journal of Construction Engineering and Management, 136(5), 528-536.

[11] El-Choum, M.K., 1995. Analytical models of cost overruns in construction, Computing in Civil Engineering. Proceedings of the Second Congress held in conjunction with A/E/C systems '95, Atlanta, Ga., June 5–8, pp. 854–862.

[12] Frimpong.Y., J. Oluwoye, L. Crawford., 2003, Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study, International Journal of project management 21,pp 321-326.

[13] Hisham.A et al., 2013, Cost overrun causes related to the Design phase in the Egyptian Construction Industry, Journal of Engineering Management Research, 1(5).

[14] Karla Knight and Aminah Robinson Fayek .,2000 A preliminary study of the factors affecting the cost escalation of construction projects Can. J. Civ. Eng. 27: 73–83.

[15] Kaming, P., Olomolaiye, P., Holt, G., and Harris, F.C., 1997, Factors influencing construction time and cost overruns on high-rise projects in Indonesia, Construction Management and Economics, 15(1), 83-94.

[16] Koushki, P.A, AL-Rashid, Khalid and Kartam, Nabil., 2005, Delays and cost increases in the construction of private residential projects in Kuwait, Journal of Construction Management and Economics, 23(3), pp. 285-294.

[17] Koushki, P. A., Al-Rashid, K and Kartam,N., 2005. Delays and cost increases in the construction of private residential projects in Kuwait. Construction Management and Economics, 23, 285-294.

[18] Le-Hoai L et al., 2008 Delay and cost overruns in Vietnam large construction projects: Acomparison with other selected countries. KSCE journal of civil engineering , 12(6) pp 367- 377.

[19] Lo Zhu. K. and Lin.L., 2004, A stage – by – stage factor control frame work for cost estimation of construction projects, Owners Driving Innovation International Conference. [20]Mansfield, N. R., Ugwu, O.O., and Dorna, T., 1994, Causes of Delay and Cost Overruns in Nigerian Construction Projects, International journal of Project Management, 12, pp 254-260.

Modeling And Simulation Of Locally Manufactured Elevated Water Tank Stands

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A B S T R A C T

The collapse of metal stands occurs quite often with considerable accidents reported. This paper deals with induced stresses of locally manufactured water tank stand models. The modeling and simulation were done by using Solid Edge Software. Different Stresses were found at different loading conditions and the results compared and tabulated along with graphs. Recommendations for some optimum designs were made.

Keywords : Structural Stress, Simulation, Water Tank Stand

1. INTRODUCTION

Water is a human basic need for daily life. “Access to safe water is a fundamental human need and, therefore, a basic human right. Contaminated water jeopardizes both the physical and social health of all people. It is an affront to human dignity.”Kofi Annan, Former United Nations Secretary-General.An emergency water supply is recommended in every household to meet interruption of safe water supply which may arise as a result of natural disasters such as draught and earthquakes. According to Teng Ke Wong (2014) and Water Aid (2009), more than 70 % of the households surveyed in Accra reported having intermittent water supply, and over 90% of the population relies on storing water in containers for their daily supply. Household water storage tanks of 200 to 6000 L are commonly used in Ghana, TengKe Wong (2014). These tanks are typically elevated, thereby providing households with 24-h access to pressurized water. The vulnerability of the staging structure is primarily responsible for the failure of elevated water tanks, Chennababu et al (2014).Several studies have been conducted to investigate the effect of columns, braces, number of panels, initial tension of bracing rods, lateral stiffness of the staging structure as well as soil structure interactions which influence failure of staging structure under seismic conditions. However, the stress analysis of local materials and design of water storage tank supports have not been recorded. This work seeks to establish the design of locally

Manufactured Elevated Water Tank Stands in Ghana by performing Finite Element Analysis of these tanks using the Solid Edge Software.

WATER TANK STAND

Three water tank stands are commonly used in Ghana to elevate water storage tanks;

(a) (b) (c)

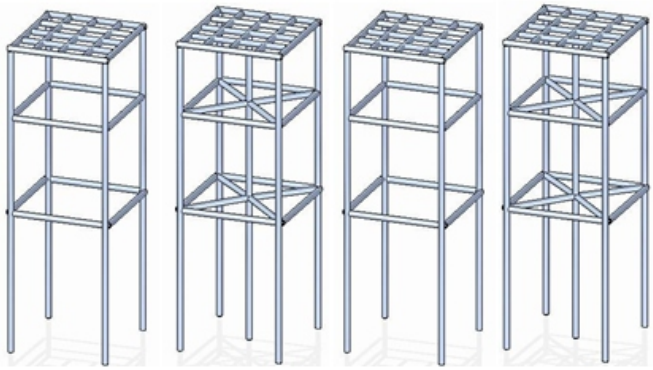
Figure 1: Water tank stands commonly used in Ghana (a) Metal tank stand (b)Cement tank stand (c)Water tank tower

The metal tank stand shown in Figure 1(a) has gained popularity especially in the Wa municipality of Ghana (everywhere in Ghana) because it takes less time to construct compared to the cement tank stand and the water tank tower, it is comparatively cheaper to construct and that it can be moved around incase one is relocating. Metal stands must be designed to withstand lateral loads, including wind loads, impact loads, and earthquake loads. There are reported cases of failure of tanks stand both locally and internationally. The Plumbing Regulation News Update (Issued: 7 May 2009) of Australia reported a case in Melbourne where a water tank stand collapsed in a suburban backyard where a five year old child usually played. There are also reported cases of failure of metal stands at FIC educational complex and Jams Guest houses both in the Wa Municipality of Ghana. The design and fabrication of metal stands in the Wa Municipality (Ghana)are either under designed or overdesigned because of the difficulty in selecting the right material (steel/ galvanized pipes) for the fabrication. This paper presents four (4) models of metals stands designed by local artisans and their capability to withstand lateral loads. Recommendations on the types of pipes for optimum designs are also presented.

Figure 2: Remnant of water tank **Figure3:Reconstructed stand at FIC Educational Complex**

METHODOLOGY METAL STAND MODELS

Two model stands were identified as shown in Figure 1 and Figure 2. Of these models the sizes of the pipes were also realized to have been different ranging from 2 to 4 inches galvanized steel pipes. 2 and 3 inches pipes were then selected on merit to give four models which were the used for the simulation process.



(a) Model 1 (2”pipe) (b) Model 2 (2”pipes) (c) Model 3 (3”pipes) (d) Model 4 (3”pipes)

Figure 4: Metal Stand Models

PARAMETERS OF METAL STAND

Size of metal stand top	1800 mm × 1800 mm
Height of metal stand	3600 mm
Bracing distance	1000 mm

SIMULATION PROCESS

The Simulation process involved three essential stages; pre-processing, solving and post- processing. During preprocessing, the metal stand models were developed in solid edge assembly environment and divided up into smaller blocks or elements, appearing as a "discretized" mesh superimposed over the structure. These elements are defined in space by nodes, at which the stress strain computations occurred. During solving, the finite element solver of the software generates a stiffness matrix for each element, the displacements due to an applied load, and then assembles each element's contribution to form a response matrix for the whole model. Table 1shows the different point or concentrated loads that were applied to the models. These loads were computed from capacities of tanks that are commonly mounted on metal stands.

