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Evaluation Some Types of Sand and Gravel In Iraq and their application in Rood buildings

Research presented by the student

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to the college of science –department of chemistry- which is part of their requirement to obtain a bachelor of science/chemistry science

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الأهداء و الشكر

اهدي ما بيدي الى حبيب خلق الله و رسول الإنسانية محمد(صلى الله عليه و اله وسلم)

كما اتقدم بالشكر والتقدير لكل من ابدى مساعدة لي في اخراج البحث وان الكلمات لتعجز عن شكركم على مجهودكم وتعبكم معي وجعلي من انجح الناس وفخر بين جميع اهلي واخوتي واخواتي... واتمنى ان تبقون شمعة تنيرون كل من يعرفكم اساتذتي في (المركز الوطني للمختبرات الانشائية)(المهندس حيدر لؤي عبد المحمد، امير رحمن عبد الله ، فرح جعفر محمود)

كما اتقدم بالشكر والعرفان الى الدكتورة (زينا محمد كاظم)التي لاختيارها موضوع البحث والجهد المبذول في كل خطوة فيه.

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Chapter one :

Introduction

1-1 Sand

Sand is a granular material composed of finely divided rock and mineral particles.

It is defined by size, being finer than gravel and coarser than silt, Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass[(1).]

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-topical coastal settings is silica (silicon dioxide, or SiO_2) usually in the form of quartz. The second most common type of sand is calcium gravel roads. Both sand and small gravel are also important for the manufacture of concrete[(3)].

Large gravel deposits are a common geological feature, being formed as a result of the weathering and erosion of rocks. The action of rivers and waves tends to pile up gravel in large accumulations. This can sometimes result in gravel becoming compacted into the sedimentary rock called conglomerate. Where natural gravel deposits are insufficient for human purposes, gravel is often produced by quarrying and crushing hard-wearing rocks, such as sandstone, limestone, or basalt. Quarries where gravel is extracted are known as gravel pits. Southern England possesses particularly large concentrations of them due to the widespread deposition of gravel in the region during the Ice Ages[(2)].

1-2 Gravel

Gravel is a loose aggregation of rock fragments. Gravel is classified by particle size range and includes size classes from granule-to boulder-sized fragments*c*[2]. In the Udden-Wentworth scale gravel is categorized into granular gravel (2 to 4 mm or 0.079 to 0.157 in) and pebble gravel (4 to 64 mm or 0.2 to 2.5 in). ISO 14688 grades gravels as fine, medium, and coarse with ranges 2 mm to 6.3 mm to 20 mm to 63 mm. one cubic meter of gravel typically weighs about 1800 kg (or a cubic yard weighs about 3000 pounds)(3).

Gravel is an important commercial product, with a number of applications. Many roadways are surfaced with gravel, especially in rural areas where there is little traffic.

Globally, far more roads are surfaced with gravel than with concrete or tarmac; Russia alone has over 400000 km (250000 mi) of gravel roads(2) Both sand and small gravel are also important for the manufacture of concrete.

1-3 Effect of Sulphates and chloride on concrete

Sulphates are natural mineral salts found in soil or water, some types of soil are rich in gypsum, which is a kind of ($CaSO_4$) and ($MgSO_4$), when soil is soaked due to watering or rain , Some of these Sulphates dissolved in water and penetrate into the concrete of poor quality, which contains many pores, The Sulphate striker starts to fall down in the form of hair cracks or a white powder called (Efflorecsence) when the Sulphate permeates the concrete pores, It begins to interact with it's compound (C-S-H) with concrete mortar, The reaction then begins by destroying this mortar, which encapsulates the granules of aggregates and binds them vigorously, The Sulphate dry up, forming new substances called (Efflorecsence) in the form of crystals occupy the spaces in the concrete mortar more and more and cause cracking of the concrete then increase the permeability of the concrete and start reinforcing steel more exposure to corrosion factors and at the end of the concrete begins to crumble and lose its connection with reinforcing steel or significantly reduced the age of reinforced concrete elements begin to crumble and fall

1-4 Effect of chlorides from two sources in the concrete**:-**

1-4-1 Internal chlorides

Which is added to the concrete when it's prepared and of this type calcium chloride used as an additive for cement to accelerate the reaction and aggregates contaminated with, substances containing chlorides, as well as water containing chloride salts.

