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Concrete mix design in Asalouye climate

Mehdi Aghaei
M.Sc, Department of Civil Engineering, Islamabad Gharb Branch, Islamic Azad University, Iran

Abstract
The issue of durability has gradually become very important nowadays. However, different engineers and designers in Iran and the world have not yet acquired the experience in relation to the issue of durability. Everyone constantly talks about durability, but usually in the technical specifications of the projects, there is not much mention of durability and its evaluation and providing criteria for control; except that they raise certain restrictions in connection with the ratio of water to cement, the minimum and maximum grade of cement or the type of cement used. It seems that the necessary preparation for conducting durability control tests in Iran and the world has not yet been made. Although in a circular from the Management and Planning Organization for the Persian Gulf, such a thing has been declared mandatory, but the fact is that these tests can only be done when preparing the concrete mix plan and there is no sufficient opportunity and sufficient facilities to perform them as a continuous control test, such as determining the compressive strength of concrete, on the concrete produced in the workshop. In this research, the design of concrete mix in Asalouye region has been studied.

Keywords; durability of concrete, concrete mix, Asalouye climate

Background

The Road, Housing and Urban Development Research Center has published an article titled "Comprehensive Concrete Vision Document 1404 (a step towards sustainable development in the construction industry)" in 2012. The article states:
The initial schedule for the implementation of the objectives of the 1404 concrete vision document has been considered in three short-term, medium-term and long-term time frames. The concrete industry and its related industries are considered to be one of the country's development infrastructures. Despite the importance of this industry in construction, as well as its impact on energy consumption and environmental pollution, its production and consumption cycle in the country is not suitable. The Comprehensive Concrete Document 1404 has been compiled in order to improve the quality of strength and durability of concrete and concrete structures in the country.
Ghafari, Mohammad Javad, Jazayeri Moqaddas, Seyyed Mahmoud, in his article entitled "Investigation and comparison between 7 and 28 days compressive strength of concrete", in a laboratory work and comparison of coefficients with Iran's Concrete Regulations (ABA) which was published in (2014) has been published in the international conference on civil engineering, architecture and urban infrastructure, they have achieved the following results:
One of the most important things in projects is to check and test the compressive strength of concrete, which must be equal to the design strength so that it can be used in the design. Because in most construction projects, 28 days is a very long time to obtain the compressive strength of concrete, in this regard, several scientific relationships have been presented that may not be usable or provide us with inappropriate numbers due to differences in the cement of different countries and other factors. One of these reasonable methods in Iran is to check the 7-day strength of concrete, which can be converted to 28-day strength with the coefficient given in ABA. In this article, research and investigations have been done on 52 samples obtained during 14 months from a construction project, and the coefficients have been compared with Iran's concrete regulations. For type 2 concrete, the coefficients should be between 1.3 and 1.7, the average number obtained from 52 samples is 1.38, and this shows the proper adaptation of the coefficients.

Introduction

As the term "characteristic resistance" or "minimum resistance" is used to specify the resistance level of concrete used in a project, when a specific level of durability is considered by the project designer, it is necessary to use the word characteristic durability or mention the type of durability and quality of concrete; for instance, characteristic water absorption or characteristic electrical resistance can be used (Dorontsev AV, et. al., 2022; Bubunets EV, et. al., 2022). It is obvious that the characteristic durability, like the characteristic resistance, is a probabilistic value that is called the qualitative level of concrete in terms of durability (Asfahani A., 2022; Soboleva MS, et. al., 2022). As in the concrete mix plan, using the characteristic strength, the average strength value of the mix plan is calculated, and in this calculation, the resistance standard deviation or the safety margin of resistance is used according to the quality level of concrete production (Sadovnikova N, et. al., 2022; Hanawi SA, et. al., 2022). Here too, the term durability of the purpose of the mixture design should be used, and it is necessary to consider a special place for these definitions in the concrete regulations and concrete mixing design methods in the future (Alsafi R, et. al., 2022). On this basis, after making the test mixtures, the achievement of these goals should be checked. It is recommended to accept a 5% reduction in the target durability of the mix plan and not need to change the mix plan.

Applying concepts of evaluation and acceptance of concrete based on durability

In all existing regulations of the world, the acceptance of concrete in terms of resistance and conformity to the desired category or characteristic resistance has special statistical criteria. For example, it is said that first, there must be a certain frequency in sampling, and secondly, the average of the results of all three consecutive samples should not be less than the characteristic resistance or even less than the characteristic resistance plus a certain value. Also, in order to accept the concrete of a project, each of the results of the samples should be less than the characteristic resistance minus a certain amount.

