



Investigating and Presentation Solutions for Concrete Corrosion in Coastal Structures

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Abstract: Concrete has used extensively in coastal areas especially marine structure due to its easy access and relatively high compressive strength, toughening and ductility during construction and long durability. High humidity in coastal areas has exacerbated the corrosion of metal and as a result concrete as a durable and resistant material has a special position in marine work and adjacent seaside buildings. Concrete corrosion in coastal structures causes a lot of economic losses to us and we can prevent this damages by providing appropriate solutions in the field of construction. In this paper we first examine the types and circumstance of concrete corrosion in coastal structures and then discuss the construction and use of reinforced concrete in coastal structures.

Keywords: Concrete, corrosion, micro silica, sulfate, coast, structure

1. INTRODUCTION

In our country consumption of concrete has become widespread recently. Understanding the nature and function of concrete and most importantly the proper use of it is very important. Inappropriate behavior with concrete may have two aspects (Samaee F, Samaee A. 2005):

- 1) Calculation
- 2) Lack of coordination with surrounding environment

Concrete should be durable and in general it should not be ruined earlier than expected. Durability of concrete made from Portland cement is its strength against weathering, abrasion, chemical attack and other aggressive agents (Samaee F, Samaee A. 2005).

Destruction of concrete can be seen in the form of cracking, dandruff, scaling, rusting and so on. Concrete can be obtained with favorable resistance in coastal area by reviewing the general rules and regulations (Samaee F, Samaee A. 2005).

Fire causes a dangerous menace to the life of the structure and inhabitants, as it enforces damaging results at the structural area both tiny term and lengthy term. The security and the operative life of concrete constructions after experience to fire depend on two significant reasons i.e. residual stability and resistance. Reuse concrete aggregates sourced from waste concrete are a tolerable intermittent to intrinsic squashed stone aggregates. The factors examined in the empirical investigation are water-cement ratio, cement constituents in concrete and percentage substitution of rough aggregate. Durability features such as water sorption, sorptivity, acid attack persistence, and chloride penetrance are also specified. A mix plan methodology applying the expanded patterns is suggested to support exercising engineers to specify the mix ratios of reused concrete aggregates concrete. Applying frequently reused rough aggregate to provide structural concrete is an essential means for directing the economic, environmental, and social issues effected by the lack of natural aggregate resources. The consequences display that the qualities of the reused rough aggregate that result in the durability of concrete spoil with an enhancing number of reprocessing cycles. Durability standards of the reused rough aggregate (freeze-thaw persistence, chloride ion penetrance factor, and carbonization depth) reduce regularly with an enhancing number of reusing cycles. However, the reused rough aggregate in

each cycle could encounter the demands for structural concrete aggregates, and concrete employing reused rough aggregate can be intended as structural concrete with a life time of at minimum 50 years.

1.1. Corrosion Phenomenon

The corrosion phenomenon is an electrochemical process which creates a reaction between the armature and surrounding area and leads to form an oxide layer or other compounds similar to the original raw material obtained from the metal. This phenomenon causes many economic losses every year and according to the existing statistics 2 to 4 percent of gross national income destroys by phenomenon of corrosion and this forces us to pay particular attention to this phenomenon¹ (Samaee F, Samaee A. 2005). Chloride-induced erosion of steel reinforcement in concrete is one of the main reasons for the decadence of reinforced concrete constructions. Mainly moisture treatment combined with the transport of erosion yields in fractured concrete and its impact on the erosion-induced destroy has not been directed so far. Erosion of the steel reinforcement is among the basic reasons of decadence in concrete constructions. Measures of erosion levels are typically applied to assess the further decrease in steel-to-concrete connection, but consequences shortage accuracy. We determine recent ways depend on compositional utilization of the cementitious binder, and its geometrical arrangement, to reduce steel erosion in concrete, and a recent capacity to study erosion procedures from a basic point of vision. Eroded steel bars mostly exist in concrete constructions under chloride disposal situations; furthermore, eroded reinforced concrete is not nonflammable. Because the thermal spread factor of air is higher than that of concrete, an erosion-induced fracture enhanced the heating rate of the eroded steel bar inside the concrete, and the vertical fractures affected by the used loading had an important effect on the temperature field of the beam tensile area. Extremely, reinforcement erosion may due to fragile fracture in a moderate-reinforced beam exposed to fire. Qualitative and quantitative differentiations of consequences from diverse patterns are made in order to evaluate their precision. In different patterns, alongside the pressure and movement states in concrete are diverse, the erosion level is also shoed otherwise, which should be considered when explaining the modeling consequences of erosion level-fracture level relation. As well as, the ultimate corrosion width around the steel environment and the corrosion width/eroded depth ratio is displayed to be non-constant under both constant and non-constant erosion, which is affected by the regional fracturing in concrete.