1-4-2-External chlorides

These are the substances containing chlorides and the intervention of concrete pores after hardening.
Some of the Saline materials are applied to some concrete road installations for melting of snow , sea water that touches the concrete parts of the buildings beside the beaches such as piers or because of the air saturated with sea moisture , which hits the concrete surfaces ,The effect of chlorides depends to a certain extent on the addition of the concrete.

1-5- Importance:

Used real models of fine and rough aggregates located in the quarries of Karbala and have been working according to Iraq standards and compare with the British international standards a doped in Iraq and used for roads and bridges and the construction of canals that are in direct contact with water .

In this work it is necessary to find the percentage of sulphates found in the fine and coarse aggregates as they exceed the permissible percentage of these salts. Therefore, the tests conducted on the aggregates are to determine the percentages of sulphate salts because they cause more and more cement slag cracks and cause cracking of the concrete .At the end of the matter, the concrete begins to crumble and lose its bond with the reinforcing steel and concrete elements begin to fall.

The salts of chlorides are more dangerous to the concrete works than sulphate salts, so the permissible rate is vary few, they attack the reinforcing iron with its base and lead to eat and its column with the passage of.

Chapter two:

Part of practical

2-1 Materials, tools and device

2-1-1 Materials

1. Sand
2. Gravel
3. Hydrochloric acid HCl %10
4. Barium chloride $BaCl_2$ %5
5. Distilled water
6. Gravel adjuster
7. Ferrous sulphate (Fe SO_4)(0.5N)
8. Sulphuric acid(H_2SO_4)
9. Potassium dichromate $KClO_4$.
10. Phenyl reagent

2-1-2 **Tools**

1. Wire gauze
2. Round bottom flask
3. Medicine dropper
4. Watch glass
5. Washing bottle
6. Tong
7. Beaker
8. Conical flask
9. Glass rood
10. Graduated cylinder
11. Filter Paper No.1
12. Filter Paper No.542
13. Funnel
14. Mortar
15. Buret
16. Test tube brush
17. Crucible
18. Sieve

2-1-3- Devices

1. Drying oven
2. Balance
3. Hood
4. Mill
5. Shaking
6. Heater
7. Fracture
8. Aliquot

2-2 the method of work (preparation of solutions)

2-2-1 Preparation of barium chloride $BaCl_2$ %5[4]

1. Weight 0.5 of the form (barium chloride powder)
2. Add 10 ml of distilled water

- **2-2-2 Preparation (HCl) %10**

1. Take 10 ml of concentrated hydro chloric acid (HCl) in the volumetric flask.
2. Add the acid (HCl) to 90 distilled water.

- **2-2-3 Preparation ferrous sulphate 0.5 N :-**

1. 140 g of ferrous sulphate.
2. 14 ml sulphate acid concentrated into flask with a capacity of 1000 ml.

- **2-2-4 Preparation potassium dichromate.**

- Add 49.05 g of potassium dichromate (powder) to a volumetric flask with a capacity of 1000 ml (add the distilled water to 1000 ml)

2-3 The method of work the sand in according to B.S properties[4] :-

Find the percentage of sulphate SO_3% according to the British (roads and bridges)

1. The model is dried out the day before work
2. The model is divided by the, as Figure (2-1)
3. The model grinds the mill and sinks on sieve 40, the size of which is 0.42 mm
4. 2 g of the model is weighed in a sensitive balance and placed in a 250 ml flask.

5. Add 200 ml of diluted hydro chloric acid.

6.The mixture is heated near the boiling point.

7.The solution is filtered on the filter paper No.1

8.Add boiling distilled water to the filter paper (wash the filtration paper) until it reaches a size of 400 ml (until a larger quantity of sulphur is guaranteed)

9. Add 10 ml of Barium chloride (incremental addition with continuous stirring) %5

10. Leave the solution on the heater for a full hour without the boiling point and while it's covered with watch glass.

11.Leave for 24 hours to complete the deposition process.

12.The following day, the form is filtered on the filter paper No.542. The filter paper is washed with distilled water to get rid of the chlorides attached.

13. Place the filter paper in a crucible burn the primary burner 250° C until the paper is blended.
14. The crucible is placed in an oven of 850 (800-900) degrees.

The crucible extracted after 15 minutes and the weighted with the precipitate.