It is clear that if the issue of durability is considered equal to resistance; such criteria should also be formulated for the acceptance of concrete in terms of compliance with characteristic durability. Also there must be criteria for sampling frequency. Therefore, in important projects, it is necessary for local laboratories to be equipped with special tools and equipment to perform the desired durability tests, and like report on the strength of concrete samples, report the desired durability parameters so that the quality of concrete can be monitored and acceptance or non-acceptance is on the agenda.

At present, it is proposed to use the existing form of compliance with characteristic resistance with some minor changes for compliance with characteristic durability, as their statistical concepts seem to be the same.

Compilation of criteria and methods for checking low durability concrete

As in all the valid regulations of the world, there is a section under the title of checking low-strength concrete, as a result, it is necessary to develop criteria based on which low durability concretes can be examined and accepted or rejected. In any case, in this regard, the similarity of the issue of durability with resistance may not be so great, but the work procedure can be developed with the inspiration of examining low-strength concrete. Analytical investigations and durability testing and application of an acceptance rule are among these cases but things like loading may not be modeled. However, other measures such as applying coating materials on the surface of concrete or taking measures to make concrete or concrete parts and structures more durable can be similar to measures to accept low structural strength concrete (Tadayyon, 1381).

Concrete mixing plan in Asalouye climate

The final report of the concrete mixing plan, the construction project of technical buildings, laboratory, fire department, HSE and electrical substation

Client: Nouri Petrochemical Company

August 1400

Determining the concrete mixing plan or determining the proportion of concrete mixtures is a process through which the correct combination of cement, aggregates, water and additives can be achieved to make concrete according to the given specifications. Although to date, several detailed technical principles regarding the determination of concrete mixing ratio have been recorded, but for various

reasons, it has been proven that these trends are not based on scientific foundations and are more considered an experimental art. Although most of us engineers do not feel comfortable with subjects for which certain simple relationships (such as buckling relationship of compression member - Weiler relationship) have not been formulated, but knowing that mixing ratios can have a significant impact on the price and properties of concrete (such as efficiency, resistance and durability), inevitably by understanding the basic principles and repeating and practicing to some extent, we can learn this experimental art, which by the way will give us a great reward (which includes reducing the price and increasing the strength of concrete).

Consumable materials in concrete mixing plan

Batching Kandovan of Pars Mixing Plan

Stone materials

The mixing plan is carried out on the stone materials of Jam Afshan mine, located in Jam city. Stone materials, "sand, pea gravel and almond gravel" were sampled on 1400/1/17 from the Batching Kandovan of Pars. Then, determining the optimal percentage of sand and conventional tests was done to check the quality of aggregates for use in concrete.

Cement

The cement used in the mixing plans is the type II cement of Ilam Cement Factory, which was sampled on 17/01/1400 from Batching Kandovan of Pars and sent to the central laboratory on 08/02/1400 to perform physical and chemical tests of the cement. It was sent to Tehran.

Additives

In order to maintain resistance, in addition to providing the required slump, and to achieve the efficiency and durability of concrete, microsilica additives and SUPERFLOW360 super-lubricant, a product of Kariz Chemical Company, were used in the construction of the Kandovan Pars concrete mixing project.

Water

The water used in concrete was sampled from the batching water pond of Pars on 1400/1/17 and sent to the central laboratory for additional chemical tests of the water.

The mixing plan of the leading batching of Sanat Sahel road

Stone materials

Done mixing plan is on the stone materials of Parsian Mine.

Stone materials, "sand, pea gravel and almond gravel" were sampled on 1400/1/27 from the leading batching of Pishro Rahe Sanat Sahil located in Shir Mino, and then the optimum percentage of sand was determined and chemical and physical tests of the materials were carried out.

Cement

The cement used in the mixing plans is type II cement of the Lamerd cement factory, which was sampled on 1400/1/27 from the batching of Pishro Rahe Sanat Sahil and in order to perform physical and chemical tests, it was sent to the central laboratory of Tehran on 1400/2/8.

Additives

In order to maintain the strength along with providing the required slump and also to achieve the efficiency and durable characteristics of concrete, microsilica gel additives SSG-001, the product of the Pishro Rahe Sanat Sahil Company were used in the construction of mixed designs.

Water

The water used in concrete was sampled from the batching water pond of Pishro Rahe Sanat Sahil on 1400/1/17 and sent to the central laboratories for additional chemical tests.

