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APPLICATION OF MUMMIFIED TURK SALTY FIBER CONCRETE AS PROTECTION AGAINST SALTY DOMES AND DESERT INTRUSION FOR WATER RESOURCES

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Turk salty fiber concrete is designed to isolate retaining walls against saline materials. In 2018, TSFC mixture design was applied to the salt domes in the GOTVAND reservoir dam, SE of Iran in order to isolate them Enormous salt ridges were discovered inside the dam reservoir before construction operations began in 2005 which are also identifiable through the use of geotechnical maps. The designed mixture of TSFC contains salt stone (S), water (W), cement type II (CII), bentonite (B), clay (C) and cotton or synthetic fibers (F). In the laboratory, TSFC is produced taking into account the variable of saline water. The figure ζ is defined by the proportion of the weight of the salt and water over the weight of the combined mixture of cement, bentonite, clay and fibers. The maximum value ζ has been obtained as being a bit over 6.5 for laboratory samples. It means that more than 87% of the sample weight is related to saline water and 13% is related to other materials (CII, B, C and F). The axial load test is the main index to compare resistance with friction of salt formations. The results obtained show the axial resistance of broken TSFC samples to be more 12,000KPA. SEM images were taken to study TSFC adhesiveness between the salt and fibers. The SEM showed cubic crystallization which in itself supports the hypothesis of salty mummification due to the integrating of the salt concrete and fibers.

Keywords: Axial Load, Mixture, Injection, Salty Concrete, Mummy, Crystallization.

1 INTRODUCTION

Concrete structures are damaged by the salt water effects along coastlines. Chloride ions penetrate into concrete surface and bring about steel rebar corrosion. In order to protect the dry-wet zone against the incurring of extra costs and time, necessary preparation is required, Figure 2. The production of adhesive TSFC in recent years has led to a decline in sea water issues impact, in as such that it has been applied to stabilize salt domes, sinkholes, land slide stabilization, coastline protection and intrusion of deserts as a result of manmade droughts in Figure 1, (Turk 2017, 2018; Gutiérrez 2016). Although TSFC was initially believed that cement and salt do not have a strong adhesiveness, the primary design mixture which was composed of salt, cement, green bentonite and clay in 2016 showed that after saturation the concrete hardened perfectly and had no sedimentations. Mixture design samples were broken up to study the behavior of the modulus of elasticity under a compressive jack. The modulus of elasticity and axial stress fluctuated due to the sensitivity of clay and bentonite. Moreover, by adding fiber, a variation in the hardening behavior of the concrete was observed. Mechanical characteristics such as axial stiffness, integration resistance in saturation mode and mummifying also improved, (Saltmen 1993 and Waltari 1945). TSFC continuity cohesion was demonstrated by interpreting the results obtained through SEM- Scanning Electronic Microscopic images, (CENLAB 2019). Images portrayed the uniformity, mummifying, and fibers continuity.

Figure 1. TSFC stabilizing a salt desert against dust storm phenomena, EC=180’000 μs/cm, SW of Iran.

2 MATERIALS OF TSFC

TSFC improves and increases the modulus of elasticity and cohesion resistance during the saturation phase. Samples in Figure 5, have been immersed into water since 2016, (KTNSE 2016, 2018, 2019; Turk 2017, 2018; Report2 2017). Although, the samples are broken, all of them have stable shapes in the water. It has been proposed to use cotton or plastic fibers as additional material TSFC materials contain the Salt stone (S), Water (W), Cement type II or V (Cii, Cv), Shushtar ceramic Clay (C), Bentonite (B) and Fibers (F). Eq. (1) defines the main TSFC figure ζ_{Turk} which represents the amount of saline water in the sample. The values of ζ_{Turk} varies from 0.56 to 3.70 for fibers. Eq. (2) defines the TSFC resistance index which is represented by μ_{Turk}. Figure μ_{Turk} is the combination of the axial resistance of sample S950713 after 10 days of aging and ζ_{Turk1} shows the amount of saline water after 10 days of aging Table 1 presents the TSFC materials with the values of ζ_{Turk8} and μ_{Turk8} in the mixture design and the modulus of elasticity. Table 1 represents the behavior of materials vs the μ_{Turk1} of samples after 10 days of aging.