2. EFFECTIVE FACTORS IN DESTRUCTION OF REINFORCED CONCRETE IN PERSIAN- GULF REGION

2.1. Humidity

Damage to concrete is due to transfer of destructive factor such as gases, water and chemical agents through the pores of concrete and entering them into the concrete. In wet areas where part (or all) of pores of concrete is filled with water moisture is responsible for distribution of water-soluble destructive elements and the operation of concrete degradation is performed more quickly¹ (Samaee F, Samaee A. 2005).

The concrete corrosion approach also slowly altered from ductile to fragile with curing humidity reducing and hydration time passing. The consequences displayed that the moisture loss and water sorption all showed a linear relation with the time square root; as well as, the moisture conveys increased with the enhancement in load detriment. The comparative humidity reaction rate increased rapidly with the incremental load harm, changing quickly at first, but then presumed a steadier rate, reducing with time. The consequences disclosed that moisture diffusivity impacted the hysteresis time of the relative humidity answer. This cannot be mistreated when analyzing concrete harm creates and living length. The similar maintain true for the results of humidity various and sample size. Therewith, the result of load loss on relative humidity answer increased with the progressive sample size.

2.2. Temperature

The ambient temperature is very effective in microscopic structure of the concrete. The hydration rate increases as the temperature rises and the physical properties and durability of the concrete also

¹ Sayed Askari N. Concrete damage, causes and factors. Housing Research Center Publishing.

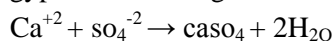
change. Research has shown that a high temperature is created the problems such as reduced efficiency, reduced long-term resistance, increased concentration and cracking in concrete that a surface degradation of the concrete and initial cracking will cause many problems such as the penetration of destructive and effective factors in the corrosion of the rebar, etc. the corrosion of the rebar in the concrete increases by increasing the ambient temperature¹ (Samaee F, Samaee A. 2005).

The way in which temperature impacts concrete elements or constructions have been considered extensively for many usages, like pavements, bridges, and frames. But, little consideration has been given to the temperature results on concrete surfaces. It is completely recognized that high temperature during casting of concrete leads to a detriment on the substance microstructure. Multiple of the most important impediments of high temperature concreting involve the increased water requirements, slump loss, drying contraction, autogenous contraction reduced mechanical and persistence features. The hasten drain of ciliary holes owing to severe drying or fast cement hydration may enforce pressures within the material's formation. Hydration heat confined in concrete can appoint fractures owing to thermal pressure effected by temperature gradient inner the concrete. The confined heat can be removed by applying the post-cooling method, where the concrete is fresh by current water through pipes seted in it. Cement concrete is extensively applied as a constructive substance in building construction where fire persistence is one of the clue observations in plan. High temperature is established for really harmful micro- and mesostructure of concrete, which consequences in a total mechanical decomposition of the concrete and even damaging results at the structural level, owing to the concrete laminating and bar disposal to the blazes, in case of fire. Concrete, at raised temperatures, tolerates considerable physicochemical alterations. Fire answer of the concrete building members is related to the thermic, mechanical, and distortion features of concrete. The goal of this task is to examine the impact of high temperature on the mechanical features of concrete. The mechanical features of concrete that are of early attention in fire persistence plan are pressing strength, tensile strength, elastic modulus, and the stress-strain answer in compaction.

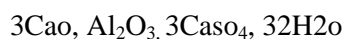
2.3. Chemical Reactions

2.3.1. Sulfate Attack

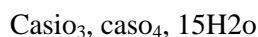
Sulfates are presented mainly in ground water, seawater and soils and also be present in primary material. When sulfate ions enter the concrete pores they react with the free lime in it and produce the gypsum according to the following formula (Samaee F, Samaee A. 2005):



Gypsum reacts with the calcium aluminate hydrate and produces etheringite



The formation of this salt within the hardened concrete is accompanied by expansion and when the expanding forces are larger than the tensile forces cracking occurs. The other salts obtained from the reaction is tamazite that the formula is as follow (Samaee F, Samaee A. 2005):



The salt is expanded at low temperature. Within the cement matrix there is always the amount of calcium sulfate which plays a role in solidification time of concrete. in normal condition it reacts with water and aluminate and produces etheringate which itself has become mono sulfate over the time which the expansion does not occur in the process. However, when concrete is placed in high temperature and humidity the etheringate expands and forms the crack in the concrete. in general, the severity of damage caused by the sulfate attack from the inside of system depends on pores, humidity, temperature and the type of sulfate. In this phenomenon magnesium sulfate is more aggressive than sodium sulfate and calcium (Samaee F, Samaee A. 2005).