The tests performed on the materials sent and the design of the mixes made

The following various tests have been carried out on the materials sent from Pars Kandovan batching Pishro Rahe sanat Sahil batching and concrete mix designs:

1- ASTM C136 sand gradation test
2- Test of dry surface saturated density and water absorption capacity of sand and gravel ASTM C127, 128.
3- Determination of equivalent fracture percentage Test, ISIRI 11568.

4- Cement volumetric mass determination and percentage of normal concentration determination test, ISIRI 7148.
5- 7-day and 28-day compressive strength test on the samples, ISIRI 3206.
6- Compressive strength test of cement sand mortar, EN196 (ISIR393).
7- Primary and secondary cement setting test, ASTM C191.
8- Determining the amount passing through a 75 micron sieve test, ASTM C117.
9- Abrasion numbers of stone materials test (Los Angeles), ASTM C131.
10- Elongation and contraction test, BS812 part1.
11- Sand value determination test, ISIR 1685.
12- Impact value of stone materials test, BS812.
13- Additive pH determination test, ISIR 3178-18.
14- Determining the percentage of additive solids test, EN480-8.
15- Determining the specific weight of the additive test, ISIR 898.
16- Chemical testing of water, ASTM C1602.

Characteristics of concrete required for the project

According to the characteristics of the acceptable limits of the concrete ingredients required for the project, according to the table of technical specifications of the concrete, the type used in the structures is type D.

CONCRETE MIX TYPE							
Minimum Required characteristics		A	B	C	D	E	F
Concrete Strength		C25	C21	C15	C35	C35	C21
Cement		ASTM C150	ASTM C150	ASTM C150	ASTM C150	ASTM C150	ASTM C150
Size of Coarse Aggregate		20mm Maximum	12mm Maximum	Between 20mm and 50mm	Between 20mm and 50mm	Between 20mm and 50mm	Between 20mm and 50mm
Maximum Slump		75mm (Note1)	100mm (Note1)	100mm (Note1)	75mm (Note1)	100mm (Note1)	50mm (Note1)
Admixtures		Air Entraining	Note	None	Silica Fume 7-10% Super-plasticizer	HicroSilica Gel	HicroSilica Gel
Water-Cement Ratio	Moderate exposure	0.45	0.5	0.56	0.4	0.5	0.45
	Severe exposure	0.4				0.45	
Minimum Cement Content	Moderate exposure	350kg/m	350kg/m	150kg/m	400kg/m	400kg/m	300kg/m
	Severe	400kg/m					

	exposure						
Use		Slabs, paving, sumps	Fireproofing concrete	Lean, concrete, backfill and Binding concrete	Piles, Pile caps, foundation and other special applications	Super-structure	Mass-concrete

Technical characteristics of concrete required for the project

Status and characteristics of materials

Status and characteristics of batching materials of Kandovan Pars

Investigation of aggregates of Jam Afshan Mine

The stone materials of Jam Afshan Mine located in Jam city were sampled on 1400/1/17 from Pars Kandovan Batching and then conventional tests were conducted to check the quality of aggregates for use in concrete.

It should be mentioned that according to the records and knowledge of the materials in Asaluye, it was decided that the test to determine the amount of chloride and sulfate ions in the aggregate should be done in order to ensure the health of the aggregate. In the following, the results of the tests performed on the aggregates are presented.

Coarse aggregates of Jam Afshan mine

A- Almond gravel 4/3

About 90% of the material granulation is in the allowed range of 9.5-19 astm c33 standard and the rest is on the graph close to the coarse grain range. The percentage passing through the 200 grade sieve, which is almost a measure of the cleanliness of the materials, is equal to 0.36%. Iran's concrete regulation (ABA) has allowed this amount up to a maximum of 1%, which is in a satisfactory condition.

The amount of specific weight is 2/66gr/cm^3. This test is based on ASTM-C128. It is recommended that the specific weight of stone materials be between 2.6 and 2.8 grams per cubic centimeter. The amount of water absorption of the mentioned materials is 1.73, and it is recommended that the water absorption of the materials is less than 2.50%. The amount of needle and scaly grains of the materials is 14.0% and 14.5%, respectively. This test is done according to BS-812. Iran's concrete regulation (ABA) has limited this amount to 40% for needle materials and 30% for scaly materials.

The chemical tests performed on the almond coarse material show the amount of chloride ions at 0.41%, sulfate at 0.109% and the pH value at 11.01. Iran's concrete regulation (ABA) has limited the amount of chlorine ions to a maximum of 0.04% and the amount of sulfate ions to a maximum of 0.4%.