Hence, without the precipitate and the weight difference, we find the weight of the salt

Figure (2-1): Shows the shape of the Aliquot

2-4 The method of work the sand according to I.Q properties

Find the percentage of sulphate $SO_3\%$ according to the Iraqi properties (Building)

1. The model is dried out the day before work
2. The model is divided by the Aliquot
3. The model is grinded the mill as in figure (2-2) and is sieved on sieve No.100, the size of which is 0.15 mm

4. (3 g) of the model is weighed in a sensitive balance and placed in a 250 ml flask.
5. (200 ml) of diluted hydro chloric acid %10.
6. The mixture is heated near the boiling point.
7. The solution is filtered on the filter paper No.1
8. A boiling distilled water is put on the filter paper (wash the filtration paper) until it reaches a size of 400 ml.

   (until a larger quantity of sulphur is guaranteed)

9. Add 10 ml of Barium chloride (BaCl) (incremental addition with continuous stirring) %5
10. Leave the solution on the heater for an hour without the boiling point and while it's covered with a watch glass.
11. Leave for 24 hours to complete the deposition process.
12. The following day, the form is filtered on the filter paper No.542. The filter paper is washed with distilled water to get rid of the chlorides attached.
13. Place the filter paper in a crucible burn the primary burner 250° C until the paper is blended.
14. The crucible is placed in an oven of 850(800-900) degrees. The a crucible extracted after 15 minutes and the weighted with the precipitate.

    Hence, without the precipitate and the weight difference, we find the weight of the salts

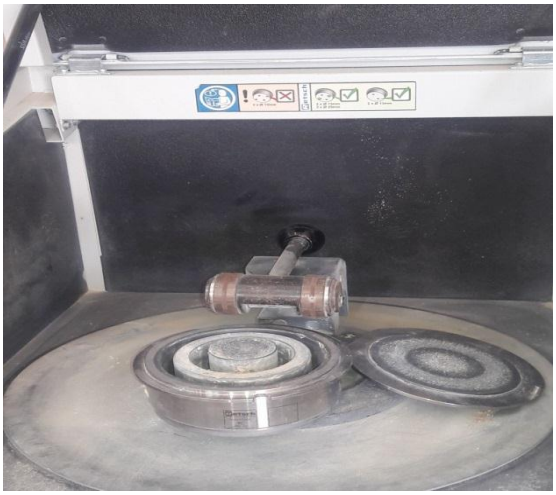

Figure (2-2): Shows the shape of the mill

2_5 The method of work the Gravel according to (B.S) properties:-

Find the percentage of sulphate SO_3 according to the(B.S)(roads and bridges) .

1.The model is dried out the day before work.

2. The model is broken by a Fracture

3. The model is divided by the Aliquot

4. The model grinds the mill and sinks on sieve NO.40,the size of which is 0.42mm

5. (2g) of the model is weighed in a sensitive balance and placed in 250ml flask .

6. Add 200ml of diluted hydrochloric acid.

7. The mixture is heated near the boiling point.

8. The solution is filtered on the filter paper NO.1.

9. Add boiling distilled water to the filter paper(wash the filtration paper) until reaches a size of 400ml.

10. Add 10ml of Barium chloride (incremental addition with continuous stirring) 5%

11. Heat the solution on the heater for a full hour without the boiling point and covered with watch glass.

12. leave the solution for 24 hours to complete the deposition process.

13. The following day, the form is filtered on the filter paper NO.542. The filter paper is washed with distilled water to get rid of the chlorides attached.

14. Place the filter paper in a crucible burn the primary burner 250 until the paper is blended.

15. The a crucible is placed in an oven of 85 (800-900) degrees. The jar extracted after 15 minutes and weigh with the precipitate.

Hence without the precipitate and the weight difference, we find the weight the salts.

2-6 The method of work the Gravel according to (I.Q) properties [5]

Find the percentage of sulfate SO_3% according to the Iraqi (Building)

1.the model is dried out the day before work.

2. the model is broken by Fracture .

3. The model is divided by the Aliquot.

4. The model grinds the mill and sinks on sieve No.100, the size of which is 0.15 mm .

5.(3g) of the model is weighed in weighed in a sensitive balance and placed in a 250ml flask.

6. Add 200ml of diluted hydro chloric acid 10%.

7. The mixture is heated near the boiling point.

8.The solution is filtered on the filter paper NO.1.