Table 1: Commonly used Tanks and their capacities and Weight

Polytank Model Name	Capacity (litres)	Weight of full capacity water (kg)	Force exerted by water on stand (N)
R100	1000	1000	9810
R180	1800	1800	17658
R300	3000	3000	29430
R350	3500	3500	34335
R600	6000	6000	58860

RESULTS

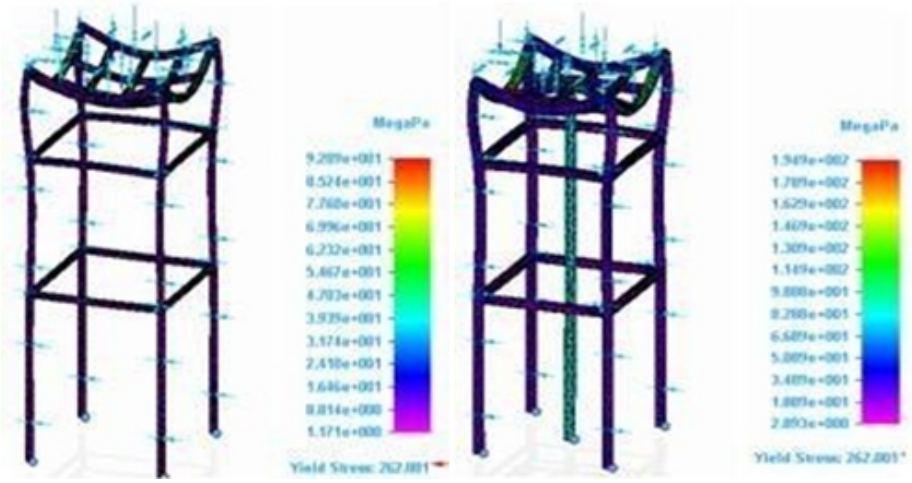


Figure 5: Results of Finite Element Analysis of Models

Table 2: Von-Mises Stress Result for different Tank Stand Models

Tank stand Model/ Factor of Safety	Von-Mises Stress Result (MPa)				
	1000 liters	1800 liters	3000 liters	3500 liters	6000 liters
Model 1	95.38	190.8			
Factor of Safety	2.8	1.4			
Model 2	39.86	71.75	119.6	139.5	
Factor of Safety	6.6	3.7	2.2	1.9	
Model 3	41.04	73.87	123.1	143.6	
Factor of Safety	6.4	3.6	2.1	1.8	
Model 4	17.62	32.5	54.17	63.2	108.3
Factor of Safety	14.9	8.1	4.8	4.1	2.4

Table 3 : Von-Mises Stress for different height of Model 1 Metal Stand

	Von-Mises Stress Result (MPa)				
Height (m)	1000 liters	1800 liters	3000 liters	3500 liters	6000 liters
3.5	102.6	184.7	307.9	359.2	615.8
3	99.83	179.6	299.3	349.2	598.6
2.5	74.45	134	233.3	260.6	446.7
2	58.77	105.8	176.3	205.7	352.6
1.5	62.82	113.1	188.5	219.9	376.9
1	70.31	126.6	210.9	246.1	421.9

Von-Mises Stress for different Heights in Model 1

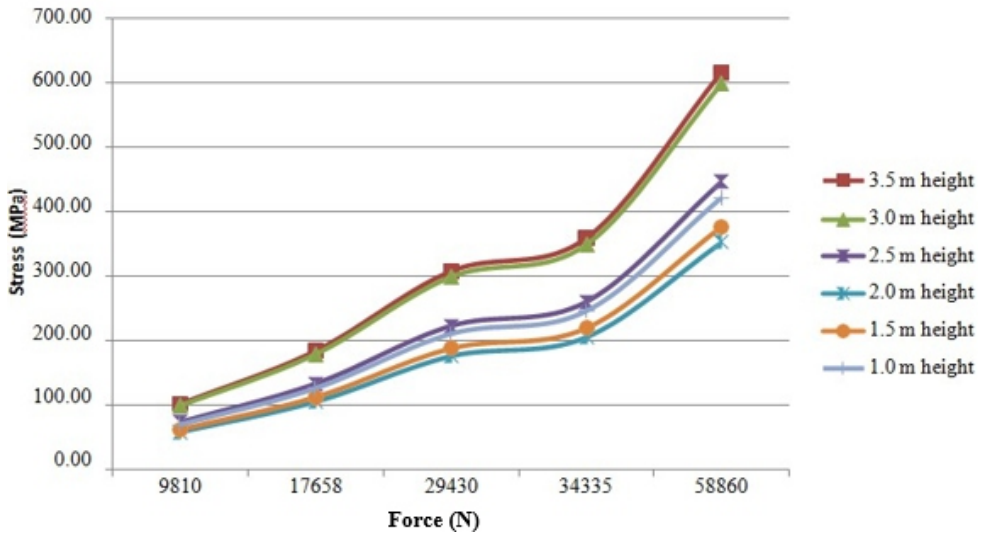


Figure 6: Von-Mises Stress for the different Heights in Model 1

Table 4: Von-Mises Stress for different height of Model 2 metal stand

	Von-Mises Stress Result (MPa)				
Height (m)	**1000 liters**	**1800 liters**	**3000 liters**	**3500 liters**	**6000 liters**
3.5	40.04	72.07	120.1	140.1	240.2
3	39.43	70.98	118.3	138	236.6
2.5	25.88	46.58	77.64	90.58	155.3
2	19.25	34.65	57.74	67.37	115.5
1.5	20.5	36.91	61.51	71.77	126.7
1	22.84	41.11	68.52	79.94	137

CONCLUSION

Four designs of the water tank stand were modeled in Solid Edge assembly environment. Linear static and structural analysis was done and achieved the accurate results. The simulation was done for five different loads and six different heights of the stand. Using the classical rule-of-the thumb method which is based on estimations of five measures (David G. Ullman, 1986) a factor of safety of 2.05 was considered. Applying the results achieved from equivalent stress, the recommended model stand for the different tank capacities loads are in Table 5 below.