This article shows both an experiential and theoretical examination of the used and collected rates of sulfate ions in concrete. The writers examine the results of sulfate solution condensation and the water-cement proportion on the sulfate ions dispensation. Depend on the propagation outlook; a sulfate transport pattern for concrete was appointed examining the result of surface sulfate condensation. On this base, an impressive transport pattern of sulfate offensive is shown, which depends on impressive diffusivity. This pattern can be used to foretell the sulfate ions dispensation; therewith, its forecasted values are in nice compromise with the empirical ones. Concrete carbonation

is considered as a considerable result of reinforcement erosion in constructions. The consequences displayed that a greater carbonation depth in the concrete affected more concrete scaling and those sulfate crystals were also determined in the carbonated concrete. Owing to their susceptibility to carbonation, mixed concretes including fly ash and slag displayed more scaling than Portland concrete. Thus, the “physical sulfate offense on concrete” can be more exactly qualified as the “physical sulfate offense on carbonated concrete.”

2.3.2. Alkaline Reaction of Granular Stones

Some granular stones contain active silicic dioxide. These compounds react in the presence of water or solution containing alkaline ions (sodium and potassium) and produce alkaline silicates. This product absorbs large amounts of water and expands and leads to crack of concrete. This process is accelerated especially at high temperature in presence of moisture¹ (Samaee F, Samaee A. 2005).

The efficiency pressure and the viscosity of the alkali-silicate operated low-calcium fly ash dependencies enhance with the alkalinity of the colloidal solution, which is owing to alters in the surface charges on fly ash bits with the alteration in the ionic medium. Expanding the alkalinity consequences in the less negative zeta possible of fly ash in the alkaline dilution of colloidal silica. The thixotropic treatment in alkali-silicate operated low-calcium fly ash dependencies is related with structure separation to a delicately scattered suspension of bits made by shearing. An analogy of alkali-silicate operated low-calcium fly ash interruptions is stated with interruptions of Portland cement in water, which are coordinated for similar physical flow features and yield pressure. Alkali-silicate operated low-calcium fly ash interruptions have a larger solid deduction than the cement interruptions in the water of analogous yield pressure. The zeta capacity of cement elements in water is less minus when contrasted to fly ash in alkaline-silicate dilutions. The alkali-silicate operated low-calcium fly ash interruptions of comparable yield stress display a notably higher viscosity than the cement interruptions in water. The proficiency profits and usable energy economies can be done by use of self-compressing alkaline activated concrete generally recognized as Self-Compressing Geopolymer Concrete.

2.3.3. Chlorine Reactions

The presence of chlorine ions in the concrete is one of the most important causes of corrosion of rebar in Persian- gulf region. These ions can be incorporated into concrete in different ways and by removing the protective layer of steel cause corrosion in the rebar. Steel corrosion is defined by the influence of chlorine ion invasion as galvanic corrosion. In this case large number of anodic holes are created alongside each other on the surface of the steel and corrosion is done uniformly. In this case the critical mass of chlorine in concrete is 0.4 percent of the mass of cement and the corrosion rate of calcium chloride is higher than sodium chloride and potassium chloride¹ (Samaee F, Samaee A. 2005).

Evaluation of chlorine in concrete is very essential for examining of erosion of reinforcing steel in concrete. Erosion of reinforcing steel is firstly assigned to the infiltration of chloride ions to the steel area. Protective actions for eluding concrete structure reinforcement erosion needs monitoring the chloride ion condensation in concrete so that its condensation does not surpass a threshold limit to begin reinforcement concrete erosion. Prohibitive proceedings opposed to reinforcement erosion in concrete needs enhancing concrete density to hinder the propagation of chloride ions to the steel surface. Observing the chloride condensation in concrete is needed to evaluate the chances of reinforcement erosion.