9.Add boiling distilled water to the filter paper (wash the filtration paper) until it reaches a size of 400ml

10.Add 10ml of Barium chloride (incremental addition with continuous stirring) 5%

11.Leaves the solution on the heater for a full hour without the boiling point and covered with watch glass .

12. Leave for 24 hours to complete the deposition process .

13.The following day, the form is filtered on the filter paper NO.542,The filter paper is washed with distilled water to get rid of the chlorides attached.

14.place the filter paper in a crucible burn the primary burner 250C until

15. the a crucible is placed in an oven of 850 (800-900) digress the crucible extracted after 15 minutes and weighed with the precipitate.

Hence without the precipitate and the weight difference, we find the weight the salts.

2-7- Gravel Adjuster[6]

There are three tests in the gravel adjuster

1. Sulphate test.
2. Organic materials.
3. Total dissolved salts T.D.S

2-7-1-The method of work (The preparing room of models)

1. Take the weight of (4-5) kg from Gravel Adjuster the total weight (3990 kg)
2. Squeeze on sieve No.4 The size of it's opening 4.75 mm
3. The transit of the sieve number 4 sinks on the sieve No.10 the size of it's openings is 2 mm.
4. Transit of the No.10 weighted (1528 g)
5. The transporter from No.10 is divided into two parts

- The first section is taken from sulphate and organic materials
- The second section blends with a half stop on the number 10 sieve to obtain samples of dissolved salts.

6. The first model is divided by the Aliquot to obtain a simple for grinding
7. The second values will not remain as is (Total dissolved salts)

2-7-2- The Calculation the percentage of Sulphate

1. It weighs 2 g of grounded from.
2. Add 200 ml hydro chloric acid %10
3. Filtration on the filter paper No.1 and add the distilled water to 400 ml.
4. Add 10 ml Barium chloride gradually.
5. Leave the model on the heater without boiling.
6. Leave it for 24 hours while it's covered with a watch glass.
7. Filtration on the filter paper No.542 and remove the leachate and wash with boiling distilled water for 400 ml.
8. Burn primary burn in the crucible (filter paper with crucible)
9. Burn in a temperature oven (850° C)

2-7-3-Organic Substances in the oxidation of dichromate.

1- Take 2 g of the model and put in the flask and add 10 ml of potassium dichromate and take another flask .
2- Add 20 ml of concentrated sulphnrica acid (specific weight 1.84) to the two flasks, leave the model in an isolated place for half an hour.
3- Add 200 ml of distilled water.
4- Add 10 drops of phenyl reagent and mix it with ferrous sulphate. Color changes from black to green and record size.

2-7-4- The Calculation the percentage of (T.D.S)

1. Weigh 10 g of the model
2. Put it in a plastic bottle and add 500 ml of distilled water.
3. The plastic bottle is placed in the shaking for 4 days.
4. Filtration on two filter paper No.1
5. Take 200 ml of leachate in the beaker and place it on the heater until the total dehydration as Figure (2-4)
6. Leave the beaker for 15 minutes to cool down.
7. The beaker weighs with model and weighs empty as well.

Figure (2-4): The heating process of the model

Chapter three:

Results and discussion

3-1 The Calculation Model (1) sand according to the British (B.S) properties :-

- The weight of the empty crucible is = 44.1312 (w_1)
- Weight of the crucible with the precipitate = 44.1455(w_2)

The weight of the deposit = w_2 - w_1

= 44.1455 – 44.1312 = 0.0143

$$Sulphate\ raito\ SO_3\% = \frac{The\ weight\ of\ the\ deposit\ \times 34.3}{The\ weight\ of\ the\ model}$$

$$\%\ SO_3\ = \frac{0.0143 \times 34.3}{2} = 0.2401g$$

*The upper limit of the sand in the B.S = 0.5

.'. The analysis is successful

3-2 The Calculations Model (2) Sand according to the Iraqi (I.Q) properties :-

- The weight of the empty crucible is = 39.2331 (w_1)
- Weight of the crucible with the precipitate = 39.2556 (w_2)