Table 5: Commonly used Tanks and their capacities and Weight

Polytank Model Name	Capacity (litres)	Weight of full capacity water (kg)	Force exerted by water on stand (N)	Recommended Model Stand
R100	1000	1000	9810	Model 1
R180	1800	1800	17658	Model 2 or Model 3
R300	3000	3000	29430	Model 2 or Model 3
R350	3500	3500	34335	Model 4
R600	6000	6000	58860	Model 4

A correlation was observed to be between the stress and the stand height. The compressive stress in the stand increases with increasing height of the stand. The reasonable height of the stand was found to be between 1.5 to 2.0 m. This height will offer rational stress constitution and economical cost for the engineer.

REFERENCES

1. *Cynthia A. Schafer and James R. Mihelcic (2012), Effect of storage tank material and maintenance on household water quality, America Water Works Association, http://dx.doi.org/10.5942 /jawwa. 2012. 104.0125*
2. *David G. Ullman(1986), The Design of Mechanical Process,The McGraw- Hill Companies, Inc. Second edition.*
3. *Jui-Lin Peng, Tsong Yen, Ching-Chi Kuo, Siu-Lai Chan (2009), Analytical and experimental bearing capacities of system scaffolds, Journal of Zhejiang University SCIENCE A, ISSN 1009-3095 (Print); ISSN 1862-1775 (Online)Vol. 10(1):82-92*
4. *M.Chennababu, V. Krishnareddy, Modeling and Analysis of Water Tank Stand International Journal of Research in Mechanical Engineering & Technology ISSN : 2249-5762 (Online) ISSN: 2249-5770 (Print) IJRMET Vol. 5, Issue 1, November 2014 - Apri l 2015*
5. *Plumbing Regulation News Update 06/2009, Issued: 7 May 2009*
6. *TengKe Wong (2014), "Evaluation of Household Water Treatment and SafeStorage (HWTS) Alternatives in Ghana", Civil and Environmental Engineering Department, Massachusetts Institute of Technology.*
7. *WaterAid. (2009). WaterAid – national water sector assessment: Ghana. London: WaterAid. Retrieved from http://www.wateraid.org/~/media/Publications/national-water-sector- assessment-ghana.pdf*

Strength And Durability (Chloride Ingress) Trends Of Ground Granulated Blast furnace Slag GGBS In Concrete

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A B S T R A C T

Ground Granulated BlastfurnaceSlag (GGBS) is a solid waste produced during the manufacture of iron. Instead of it leading to an increase in solid waste generation, this industrial by-product can be managed properly and effectively by making use of its cementitious properties. This research aims at investigating the strength and durability properties of the GGBS. Three mixes were designed: 0% GGBS, 30% GGBS and 50% GGBS respectively.

Compressive strength tests were carried out and the following trend was observed: 0% GGBS > 30% GGBS > 50% GGBS at 7 days and 30% GGBS > 0% GGBS > 50% GGBS at 28 days. The concrete specimens were exposed to a wet cycle of 50% sodium chloride (NaCl) solution for 3 days and a dry cycle of 35°C oven temperature for 4 days during one month. A series of sorptivity test was carried out and the depth of penetration was also determined. For a short term durability, 50% GGBS performed most efficiently.

Keywords: Ground Granulated Blastfurnace Slag (GGBS), solid waste, strength, chloride, durability

1. INTRODUCTION

As a result to worldwide development in terms of population and economy, an increase in solid waste generation is observed. These solid wastes, if managed properly and efficiently, will protect human health and environment, preserve natural resources and reduce climate change. Among the different existing waste manage men strategies such as recycling and composting, waste reduction and disposal, this research focuses on waste reduction.

Ground granulated blast furnace slag (GGBS) is produced during the manufacture of iron in a blast furnace. When the rapidly cooling molten iron slag, which is an unwanted by-product from

oresmelting, is immersed in water, it produces a latent hydraulic material commonly known as the GGBS. This product is then grounded to cement fineness (Chen et al., 2012).Much less energy is required for grinding blast-furnace slag than for the production of Portland cement(Higgins, 2007).GGBS has many positive attributes associated with its use such as improved economic, durability and sustainability properties.

Instead of disposal to landfills, the slag wastes produced from the iron manufacturing industries can be used as supplementary cementitious material. However, it is essential that the GGBS displays satisfactory strength and durability properties which make it worthy of being used in structural concrete. This research aims at investigating whether GGBS can be used as a main component in modified concrete; primarily in an attempt to alleviate solid waste disposal. The objectives are to show satisfactory compressive strength requirements as well as an improved durability performance of the GGBS when subjected to wetting and drying exposure conditions due to solutions of sodium chloride. Chloride ingress accounts to main durability problems as far as corrosion of reinforcement in reinforced concrete is concerned.

2.0. BACKGROUND

2.1. DURABILITY

It is important to realise that problem with concrete is not only limited to strength. The real problem is in fact durability which is one of the most important properties of concrete. Aquality concrete is one which is dense, has a low water to cement ratio and has well-graded aggregates. Two important factors which influence the durability of reinforced concrete are:

- the resistance of concrete against penetration of aggressive agents, that is, a low permeability concrete.

- the thickness of concrete cover to the reinforcing steel. (Bioubakhsh, 2011).

2.2. CHLORIDE INGRESS

Chloride is a negative ion in salt (sodium chloride), normally found in sea salt, deicing salt, mixing water contaminated with salt water, improperly washed marine aggregates and calcium chloride admixture for concrete. It is the principal cause of reinforcement corrosion in concrete structures. (Arya & Y.Xu, 1995).

The movement of gases, liquids and ions through a concrete is essential due of their interactions with concrete constituents or pore water. It can change the integrity of concrete, leading to deterioration. These movements, normally called penetration, take place due to various combinations of air or water pressure differentials, humidity differentials and concentration or temperature differences of solutions.(Basheer et al., 2001).

Table 1. Transport mechanism for chloride ingress

[Source: Adapted from Hong and Hooton (1999); Otieno (2010)]

1	Diffusion	In a saturated concrete which is exposed to chloride solution, the chloride ions move from a high concentration to a low concentration to attain equilibrium.
2	Absorption (Sorptivity)	Sorption refers to uptake of chlorine by capillary suction in an unsaturated concrete surface exposed to a chloride solution.
3	Permeation	Permeability relates to the movement of a fluid under the action of a pressure differential.
4	Chloride Binding	Some soluble chloride ions are consumed or bound in thehydrated phases of the cement paste and therefore are not able to travel through the pore solution of the binder matrix to the level of the rebars.
5	Dispersion	As a chloride front diffuses intothe concrete cover, the front will tend todisperse as it travels, and the ions will move faster or slower thanthe averagediffusion rate.
6	Wick Action	Wick action is the transport of water and the ions it may contain through a concrete structure from a face in contact with water/salt solution to a drying face.

In cyclic wetting and drying regime, which is one of the main subjects of interest in this research, it is absorption due to capillary action (sorptivity) that is mainly responsible for the ingress of chloride through the surface skin.