2.3.4. Carbonation

In environments where there is a lot of carbon dioxide, silicate and calcium aluminate in fresh concrete combine with carbon dioxide in the air and cause more concentration in adjacent areas of air and outer surface. The influence of carbon dioxide into concrete and its reaction with cement causes the concrete to exhibit less alkaline property. When PH reaches 8 to 9 the protective layer of rebar is lost and corrosion occurs in rebar¹ (Samaee F, Samaee A. 2005).

The environmental effect of concrete output can be reduced by the application of cement with decreased clinker content or the replication of concrete waste prepared by the destruction of buildings in reprocess aggregate concrete. The carbonation persistence of reprocesses aggregate concrete can be reduced by particles of reprocesses aggregate that is either very permeable or already carbonated before concrete output. There were no principled variances in compressive strength and carbonation

persistence between dry and pre-saturated aggregates. The carbonation persistence at a given pressing strength reduces with reducing clinker content of the cement. The parametric investigations displayed that fatigue harm did not change the extensively admitted proportionate relationships between carbonation depths and square roots of disposal durations. Therewith, the results of disposal situations on carbonation of concrete were far more impacted by remaining strains than by remaining curvatures. Concrete carbonation is stated as a important reason of reinforcement erosion in structures. The consequences presented that a greater carbonation depth in the concrete triggered more concrete scaling, and that sulfate crystals were also recognized in the carbonated concrete. Owing to their defenselessness to carbonation, mixed concretes comprising fly ash and slag presented more scaling than Portland concrete. So, the “physical sulfate attack on concrete” can be more precisely defined as the “physical sulfate attack on carbonated concrete.”

2.4. Erosion Caused by Salts

The erosion caused by salts attack on concrete is a physical process in which 3 major mechanisms interfere¹ (Samaee F, Samaee A. 2005).

2.4.1. Crystals Growth

Formation of salt crystals in concrete pores leads to high pressure generation and resulting in cracking and degradation¹ (Samaee F, Samaee A. 2005).

2.4.2. Crystal Hydration

Salt crystals are often absorbent and expanded as a result of water absorption and cause considerable pressure within structure of concrete that resulting in cracking of concrete¹(Samaee F, Samaee A. 2005).

2.4.3. Expansion Coefficient

Most of the salts have high expansion coefficient compared to concrete or granular stones. Thus, the expansion of these salts in warm environment such as Persian-gulf leads to crack of concrete¹ (Samaee F, Samaee A. 2005).

Generally, the factors affecting salt attack include permeability and porosity of concrete. The rational steam remedial regime and the confrontation to saline soil corrosion of high-volume fly ash steam-cured concrete, high-volume normal slag steam-cured concrete, and high-volume ultra-fine slag steam-cured concrete were considered by defining the demoulding strength, response degree, strength expansion law, chloride ion penetrability, linked porosity, and sulfate attack persistence. The consequences display that although high-volume fly ash steam-cured concrete with the perfect demoulding stability and respectable persistence to chloride ion penetrability can be gained via correctly plummeting water-binder proportion and concurrently extending steam remedial time, its later-age stability expansion and the persistence to sulfate attack are not meaningfully enhanced contrasted with elementary cement steam-cured concrete. High-volume ultra-fine slag steam-cured concrete with the perfect demoulding stability and respectable persistence to chloride ion penetrability and sulfate attack can be gained without or via a little extending the steam remedial time.

3. DESIGNING OF DURABLE CONCRETE STRUCTURES IN PERSIAN-GULF REGION

To combat corrosion concrete structures with durability against corrosion should be design. To do this we need to design high-strength concrete to withstand the maximum incoming stresses and minimize the flexural cracks on the member. In this plan the concrete needed for covering of rebar should be designed according to the environmental conditions (Samaee F, Samaee A. 2005)²:

3.1. Durable Concrete Construction Methods

3.1.1. Surface Method

In surface method by depositing the surface of the concrete with impenetrable materials it is possible to prevent the entry of external solvents to concrete. Types of coating depend on factors such as penetration of intrusive material, the ability of combination, temperature, abrasion and application of structures (Samaee F, Samaee A. 2005).

Types of coatings:

² Tajzehchie. Construction method for non-corrosive concrete - Article by Hormozgan Governorate, IRAN.

Sodium silicate, dry oils, zinc flu silicate, soluble gums, bituminous coatings, synthetic² (Samaee F, Samaee A. 2005).