B- Pea gravel 3/8

The grading of this sand complies with the permissible range of 4.75-12.5 astm c33 standard about 85% and the rest is located on the graph close to the fine-grained range. The passing percentage of the 200 grade sieve, which is almost a measure of the cleanliness of this type of material, is equal to 0.27%, which is less than the permissible value of the ISIRI 302 standard.

The material breakage percentage is 86% which is in a good condition. Its specific weight is 2/65gr/cm^3. This test is based on ASTM-C128. It is recommended that the specific weight of stone materials be between 2.6 and 2.8 grams per cubic centimeter. Its water absorption value is 10.2%, which is recommended to be less than 2.50%, which is within the permissible range. The amount of needle and scaly seeds for the mentioned materials is 9.7 and 15.3, respectively. This test is done according to BS-812. Iran's concrete regulation (ABA) has limited this amount to 40% for needle materials and 30% for scaly materials. The impact value test was done based on BS-812 and it is

11.34%. Los Angeles weight loss test against abrasion according to ASTM C131 standard is equal to 26.5%, which is below the permissible limit according to the standard.

Fine aggregate of Jam Afshan Mine

Jam Afshan Mine Sand

The granularity of this aggregate does not comply with the permissible range of category 1 sand of the ISIRI 302 standard and (ASTM C33 standard); and about 65% of the materials are out of the standard range in terms of granulation. But compared to the materials of the region, it is not far from the minimum range of coarse grains, which should be corrected as soon as possible. In addition, the materials entering the workshop should be regularly tested at certain time intervals so that appropriate decisions can be made in case of changes. Also, its Fineness Modulus (FM) was obtained as 3.87, which is approximately within the allowed range provided in the ISIRI 302 standard for category 2. Changes in the fineness coefficient during the execution of the work should not be more than $2\pm$. In Publication 101 (General Technical Specifications for Roads), it is recommended that a modulus of elasticity between 2.3 will cause significant problems during operational operations. It is suggested that in order to facilitate the implementation and prevent unforeseen implementation problems, the necessary coordination for the modification of the materials of the supply mine should be done as soon as possible. The Equivalent Test Sand (SE) of the said sand, which is almost a measure of the cleanliness of the material, was 68%. The general technical specifications of the road (Publication No. 101 of the Vice-Chancellor of Technical Affairs) sand equivalent by the T176 method should not be less than 75%, but ABA has limited it to at least 80%.

The passing percentage of the score of 200 is equal to 0.67, which is in a satisfactory state. ABA has allowed this amount to be 3 to 5 percent for natural sand and 5 to 7 percent for crushed sand, depending on the type of concrete. This test is based on astm-c117.

The specific weight of the mine sand sample is 60.2 grams per cubic centimeter. This test is based on ASTM-D854. It is recommended that the specific weight of stone materials be between 2.6 and 2.8 grams per cubic centimeter.

The condition and specifications of the Pishro Rahe Sanat Sahil Batching

Analysis of Parsian Mine aggregates

Conventional tests were conducted to check the quality of aggregates for use in concrete. It should be mentioned that according to the records and knowledge of the materials available in Asalouye region, it was decided to conduct the test to determine the amount of chlorine and sulfate ions in the aggregate to ensure the health of the aggregate. In the following, the results of the tests performed on the aggregates are presented.

Coarse aggregates of Parsian Mine

Almond gravel 3/4

About 85% of the material's grain size is within the permissible range of 5/9/19 ASTM C33 standard and the rest are close to the coarse grain range. The passing percentage of the 200 grade sieve, which is almost a measure of the cleanliness of the materials, is equal to 0.10%. ABA has allowed this amount up to a maximum of 1%, which is in a very good condition.

The amount of specific weight is 2/05gr/cm^3. This test is based on ASTM-C128. It is recommended that the specific weight of stone materials be between 2.6 and 2.8 grams per cubic centimeter.

The amount of needles and flakes for the mentioned materials is 11.5% and 19.0%, respectively. This test is based on BS-812. ABA has limited this amount to 40% for needle materials and 30% for flaky materials. Los Angeles weight loss test against abrasion according to ASTM C131 standard is equal to 30.6%. Impact value test based on BS-812 is equal to 16.67%.