2.3. ABSORPTION (SORPTIVITY)

The transport of liquids in porous solids due to surface tension acting in capillaries is called water absorption. The absorbed water in the concrete is related not only to the pore structure but also to the moisture condition of the concrete.(Basheer et al., 2001).

As defined in Table 2.1 above, this absorption process is possible in unsaturated concrete which makes it relevant to the aims of this research.

A relationship exists between the cumulative absorbed volume of water per unit area of the inflow surface, i and the square root of time of exposure, t, as shown in the equation (4).

$$i = A + S\sqrt{t} \quad \text{_____(1)}$$

Where, S = sorptivity of material (normally expressed in $mm/h^{0.5}$)

A = initial absorption

The sorptivity coefficient, S is obtained from the slope of the i-versus-$t^{0.5}$ curve. Assuming an ideal situation, the initial absorption, A is taken to be 0 when t = 0, therefore resulting in zero sorptivity.

$$\therefore i = S\ \overline{t} \quad \text{_____(2)}$$

The relationship between penetration depth, d and the elapsed time, t could be represented by the equation:

$$d = d_0 + S'\ \overline{t} \quad \text{_____(3)}$$

Where, d_0 = a constant relating to intercept at t = 0

S' = Sorptivity of material related to depth of penetration [S' in (3) is not the same as S in (2), although the units are the same].

2.4. SUPPLEMENTARY CEMENTITIOUS MATERIAL

Supplementary cementitious materials such as GGBS are used to enhance the durability properties of concrete. The refinement of concrete pore structure, the reduction of the heat of hydration, the increased resistance to chemical attack and a dense micro structure which makes the mix less permeable and more durable in aggressive environments show the advantages of making use of GGBS. However, GGBS hydrates more slowly than Portland cement, therefore yielding a much slow rate of strength development.

Table 2.Typical composition of the ordinary Portland cement and GGBS used [Source: Adapted from Ecocem (2013)]

	OPC	GGBS
CaO	61.45	42.51
SiO_2	20.95	33.08
Al_2O_3	4.64	13.36
Fe_2O_3	2.94	0.43
MgO	4.15	7.53
K_2O	0.5	0.28
SO_3	2.47	0.08
TiO_2	0.25	0.61
Na_2O	0.18	0.12
Loss on ignition	1.45	0

Many publications have reported the excellent performance of concrete containing mineral admixtures (MAs), such as ground granulated blast furnace slag in coastal marine environments (Chen et al., 2012). It is worth adding that the properties of the blended concrete are dependent on fineness of supplementary cementitious material, water to binder ratio of the mix and the percentages of the cement which have been replaced (Bioubakhsh, 2011).

Preez and Alexander (2004) used concrete containing 50% GGBS in their sorptivity research on a site study of durability indexes for concrete in marine conditions. Arya, Vassie and Bioubakhsh (2014) made use of concrete cubes from 70% CEM I + 30% GGBS and 50% CEM I + 50% GGBS in their research on chloride penetration via sorptivity in concrete subject to wet/dry cycling. Last but not the least, the commonly used replacement level of GGBS in the South African construction industry is 50% (Otieno, et al., 2014).

GGBS concrete showed improved durability behaviour compared to OPC in aggressive environments, in particular where penetration of chloride presents the risk of reinforcement corrosion(Polder, 2012). Scott and Alexander (2007) worked on the influence of binder types on the corrosion rate of steel by studying the effect of cover, cracking and supplementary cementitious materials (SCMs) on the corrosion rate. The SCMs under consideration was ground granulated blast- furnace slag (GGBS), pulverized fly-ash (PFA) and condensed silica fume (CSF). They concluded that GGBS caused significant reduction in corrosion rate compared to other SCMs by making the concrete less permeable. Essentially they showed that SCMs have a higher reduction rate in corrosion than increasing the concrete cover.

2.5. WETTING AND DRYING CYCLES

A structure can be divided into three zones: the atmospheric zone (above the high-tide level), the tidal zone (between the tide lines), and the submerged zone (below the low tide level). The most severe deterioration usually occurs in the tidal zone, which is the focus of this investigation. Under laboratory conditions, this exposure condition can be simulated using wet and dry cycles.

Wetting and drying cycle results in continuous moisture movement through the concrete pores. The moisture content has a direct influence on durability, as it governs the amount of oxygen and moisture available at the rebar, and the magnitude of the capillary suction forces, which dictates the rate of penetration of water (Hong and Hooton, 1999).

The rate of corrosion in reinforced concrete structures can be accelerated by the evaporation of water during the drying phase of the wet and dry cycle. In dry or partially dry concrete, oxygen has a high diffusion coefficient. Therefore, when the chloride thresholds have been reached at the depth of the cover, the drying of the concrete makes more oxygen available to trigger corrosion of steel bars. The increased availability of oxygen and a higher concentration of chlorides to maintain corrosion explain why concrete structures subjected to alternating wetting and drying are severely attacked, while permanently immersed concrete structures are attacked the least.

Chloride ingress is strongly influenced by the sequence and duration of wetting and drying. The temperature and conditions at which the concrete is drying is very important. When exposed to salt water, dry or partially dry concrete absorbs the saline solution by capillary suction. The concrete imbibes in the salt water until saturation, or until no more salt water is left. The longer the drying time, the drier the concrete is and the deeper the chloride ions penetrate the concrete.

When the concrete stays wet, some salts move from the concrete surface towards the inside of the concrete by diffusion. However, if there is a short wetting period, the salt water enters the concrete by absorption. The salts move towards the inside of the concrete and are further concentrated during the following drying cycle.

A. Taheri (1998) used an exposure condition consisting of a drying period of 42 hours, followed by a wetting phase of 6 hours with salt water containing 5% NaCl solution. Hong & Hooton (1999)6 chose two wetting and drying cycle lengths; the wetting period with a 1.0 molar NaCl solution was kept constant for 6 h while the time of drying was either 18 h (1- dayseries) or 66 h (3-day series). Otieno et al.(2010)7 used a 5% NaCl solution with 3 days a week ponding system and 4 days of drying. Recently, S. Bioubakhsh (2011) opted for a cyclic regime consisting of 2 days of wetting followed by 12 days of drying to represent the meteorological condition in United Kingdom (UK). The salt solution employed was a sodium chloride (NaCl) solution generally made to a concentration of 178.5 g/l (50% saturated NaCl solution).

3.0. METHODOLOGY

- The coarse aggregates followed by the fine aggregates were added in the mixer. The coarse aggregate followed by the fine aggregate were added in the mixer.

- The cement and GGBS were then added.

- The mixer was covered with a plastic sheet to prevent any loss of the cementitious materials before it was switched on.

- After an initial mixing time of 30 seconds, water was slowly poured into the mixer for one minute. The batch was mixed for further 5 minutes, hence adding up to total mixing time of 6 and a half minute.