3.2. Volumetric Method

In this method constituents of concrete are selected according to quality and amount so that the internal and external destructive factors reach their lowest value. So we have to pay attention to two parameters (Samaee F, Samaee A. 2005):

1. Material used in concrete
2. The quality of concrete²

We will examine these two factors in accordance with ACI 2000 rules.

1. Material used in Concrete

❖ **Portland cement**

Calcium hydroxide forms about 15 to 25 percent of cement paste. And this is a factor for high cement PH which is very important for us. Tri- calcium aluminate in the cement reacts with chlorine in the cement and forms calcium chlorine aluminate. Research has shown that for concrete that is adjacent to the sea it is a good resistance to corrosion when C₃A concentration is less than 8 percent. The amount of tri-calcium aluminate in different types of cements is represented in table 1^{2,3} (Samaee F, Samaee A. 2005). Table 1 shows amount of tri-calcium aluminate in different types of cement (Samaee F, Samaee A. 2005).



Table1. Amount of tri-calcium aluminate in different types of cement (Samaee F, Samaee A. 2005).

Cement types	C ₃ A
1	10
2	6
3	10
4	4
5	4

Used concrete aggregates obtained from waste concrete are a maintainable another to normal crumpled stone aggregates. A combination plan procedure via the advanced models is projected to assistance involved engineers to regulate the combination proportions of used concrete aggregates concrete. Applying frequently used rough aggregate to make structural concrete is an imperative means for addressing the economic, environmental, and social issues triggered by the lack of natural aggregate resources. The consequences display that the potentials of the reused rough aggregate that affect the strength of concrete deteriorate with an increasing number of reprocessing cycles. The security and the operative life of concrete constructions after experience to fire depend on two significant features i.e. remaining strength and durability. Durability of concrete after fire contact is quantified through unintended examinations such as chloride ion penetrability, water penetrability, absorption and sorptivity. Alkali-aggregate response has been triggering the development and cracking of frequent concrete constructions universal. Alkali-aggregate response happens between the alkali hydroxides (Na, K –OH) disappeared in the concrete pore solution of hydrated cement paste and determined reflexive siliceous mineral stages of aggregates. The development is owing to the organization of continuing chemical response crops, silica gels. These wide-ranging gels create internal pressures and direct to the formation of a micro-crack meshing through the concrete when material tensile stability is attained. Therewith, gels have viscous conduct; under external and internal pressures, they gradually move into permeable spaces and fractures and increase the hysteretic treatment of concrete.

❖ **Granular Stones**

The granular stones that used in concrete contain chloride salts which must within acceptable limits and allowable sizes. The American concrete regulation recommends the amount of chloride present in the concrete relative to cement in proportion to 2% by weight (weight). And this advice us that the

³ Iran Concrete Institute

amount of chloride allowed depends on mixing plan. a table of permitted quantities of harmful material of granular stone is presented in Iran concrete regulation^{2,3} (Samaee F, Samaee A. 2005).

The consequences of the investigation display that the stability features of cement concrete applying squashed rock sand is higher and homogeneous to the normal concrete. The investigation has present that crumpled stone dust can be applied as eagerly accessible solid waste as an different to natural sand in cement concrete building work and it can decrease the charge of material and building price and can help to repair the environment problems. The practicality of blending together stones, sand and some method of binder or cement to form 'concrete' has been known since Stone Age times. The Romans advanced a rather progressive gratitude of concrete knowledge, including the apply of pozzolanas, testing with concrete reinforced applying bronze bars and the primer of lightweight and even air-entrained concrete. The stones and sand, or 'aggregates', were only comprised as bulking materials, but the literatures of Vitruvius in De Architectura prove that the Romans determined the effect of rock types and particle size spreading on the choice of aggregates for good-quality concrete and mortars. In more new times, it has become progressively understood that the possessions of aggregates can have a significant attitude on the possessions and durability of the concrete in which they are applied, so that today the needs for positive aggregates are carefully stated and controlled. Concrete is the main structural engineering material of current times and aggregates contain around three-quarters by volume of concrete so that the importance of the value of those aggregates can scarcely be overstated.

❖ Water

The water used to wash the granular stone, make and processing of concrete should be clean and clear. Avoid the use of water containing large quantities of any kind of substance such as oils, acids, alkaline, minerals, sugar materials and organic materials that damage concrete and rebar. In general, drinking water is suitable for use in manufacture and processing of concrete^{2,3} (Samaee F, Samaee A. 2005).