The weight of the deposit = $w_2 - w_1$

= 39.2556- 39.2331 = 0.0225

$$\%SO_3 = \frac{0.0225 \times 34.3}{2} = 0.25725\ g$$

*The upper limit of the sand in the I.Q = 0.5

.'. The analysis is successful

*Molecular weight of sulphate = 34.3

3-3 The Calculation Model (3) Gravel according to the British (B.S) properties :-

- The weight of the empty crucible is = 39.8322 (w_1)
- Weight of the crucible with the precipitate = 39.8432 (w_2)

The weight of the deposit = $w_2 - w_1$

= 39.8432- 39.8322 = 0.18865

$$\%SO_3 = \frac{0.18865 \times 34.3}{2} =$$

*The analysis is successful

- The upper limit of the sand in the B.S = 0.25

3-4 The Calculation Model (4) Sand according to the Iraqi (I.Q) properties :-

- The weight of the empty crucible is = 44.2755 (w_1)
- Weight of the crucible with the precipitate = 44.2875 (w_2)

The weight of the deposit = $w_2 - w_1$

= 44.2875- 44.2755 = 0.012

$$\%SO_3 = \frac{0.012 \times 34.3}{3} = 0.1372g$$

.'. The analysis is successful

Because The upper limit of the sand in the I.Q = 0.5

3-5 The Calculation Model (5) Sand according to the British(B.S) properties :-

- The weight of the empty crucible is = 41.2829 (w_1)
- Weight of the crucible with the precipitate = 41.2929 (w_2)

The weight of the deposit = $w_2 - w_1$

=41.2929- 41.2829 =0.01

$$Sulphate\ raito\ SO_3\% = \frac{The\ weight\ of\ the\ deposit\ \times 34.3}{The\ weight\ of\ the\ model}$$

$$\%SO_3 = \frac{0.01 \times 34.3}{2} = 0.1715g$$

3-6 The Calculation Model (6) Gravel according to the Iraqi (I.Q) properties :-

- The weight of the empty crucible is = 39.8322 (w_1)
- Weight of the crucible with the precipitate = 39.8332 (w_2)

The weight of the deposit = $w_2 - w_1$

= 39.8332 - 39.8322 = 0.001

$$Sulphate\ raito\ So_3\% = \frac{34.3 \times The\ weight\ of\ the\ deposit}{The\ weight\ of\ the\ model}$$

$$\%SO_3 = \frac{34.3 \times 0.001}{3} = 0.01143\ g$$

- The analysis is successful

-The upper limit of the Gravel in the I.Q = 0.1

3-7 SUMMERY

No. of Models	Type	$\%SO_3$	The way Method
1	Sand	0.2401	B.S
2	Sand	0.2572	I.Q
3	Gravel	0.18865	B.S
4	Sand	0.1372	I.Q
5	Sand	0.1715	B.S
6	Gravel	0.01143	I.Q

- In the British method, the upper limit of sulphates$c^{[4]}$ in is Sand 0.5
- In the Iraqi method, the upper limit of sulphates in is Gravel 0.25
- In the Iraqi method, the upper limit of sulphates$c^{[5]}$ in is Sand 0.5
- In the Iraqi method, the upper limit of sulphates in is Gravel 0.1
-

- The striker starts the Sulphates of the in the concrete in the form of cracks or in the form a white powder , but it must be followed that not all white powder is beaten on the cheek indicate the attacker Sulphates of the concrete and the best way to make sure it is a chemical test.

3-8 The Calculation Model (1) SO_3 for Gravel Adjuster

- The weight of the empty crucible is = 44.1312 (w_1)
- Weight of the crucible with the precipitate = 44.2755(w_2)
  Weight before sifting = 3990g (w_3)
  Weight after sifting = 1528 g(w_4)

The weight of the deposit = w_2 - w_1

= 44.2755 – 44.1312 = 0.01443

$$\%Sulphate(SO_3) = \frac{34.3 \times The\ weight\ of\ the\ deposit \times w_4}{w_3 \times The\ weight\ of\ the\ model}$$

$$= \frac{34.3 \times 0.01443 \times 34.3}{3990 \times 2} = 0.95$$

- The upper limit of the (SO_3) in the Gravel Adjuster = 5

.'. The analysis is successful

3-9 The Calculation Model (2) organic for Gravel Adjuster

- The size of the down poured in the blank = 21.1 (v_1)
- The size of the down poured of the model = 19 (v_2)

$$x = \frac{v_2}{v_1}$$

$x = \frac{19}{21.1} = 0.9$

$A = 1 - x$

$$A = 1 - 0.9 = 0.1$$

$$\% = \frac{10.5 \times 0.67 \times 0.1}{5} = 0.1$$

- Where 10.5 and 0.67 fixed ratio
- The upper limit of organic matter in the Gravel Adjuster = 2