Pea gravel 3/8

The granulation of this gravel complies with the permissible range of 4.75-5.12 astm c33 standard about 75% and the rest is located on the graph close to the fine-grained range. The passing percentage of the 200 grade sieve, which is almost a measure of the cleanliness of this type of material, is equal to 0.47% which is less than the permissible value of ISIRI 302 standard.

The percentage of breakage of materials is 83%, which is in a good condition. Its specific weight is 2/14gr/cm^3. This test is based on ASTM-C128. It is recommended that the specific weight of stone

materials be between 2.6 and 2.8 grams per cubic centimeter.
Its water absorption value is 3.25%. It is recommended that the water absorption of the material be less than 2.50. The amount of needle and scaly of gravels is 13.2% and 20.1%, respectively. This test is based on BS-812. ABA has limited this amount to 40% for needle materials and 30% for scaly materials.

Fine aggregates of Jam Afshan Mine

Jam Afshan mine sand

The granularity of this aggregate does not comply with the permissible range of category 1 sand of ISiri 302 standard and (ASTM C33 standard) and about 65% of the materials are out of the standard range in terms of granularity; but compared to the materials of the region, it is not far from the minimum range of coarse grains, which should be corrected as soon as possible. Also, its fitness modulus (FM) is equal to 3.74, which is within the allowed range provided in the ISIRI 302 standard for category 2 sand. The sand value (SE) of the aforementioned sand is 73%. The passing percentage of the 200 sieve is equal to 1.22 which is in satisfactory condition. ABA allows this amount to be 3 to 5 percent for natural sand, depending on the type of concrete. This test is based on astm-c117.
The specific weight of the sand sample from the mentioned mine is 2.29 grams per cubic centimeter. This test is done according to ASTM-D854. It is recommended that the specific weight of stone materials be between 2.6 and 2.8 grams per cubic centimeter.

The results of the granulation tests performed on the materials

Sieve (mm)	**Percent passing through the sieve**		
	sand	**Pea gravel**	**Almond gravel**
37.5	100	100	100
25	100	100	100
19	100	100	84.87
12.5	100	99.93	84.87
9.5	100	84.53	0.90
4.75	95.40	4.17	0.62
2.38	95.40	4.17	0.62
2.38	59.81	0.57	0.58
1.19	32.82	0.57	0.58
0.6	16.57	0.57	0.58
0.3	6.57	0.57	0.58
0.15	2.30	0.57	0.58

Granulation (percentage passing through sieves) of Jam Afshan mine aggregates

The results of the grading tests conducted on the materials of Parsian batching mine, Pishro Rahe sanat sahil, on the materials used in the concrete mix designs:

Sieve (mm)	**Percent passing through the sieve**		
	sand	**Pea gravel**	**Almond gravel**
37.5	100	100	100
25	100	100	100
19	100	100	84.92

12.5	100	100	84.92
9.5	99.61	89.27	0.88
4.75	99.61	89.27	0.28
2.38	93.92	13.53	0.28
2.38	59.33	0.87	0.22
1.19	35.01	0.87	0.58
0.6	21.91	0.87	0.22
0.3	12.16	0.87	0.22
0.15	4.16	0.87	0.22

Conclusion

The project designer must clearly state concrete durability specifications in the private technical specifications of the project. As the characteristic strength or class of concrete is specified, it is necessary to declare the durability of the characteristic even by mentioning the age of the concrete and the desired test instructions. This is explicitly mentioned in ISO 22965-1 and ISIRI 12284.

Obviously, according to the conditions governing the project and the desired environment, a certain parameter or parameters should be proposed and it is better to declare only a suitable parameter for any type of long-term demand in order to ensure long-term sustainability. Mentioning multiple parameters for one goal may cause confusion. In other words, it is possible that from the point of view of applying one parameter, concrete is suitable, but it is not possible to achieve another parameter and it will cause trouble. For example, if RCPT test, electrical resistance, half-hour water absorption, final water absorption, water penetration depth, etc. are used to reduce and control chloride ion penetration in concrete, it will not be interesting, and it is better to only use RCPT or electrical resistance. The reason for this can be considered to be the closeness of the mechanism of tests with chloride ion penetration in concrete. However, to reduce and control water absorption or water penetration in concrete, water absorption tests, water penetration depth, capillary water absorption or initial surface water absorption may be recommended. However, in all cases, it is necessary to use a test that is better compatible with the mechanism governing the project and the failure in question.

It should be noted that a specific relationship between durability parameters has not yet been proposed, and perhaps a relationship cannot be established between many of them in the future. Therefore, it should not be assumed that by considering a characteristic durability, all types of durability can be covered.

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