- The concrete were placed in the pre-oiled steel moulds and were compacted in two approximately equal layers on a vibrating table. The top surface of each sample was troweled level with the top of the mould.

- The cubes were covered with a plastic sheeting to prevent any moisture loss and demoulded after 24hours.

- Curing was carried out just after the concrete samples were demoulded. After 7 days of wet curing, the cubes were air-cured for the next 21 days.

- The penetration of the salt solution into the concrete cubes is maintained uni-directional by sealing all except the exposed surface of the specimen.

- The cubes were exposed to 3 days of wetting in 50% NaCl solution (178.5 g/l) and 4 days of drying in an oven set at 35oC at an age of 28 days.

- Determination of Porosity

At the end of the 28 days curing period, the 100mm concrete cubes used in the porosity test were initially weighed (Wi). They were then fully immersed in water for 3 days and the saturated weight, Ws was recorded. After that, the specimens were oven-dried at 105±5°C for 3 days to determine the oven-dry mass, Wd.

The absolute porosity of concrete is the ratio of the total pore volume to the volume of concrete and is given by

$$Absolute\ Porosity = \frac{W_s - W_d\ /\rho}{V}\ x\ 100 \quad \text{(4)}$$

Where:

W_s is the saturated mass of the cube

W_d is the oven - dry mass of the cube

V is the volume of the cube

p is the density of water

The effective porosity of a concrete has a major influence on the sorptivity of concrete. It is defined as a percentage of the available pore volume at any given time to the volume of the concrete sample and is given by the following expression:

$$Effective\ Porosity = \frac{W_s - W_i\ /\rho}{V}\ x\ 100 \quad \text{(5)}$$

Where W_i is the initial mass of the cube

- Determination of weight sorptivity

The increase in the specimen weight due capillary suction during wetting cycle as well as the decrease in the specimen weight during drying cycle are measured on an appropriate time interval. The weight gains obtained during the first four hours are plotted against the square root of absorption time; the slope of the graph obtained being the weight sorptivity. The weight sorptivity from the specimens' shows the mass of salt solution per square root of time that has been absorbed during wetting phase.

- Determination of distance sorptivity

From the weight sorptivity, the volume sorptivity of the specimen are obtained using:

$$Volume\ sorptivity\ mm^3\ \bar{h} = \frac{Weight\ sorptivity\ (\overline{g/h})}{Water\ density\ (g/mm^3)} \quad \text{(6)}$$

Knowing the volume of salt solution per square root of time that has in gressed through the specimens, the formula below can be used to calculate the depth per square root of time that the salt solution have moved upwards.

$$Distance\ sorptivity\ mm\ \bar{h} = \frac{Volume\ sorptivity\ mm^3\ \bar{h}}{Effective\ porosity\ \%\ x\ Surface\ area\ (mm^2)} \quad \text{(7)}$$

- Determination of depth of salt solution penetration

The depth of salt solution penetration (mm) is determined via the volume of solution absorbed and effective porosity of concrete as follows:

$$Depth\ of\ penetration = \frac{Volume\ of\ solution\ absorbed\ (mm^3)}{Effective\ porosity\ \ \%\ \ x\ Surface\ area\ (mm^2)}\ x\ 100 \quad \text{(8)}$$

Where,

$$Volume\ of\ solution\ absorbed\ \ mm^3 = \frac{Weigh\ gain\ (g)}{Water\ density\ (g\ mm^3)} \quad \text{(9)}$$

The following tests were carried out:

1. Sieve analysis of the aggregates
2. Compressive strength
3. Sorptivity test using wet and dry cycles

4.0. RESULTS AND DISCUSSION

4.1. PROPERTIES OF AGGREGATES

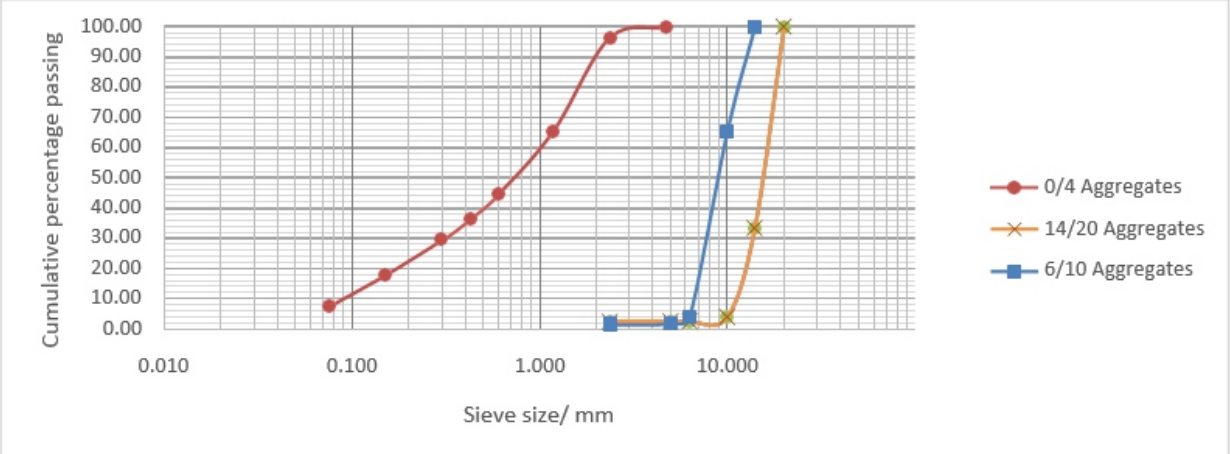

Fig.1.Sieve analysis results of the aggregates used

Both the fine and coarse aggregates used were well graded as shown by the smooth curves in the above Figure 1. Well-graded aggregates improve bond strength and permeation properties of a concrete.

Table 3. Densities and absorption values of the aggregates used

Aggregate Type and Size		Relative Density (OD)	Relative Density (SSD)	Apparent Relative Density	Water Absorption (%)
Fine	0-4	3	3.03	3.07	0.8
Coarse	10-Jun	2.69	2.76	2.9	2.8
	14-20	2.62	2.69	2.83	2.9

4.2. SLUMP TEST

As the GGBS content is increased, an increase in workability is noted. This is because the surfaces of the GGBS particles are smoother than those of Portland cement and consequently a lower volume of mixing water is adsorbed onto the surface of the GGBS particles.

However, when the GGBS proportion increases from 30% to 50%, there is a decrease in workability due to the presence of a very high concentration of finer particles.

4.3. COMPRESSIVE STRENGTH

The compressive strength was carried out on the 7th and the 28th day. It was observed that on the 7th day, all the cubes had comfortably achieved 70% of the design strength and on the 28th day, all cubes were satisfactorily above 40 MPa.