The concrete industry is one of the main creators of carbon dioxide in the universal while being one of the focal customers of drinking water. The recent knowledges and approaches which decrease air pollution and water consumption may be cooperative to attain the aims of maintainable expansion. Pozzolanic materials are one of the main alternatives of cement in concrete. The water for the concrete combination was improved with micro-nano bubbles to decrease the using of drinking water. Owing to its adaptability, strength and mechanical steadiness, concrete is an significant building material. In extremely humid sites, it is desirable to reduction the penetrability of concrete materials to water to boost both its strength and its functionality. It has been extensively described that the apply of magnetized water to combination concrete can rise the workability of new concrete and its hardened stability. The experiment consequences show that the foam strength, pressing and splitting tensile stability of foam concrete is notably refined by applying magnetized water, whereas the water absorption of hardened foam concrete reduces a little.

❖ Additives

Additives are materials other than Portland cement, granular stones and water which is in form of powder and liquid and it is added to concrete as a concrete material to modify its properties before or during mixing. Part of additives to reduce the water containing concrete including chlorides. The amount of chlorides should not exceed of 0.1 percent of weight of the cement^{2,3} (Samaee F, Samaee A. 2005).

The result of sandstone powder addition on pressing stability and the alkali-silica response was examined. The components concluded the certain surface zone, the cement substitution proportion and the silica fume hybrid. It was discovered that the enhance in the certain surface zone of sandstone powder could upgrade the stability gain. The pozzolanic treatment, the sandstone powder can impressively decrease alkali-silica response in concrete with responsive sandstone rough aggregates. In the occasion that sandstone is the only aggregate original and there is no complementary cementitious material existing in the zone, the sandstone powder, ground enough fine, can be applied as sectional substitution of cement to upgrade the permanence of concrete. Concrete is the most extensively applied construction material that is acquired by curing the mixture provided of rough and fine aggregates, cement, and water. The attributes of concrete belong on the modality and features of the aggregates, w/c proportion, the constancy of compaction of the combination. Pressing stability of concrete is one of the most significant features. The apply of chemical and mineral additives is the most impressive procedure to amend the modality of the concrete, and to give them particular

features. Fig1. Shows The microscope picture of the composition of concrete instances: (a) plan; (b) modified (T. K. Akchurin, V. D. Tukhareli, O. Yu. Pushkarskaya.2016)

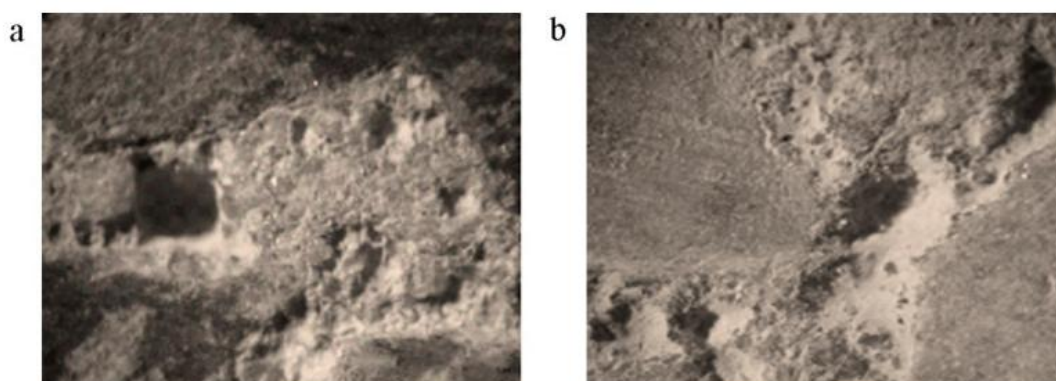


Fig1. The microscope picture of the composition of concrete instances: (a) plan; (b) modified (T. K. Akchurin, V. D. Tukhareli, O. Yu. Pushkarskaya.2016)

2. Quality of Concrete

The factors that cause the destruction of reinforced concrete are (Samaee F, Samaee A. 2005):

- Cracking
- Permeability of Concrete.

Both of the above factors cause chlorine to penetrate into the concrete. so we have to find a way to reduce crack and reduce the permeability of concrete. To achieve this concrete with lowest water-to-cement ratio should be built. Of course it is necessary to have this psychology required to accumulation of concrete. So, to achieve high performance and durability concrete the following points should be observed^{2,4}

A. Water to Cement Ratio

Reducing water to cement ratio reduces the permeability of concrete. The result of studies showed that the ration of water to cement is 0.32 is the best that can be used and have the least permeability. In general, in Persian – Gulf environment the ration of water to cement should be less than 0.4^{2,4} (Samaee F, Samaee A. 2005).