Table 1. Materials Percentages (%) of TSFC, (KTNSE 2019).

i	Sample	S (%)	Cii,v	B	C	W	F	ζ_{Turk}	θ_{Turk}	E (kg/cm²)	μ_{Turk}
1	950713	39	22v	228	0	17	0	1.30	57	-----	1.00
2	970301GS	40	19v	8	8	25	0	1.86	65	1’523	0.56
3	990706P	70.1	11ii	1.1	0.34	17.1	0.38	6.78	87.15	-----	1.39
4	980419C	45	19ii	8	8	20	0.11	1.90	66	24’000	1.53
5	970802GS	42	20v	8	8	22	0	1.78	64	-----	1.55
6	980701C	51	15ii	6	6	22	0.27	2.72	73	14’000	1.64
7	980710C	53	16ii	6	6	19	0.35	2.55	72	15’000 TA	2.02
8	981220P	71.24	10.7ii	1.35	0.52	15.8	0.39	6.69	87.00	21’000 TA	3.70

Figure 2. TSFC will be grouting in the salty layers to prohibit sea intrusion inside the aquifers.

$$\zeta_{Turk} = \frac{W_{SaltyWater}}{W_{Cii,B,C,F}} \tag{1}$$

$$\mu_{Turk,i}. = \frac{\sigma_i}{\sigma_{\sigma 10,95713}} \times \frac{\zeta_{\mathrm{Turk}}}{\zeta_{\mathrm{Turk}}} \quad ,\mathrm{i} = 1,2,3\ldots\ldots..,59 \tag{2}$$

3 TSFC ELASTICITY MODULUS

Samples were broken vertically so that the Modulus of Elasticity could be obtained directly from the linear part in Figure 4, and Eq. (3). Axial Stiffness K could be increased by index of μ_{Turk} up to a period of 120 days of aging. Figure K is denoted by Eq. (4) and is capable of being interpreted using the Step Stiffness Method -SSM, (Turk 2004). Figure F_Z in Eq. (4) represents the exerted vertical load in the z-z direction or as an injected wall in salt dome, Figure 2, Figure 3.

$$E_Z = \frac{d}{d\varepsilon} f(\sigma) = f'_{\sigma} = \Delta\sigma / \Delta\varepsilon = (\sigma_Y - \sigma_0)_Z / (\varepsilon_Y - \varepsilon_0)_Z \tag{3}$$

$$K = \frac{d}{d\delta} f(F_Z) = \Delta F_Z / \Delta_{\delta} = \frac{\sigma}{\varepsilon}\frac{A}{L} = E\frac{A}{L} \tag{4}$$

Figure 3. Breaking resistance of TSFC with reedy fibers, (Beer 2012).

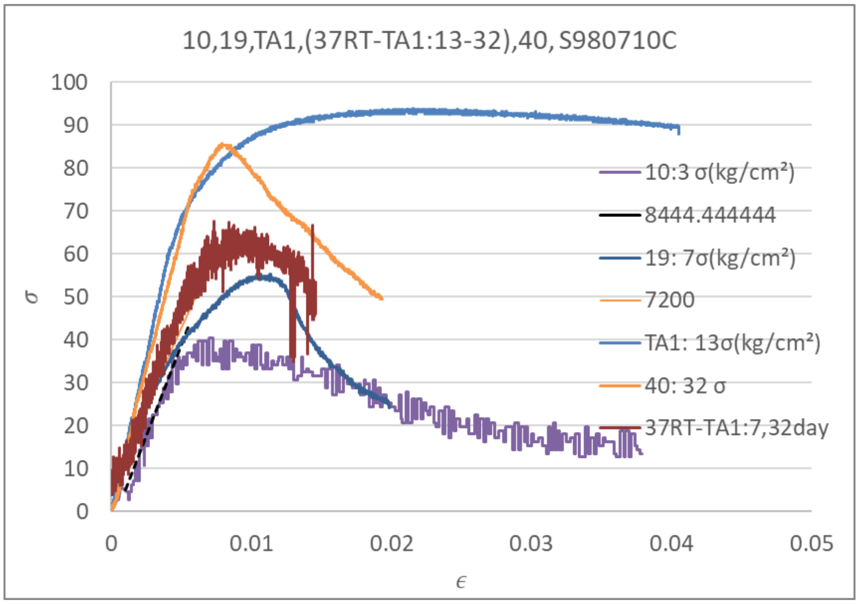

Figure 4. Mixture design of S980710C: μ=2.02, ζ=2.55, KTNSE (2019).