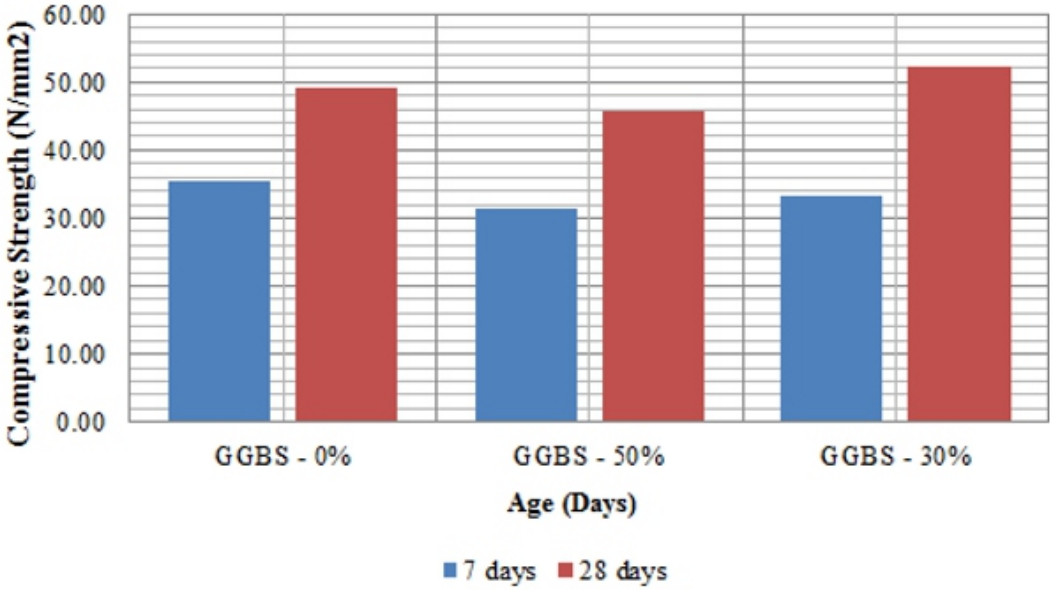

Fig.2. Characteristics cube strength for the different mixes at 7 and 28 days

At 7 days, 0% GGBS developed the highest compressive strength, followed by 30% GGBS and 50% GGBS. The compressive strength increased with increasing time of conditioning and at the end of 28 days, the strength developed was in the following descending order: 30% GGBS, 0% OPC and 50% GGBS.

At 7 day, the GGBS mixes had a lower early strength as expected. This is due to their slow rate of hydration. The 30% GGBS has a higher Portland cement content as compared to 50% GGBS. The higher the content of the pozzolanic material, the slower is the rate of strength development in the GGBS mix. This explains why 30% GGBS has a greater strength development both at 7 and 28 days.

The 28 day strength increased significantly for GGBS due to its fineness which is normally finer than that of Portland cement (Leung & Wong, 2011). This gain in strength is expected to keep on increasing due to its high proportion of calcium silicate hydrate (CSH) gel and much less lime (calcium hydroxide) in the concrete.

4.4. ABSOLUTE AND EFFECTIVE POROSITY

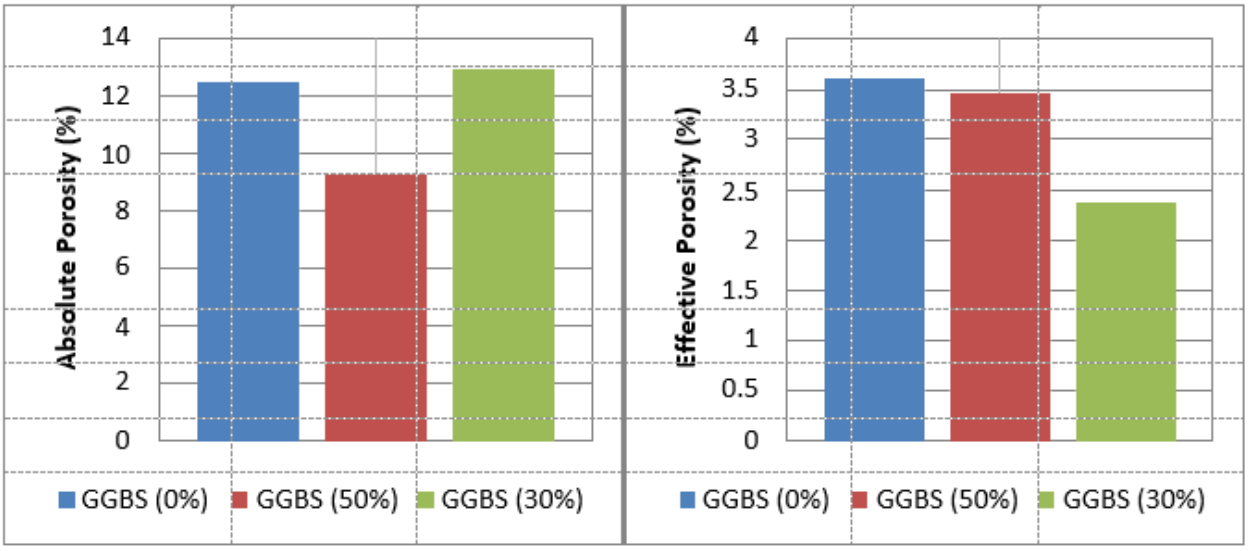

Fig. 3.Effect of absolute and effective porosity on the different mixes

The absolute porosity is higher than the effective porosity for all the mixes because absolute porosity is the ratio of total pore volume to volume of concrete whereas effective porosity is the ratio of the available pore volume to the volume of concrete at any given time.

As the percentage of the GGBS increases from 30% to 50%, the amount of OPC decreases from 70% to 50%. A decrease in Portland cement content will slow the rate at which secondary pozzolanic reactions

take place. As a result, the pores of the 50% GGBS mix are not effectively filled as compared to 30% GGBS mix. This explains why the 50% GGBS is more porous than the 30% GGBS mix in terms of effective porosity.