B. Rebar Coating

The result of studies showed that for moderate to serve corrosion the minimum coating is 38mm. the American concrete recommends a minimum cover of 75mm and ashto of 100 mm for in situ concrete and 75mm for prefabricated parts^{2,4} (Samaee F, Samaee A. 2005).

C. Mixing Plan

The amount of concrete is effective in the quality and efficiency of concrete. The cement content in terms of concrete resistance is presented in table 2 (Samaee F, Samaee A. 2005).

Table2. The cement content in terms of concrete resistance (Samaee F, Samaee A. 2005).

Compressive strength of concrete			Maximum water-to-cement ratio	Minimum amount of cement kg/m ³
32.5	37.5 to 42.5	47.5 to 52.5		
C20	C25	C30	0.7	240 to 360
C25	C30	C35	0.65	270 to 280
C30	C35	C40	0.6	290 to 310
C35	C40	C45	0.55	320 to 330
C40	C45	C50	0.5	340 to 360
C45	C50	C55	0.45	370 to 390
C50	C55	C60	0.42	400 to 420
C55	C60	C65	0.39	430 to 450
C60	C65	C70	0.36	460 to 470
C65	C70	C75	0.34	480 to 500

⁴ Tajzehchie. Construction method for non-corrosive concrete - Article by Hormozgan Governorate, IRAN.

D. Performance and Performing Of Concrete

When we reduce the amount of water to the cement we face a poor psychological problem of concrete for accumulation and we must avoid the accumulation of concrete by using appropriate compaction and proper method^{2,4} (Samaee F, Samaee A. 2005).

E. Reducing the Permeability With Filler Materials

The permeability of the concrete depends on the size and distribution and continuity of the concrete pores. Cement permeability varied with progress in hydration. On the other hand, decreasing the permeability coefficient will be faster by reducing the ratio of water to cement. Table 3 shows fixed water permeability coefficient in cement (Samaee F, Samaee A. 2005).

Table3. Fixed water permeability coefficient in cement (Samaee F, Samaee A. 2005).

Time required by day	Fixed water permeability coefficient in cement
7	0.45
28	0.60
50	0.70

Another method to reduce the permeability is using fine material to fill the pore of concrete and one of these micro-silica materials. The color is grayish –gray and has a density of 2200 kg/m³.this material is supplied to 3 forms such as paste, mixed with cement and pure^{2,4} (Samaee F, Samaee A. 2005).

This education suggests the usage of manufacturing and agronomic wastes as mineral admixtures for increasing the automatic and toughness characteristics of concrete comprising recycled concrete aggregates resulting from concrete waste. It was considered that concrete mix upon combining mineral admixtures displayed considerable betterment in both mechanical and persistence features when contrasted to concrete combination with reused concrete aggregates alone. Developments in toughness features were showed by integrating mineral admixtures maintained by lower components for water absorption, sorptivity factors and chloride ion absorptions and amplified hydration products as determined from scanning electron microscopic researches. Integrating reused materials in fresher building determinations is a very old notion, from the times of Roman Empire when people often applied stones gained from preceding roads in construction original ones. Reused materials have been into education for their combinations in recent construction works for relatively some time. Reusing concrete has significant financial and ecological profits. Reusing of concrete waste will reduce the amount of space taken up in landfills as well as remove contamination formed by moving the concrete waste by trucks. Furthermore applying reused aggregates decreases requirement to carriage recent materials which in turn supports to decrease water and air pollution and greenhouse gas emissions.