.'. The analysis is successful

3-10 The Calculation Model (3) (the percentage of (T.D.S)

- The weight of empty beaker is = 100.2732 (w_1)
- Weight the beaker with the model = 100.5254 (w_2)
  Weight of salts = w_2-w_1

  = 100.5254 – 100.2732 = 0.2534

$$\%Salts = weight\ of\ salts \times 25$$
$$= 0.2534 \times 25 = 6.335$$

- The upper limit of the salts in the Gravel Adjuster

  (T.D.S)= 10

.'. The analysis is successful

3-11 Summery of gravel adjuster

Gravel Adjuster	%	Upper limit .[6]
Sulphates	0.95	5
T.D.S	6.305	10
Material organic	0.1	2

There is an inverse relationship between organic Material and total dissolved salts, higher the percentage of total salts the less organic material and vice versa.

4-1- Discussion

Note1

The salts, especially Sulphates and chlorides, are considered the most harmful to the concrete.

They are found on the outside of the aggregates and even in the interior. Therefore, the models are always washed, so they should be dried before starting the inspection process and allowed for 24 hours until the total dryness (because the moisture affects the weight process) Temperature 75°C should not be increased on this level because the increase will lead to the combustion of sulphate and therefore cannot be quantified in the form.

Note2

In some cases when we adding hydro chloric acid (HCl) it evolving gases (especially Sand) caused by the release of chlorides and sulphides. This means that the model contains large impurities.

Note3

Some tests when adding barium chloride turns the Leachate into white and when it left for a period of time it will be noticed that deposition of a white matter as in the equation:-

$$NaSO_3 + BaCl_2 \rightarrow NaCl_2 + BaSO_3$$

Note4

There is an inverse relationship between the total salt and the organic matter in the gravel where the more salts the lower the organic matter.

Note5

These materials (Sand, gravel, gravel adjuster) are taken from different parts of Iraq (from quarries).

According to the work of the (Mahari quarries) located in Samawah.
In general , the salts are increasing as we move from northern Iraq to south because they are connected to the rivers, where they are increasing in the south.

Note6

As well as increase the proportion of salts in the Basra of sight and study indicates that the source of sulphates in the Basra of sight is gypsum and anhydrite mixed with modern sediments as well as ground water rich in sulphate ions or some tributaries of the Shatt al Arab passing through the study area[(11)].

Part of the sulphate comes from the degradation of proteins found in[(12)] heavy water ,the proportion of sulphates in dry soil increases due to high evaporation rate in wetland soils .

5-1- Conclusions and Future work

Corrosion is defined as the spoilage of the substance or its properties[8] as a result of its interaction with external or internal in fluencies or is the damage resulting from the interaction of two or more substances or their components in the presence of an auxiliary medium such as heat, moisture and salt .

The erosion of reinforcing steel in reinforced concrete facilities in central and southern Iraq is a serious problem due to the increase in chloride salts in soil, ground water and high temperatures in summer ,which encourages cracks in the concrete.

We conclude from the above that the presence of salts (sulphate salts[9] and chlorides) lead to the weakening of the mechanical properties of the concrete and thus reduce their resistance to external factors, which leads to reduction in the age of origin.

It was concluded from this research that increasing the percentage of sulphate salts poses a danger to buildings or roads and bridges if they exceed the existing limit (As shown in the table 4-2) .

This problem can be solved by increasing the quantity of sulphate resistant cement.

5-2- Table showing the maximum allowable amount of sulphate in aggregates

NO.	Sample	Limit upper
1	Sand I.Q	0.5
2	Sand B.S	0.5
3	Gravel I.Q	0.1
4	Gravel B.S	0.25
5	Gravel Adjuster	5

5-3-To prevent the effect of Sulphates

1-The practical using of the Sulphates resistant cement.

2- The concrete content of cement is not less than 400kg\m^3

3-Use a few pores with good pores when pouring.

4-When chloride ions are present in the reinforced concrete, they may cause corrosion of reinforcing steel.

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