4.5 Weight Gain

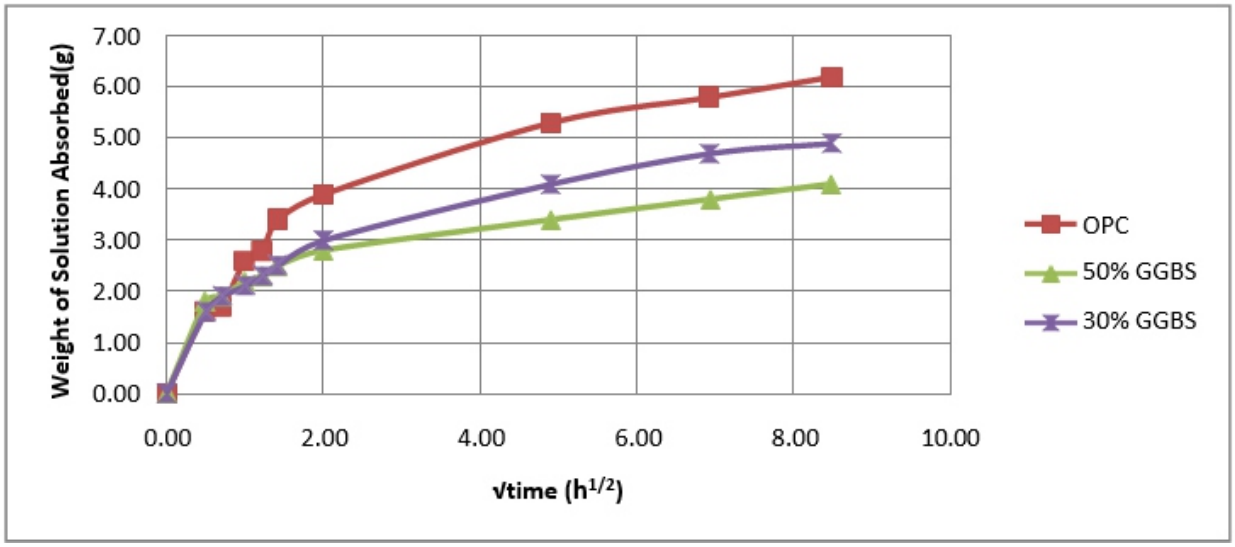

Fig.4. Weight gain graph during the first cycle

The concrete samples of the three different mixes in this experiment were exposed to 4 cycles of 3 days wetting and 4 days drying. The above graph shows that during the first four hours of exposure to the wetting cycle, there is an initial rapid absorption rate. After that, rate of absorption slows down.

This can be explained as follows. The concrete being unsaturated absorbs the chlorine by capillary suction until the pores are no more empty, leading to a gain in weight. With time, as the pores are being filled, the rate of chloride ingress into the concrete specimens decreases.

As shown in Figure 4, both the 30% and 50% GGBS obey a linear relationship during the first four hours of exposure when a graph of cumulative weight of solution absorbed is plotted against the square root of time of exposure. This confirms the relationship existing between the cumulative absorbed volume of water per unit area of the inflow surface, i and the square root of time of exposure, t, as shown in the equation (1).However, the relationship for 0% GGBS is a non-linear one. This may be as a result of the initial moisture content.

Normally, the volume of liquid absorbed increases with increasing effective porosity. The effective porosity was in the following descending order: 0% GGBS, 50% GGBS and 30% GGBS whereas the

weight gain obtained during cycle 1 was in following descending order: 0% GGBS, 30% GGBS and 50% GGBS. The reason why the 50% GGBS mix had the smallest weight gain might be due to the refinement of microstructure of GGBS, forming a denser matrix than 30% GGBS.

4.6 Weight Change

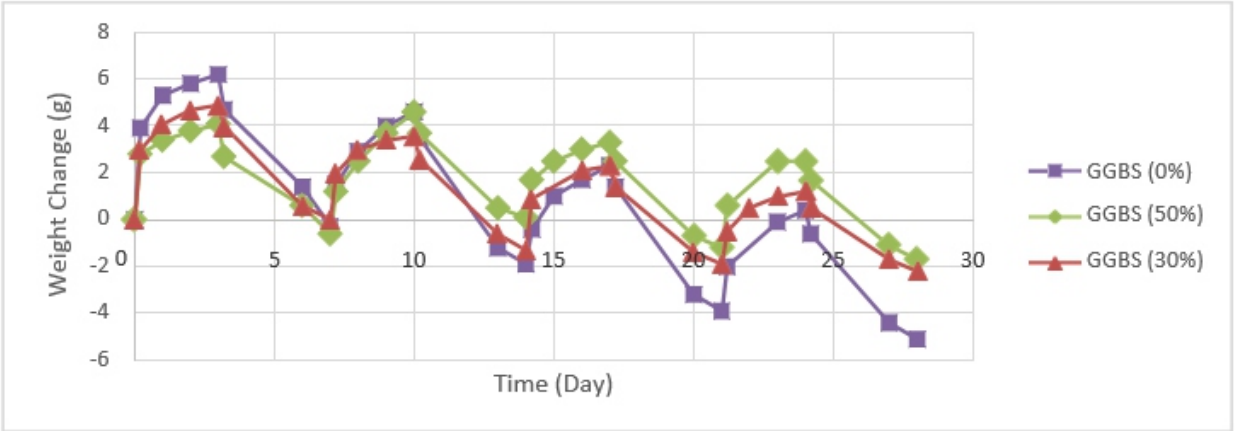

Fig.5.Weight change during all the cycles

As the number of cycles increases, there is a decrease in the weight change. This is due to the enhancement of the pore structure. The rate of weight gain is not equal to the rate of weight loss. As observed in Figure 5, the concrete samples for all the mixes have lost more water than it initially absorbed. The specimens are exposed to a high conditioning temperature of 35°C of oven during the drying cycles and there is also loss of residual moisture during the drying process to explain why the loss of water.

4.7. DEPTH OF PENETRATION

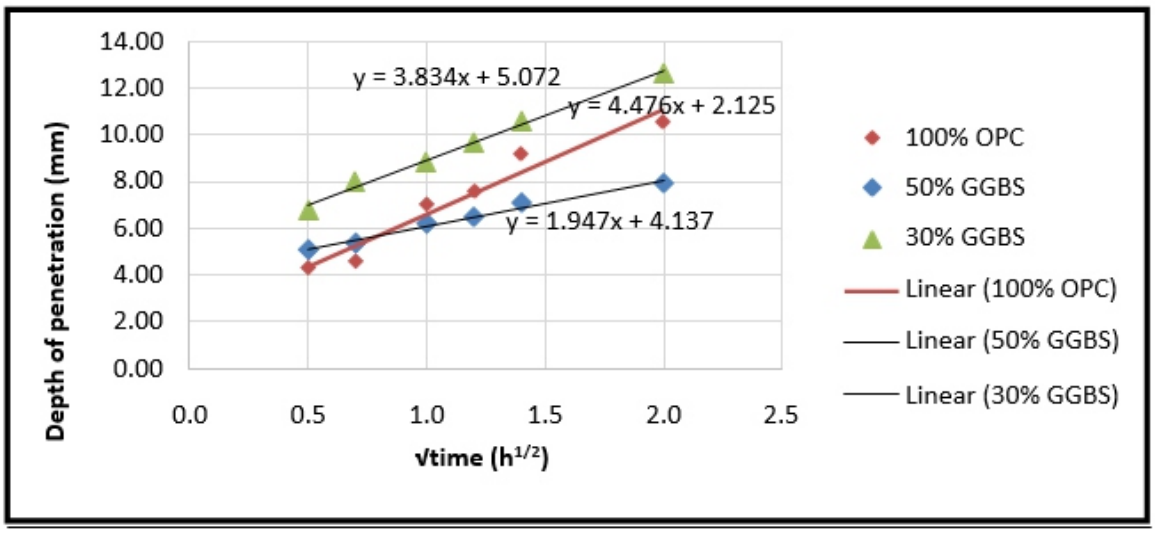

Fig. 6.Typical depth of penetration against root of time graph for cycle 1.