Reused concrete aggregates in over-all resultant from procedure of destroyed concrete waste, contain of aggregate particles covered upon by followed mortar. This mortar is feeble and leaky which makes substandard the value of aggregates shaped. When applied in new concrete, this main to toughness problems along with related subsidiarity in its mechanical belongings. Scholars from numerous countries have examined the belongings of applying reused materials in building works. Addition of reused aggregates is said to criticize the quality of concrete shaped by dropping its compressive, flexural strengths and enhancing the water absorption and reduction standards. This devaluation in concrete belongings may be accredited to feeble followed mortar, fine fractures and cracks related with reused concrete aggregates important to higher water absorption of concrete. Concrete integrating reused concrete aggregates are supposed to detect toughness problems such as rise in carbonation depth, reduction, water absorption and chloride ion condensation standards. integrating reused concrete aggregates does lower the concrete features both in mechanical and strength features. This is mainly related with the adhered external mortar nearby the aggregate particle. Few beneficitation procedures suggested by different scholars support in elimination of this mortar thus refining the value of aggregates. Mineral admixtures are supposed to recover the mechanical and strength characteristics of concrete qualified to their pozzolanic features. Fig 2. Shows Destroyed concrete waste. Reused concrete aggregates mass-produced from concrete waste (Abhishek Jindal, G. D. Ransinchung R.N.2018) and Fig 3. Shows Observed mortar detached (Abhishek Jindal, G. D. Ransinchung R.N.2018)

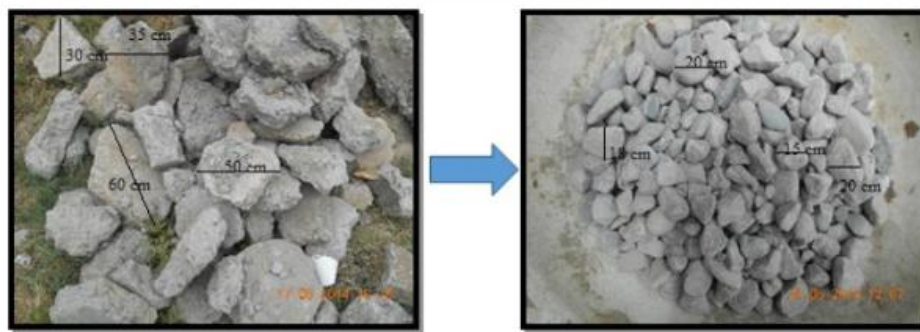


Fig2. Destroyed concrete waste. Reused concrete aggregates mass-produced from concrete waste (Abhishek Jindal, G. D. Ransinchung R.N.2018)



Fig3. Observed mortar detached (Abhishek Jindal, G. D. Ransinchung R.N.2018)

Reprocessing of building waste is an initiative that is tremendously significant as well as hard to complete in terms of ecological safety. One of the likely conducts of the application of the building waste, from destruction of concrete buildings, is its re-use as reused concrete aggregates in manufacture of constructive concretes.

3.3. Micro- Silica

A. Chemical Process of Micro-Silica Composition

During Portland cement hydration micro- silica combined with calcium ion and forms calcium hydrate silicate. The increase micro-silica causes to increase in hydration temperature. But since the cement hydration temperature is more than micro-silica hydration practically the micro –silica substitution results in reduction of hydration temperature⁴ (Samaee F, Samaee A. 2005).

B. The Effect of Micro-Silica on Concrete Properties

1-water

As the percentage of micro-silica in the concrete mix increases the amount of water consumed increases. So we use a lubricant to get resistant concrete⁴ (Samaee F, Samaee A. 2005).

2-Solidification time

Micro-silica has no effect on the solidification of concrete⁴ (Samaee F, Samaee A. 2005).

3-Performance

Micro-silica raises the adhesion of concrete⁴ (Samaee F, Samaee A. 2005).

4-Density

The density of concrete does not change by adding this material⁴ (Samaee F, Samaee A. 2005).

5-Cracking

The cracking reduces by adding micro-silica to concrete^{4,5} (Samaee F, Samaee A. 2005).

C. Mixing Plan of Concrete Containing Micro-Silica

the amount of cement is 324 to 390 kg/m³ with a water ratio of 0.35 to 0.45 and with a micro-silica 3.5 to 10 percent added to cement to prepare of resistant concrete⁴ (Samaee F, Samaee A. 2005).

5- Using of fiber concrete

It is possible to prevent cracking in concrete by adding the appropriate construction of this concrete⁵ (Samaee F, Samaee A. 2005).

6-Using of reinforced concrete to FPR armature

In environments where steel corrosion is widespread FPR armature can be used instead of steel armature⁵ (Samaee F, Samaee A. 2005).

4. CONCLUSION

1. Proper use of cement for manufacturing of concrete.
2. Choose of the suitable ratio for water-to cement for mixing plan.
3. Use of material in accordance with the regulation for the manufacture of concrete.
4. Proper process and accumulation of cement.
5. Use of suitable additives such as micro-silica to decrease permeability.

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⁵ Performance of some materials for surface concrete repair in simulated Gulf conditions

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