At the end of all the cycles, 30% GGBS had the highest penetration depth. As the number of cycle increases, there is a decrease in the effective porosity implying that the chloride solution will now have to move deeper into the concrete than it did in the first cycle for absorption to occur. A decrease in sorptivity while an increase in weight absorbed will lead to a high penetration depth.

At the end of the first wetting cycle, the 0% GGBS had a higher penetration depth as compared to 50% GGBS. However, in the subsequent cycles, it was observed that 50% GGBS had a higher penetration depth than 0% GGBS. Nonetheless, it is worth highlighting that 50% GGBS had a consistent penetration depth during all the cycles.

4.8. WEIGHT SORPTIVITY

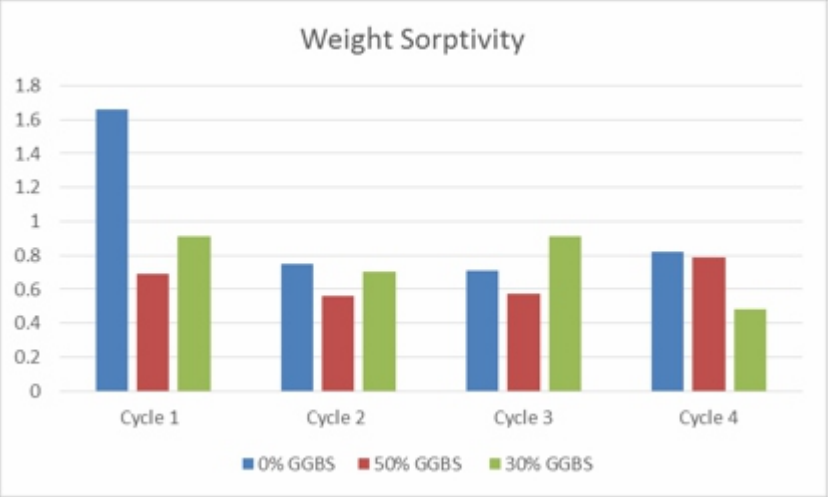

Fig. 7.Weight sorptivity at different cycles

In the 0% GGBS mix, a decrease in weight sorptivity was observed during the first three cycles. However, on the 4th cycle, an increase in weight sorptivity was observed. Same was observed for the 50% GGBS mix. In the 30% GGBS mix, the 3rd cycle surprisingly had the same weight sorptivity as the first cycle.

In principle, the sorptivity decreases as the number of cycles increases for most the mixes as a result of an increase in residual moisture content and a decrease in effective porosity. When the concrete samples have undergone the wetting cycle process, there is a gain in residual moisture. The increase of the number of cycles is directly proportional to the age of the concrete specimens. With time, there is a refinement of the pore structure of the concrete which explains why there is a decrease in effective porosity.

5.0. CONCLUSION

The use of GGBS in the concrete mix was satisfactory both in terms of compressive and durability properties. Despite having the drawback of developing late strength gain, both the 30% and 50% GGBS had comfortably achieved a compressive strength of above 40 Mpa.

When exposed to cyclic wetting and drying regime of 3 days and 4 days drying, the 50% mix had a consistent low penetration depth and the least weight sorptivity. This mix can therefore be recommended instead of 0% and 30% GGBS for its good resistance to chloride ingress.

It should also be highlighted that among all the mixes used, the 50% GGBS had the highest slag waste content and yet, it proved to be the most effective under short term durability exposure and compressive strength. With further refinement of the pore structure, its performance is expected to improve in the long term.

Hence, in light of the above, GGBS should be encouraged as a solid waste management strategy.

6.0. REFERENCES

Arya, Bioubakhsh & Vassie, 2014. Modelling chloride penetration in concrete subjected to cyclic wetting and drying. Magazine of Concrete Research, 66(7), pp. 364-376.

Arya, C. & Y.Xu, 1995. Effect of cement type on chloride binding and corrosion of steel in concrete. Cement and Concrete Research, 25(4), pp. 893-902.

Basheer, L., Kropp, J. & Cleland, D. J., 2001. Assessment of the durability of concrete from its permeation properties: a review. Construction and Building Materials, Volume 15, pp. 93- 103.

Bioubakhsh, S., 2011. The penetration of chloride in concrete subject to wetting and drying: measurement and modelling, s.l.: University College London.

Chen, H.-J.et al., 2012. Effect of curing environments on strength, porosity and chloride ingress resistance of blast furnace slag cement concretes: A construction site study. Construction and Building Materials, Volume 35, pp. 1063-1070.

Ecocem, 2013. Holcim. [Online]. Available at: http://www.holcim.mu/fileadmin/templates/OU/doc/Data_sheet_Holcim_Ecocem_CEM_II.pdf [Accessed 7 February 2015].

Higgins, D., 2007. Briefing: GGBS and sustainability. Construction Materials, Volume 160, pp. 99-101.

Hong, K. & Hooton, R., 1999. Effects of cyclic chloride exposure on penetration of concrete cover. Cement and Concrete Research, Volume 29, p. 1379–1386.

Leung, P. W. & Wong, H., 2011. FINAL REPORT ON DURABILITY AND STRENGTH DEVELOPMENT OF GROUND GRANULATED BLASTFURNACE SLAG CONCRETE,

Hong Kong: The Government of the Hong Kong Special Administrative Region .

Otieno, M., Beushausen, H. & Alexander, M., 2014. Effect of chemical composition of slag on chloride penetration resistance of concrete. Cement & Concrete Composites, Volume 46, pp. 56-64.

Otieno, M. B., Alexander, M. G. & Beushausen, H.-D., 2010. Corrosion in cracked and uncracked concrete – influence of crack width, concrete quality and crack reopening. Magazine of Concrete Research, 62(6), pp. 393-404

Polder, R. B., 2012. Effects of slag and fly ash on reinforcement corrosion in concrete in chloride environment - Research from the Netherlands. Heron, 57(3), pp. 197 - 210.

Preez, A. & Alexander, M., 2004. A site study of durability indexes for concrete in marine conditions. Materials and Structures, Volume 37, pp. 146-154.

Scott, A. & Alexander, M. G., 2007. The influence of binder type, cracking and cover on corrosion rates of steel in chloride contaminated concrete. Magazine of Concrete Research, Volume 59, pp. 495-505.

Taheri, A., 1998. Durability of Marine Concrete Under Thermal Cyclic Loads. Heron, 43(1), pp. 15-28.

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