Figure 5. Sample 104-S990708PKII3 with reedy fibers prior to immersion in Water, KTNSE (2019).

4 SEM IMAGES

Figure 6 and Figure 7 are presented by SEM of 24-S980701C20 after 20 days of aging. Pictures were taken to study the micro behaviors of TSFC adhesiveness. It was observed that the nature of the cotton fibers had changed and had merged with the TSFC salt crystallizations. In other words, cotton fibers in the chemical composition of salt take on the characteristics of a salt mummy. It may be argued that the method of making TSFC is actually based on ancient mummification techniques (Waltari,1945; Saltmen ,1993). Figure 6 is an enlarged view showing the salt and fiber adhesion status (salt crystallizations). The fibers are interestingly combined with TSFC so that the fiber and the concrete are not distinguishable. Figure 5 shows a 20μm scale cotton fiber with salt crystals impregnated within it and completely transformed into salt concrete. Figure 7 also shows the cotton fibers from another angle. 24S980701C20 shows that the salt is wrapped around the cotton fiber and integrated with it. Salt penetrates the fibers to form a uniform mixture which is parallel to the method of mummification practiced in the ancient past.

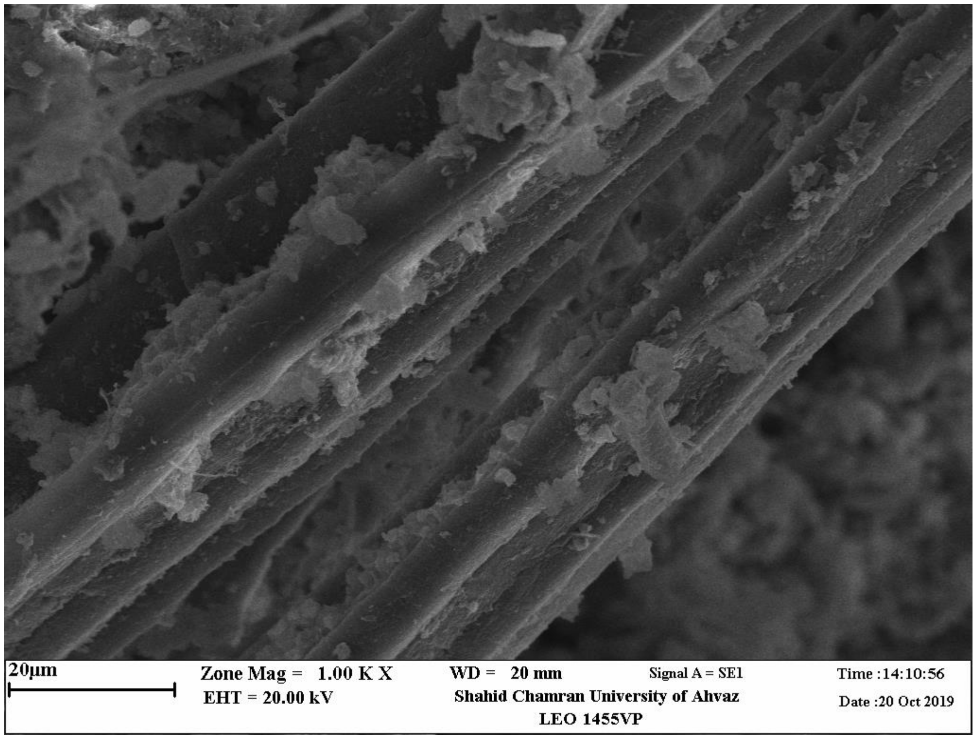

Figure 6. Zoom of S980701C20 Cotton Fibers inside the TSFC (CENLAB 2019).

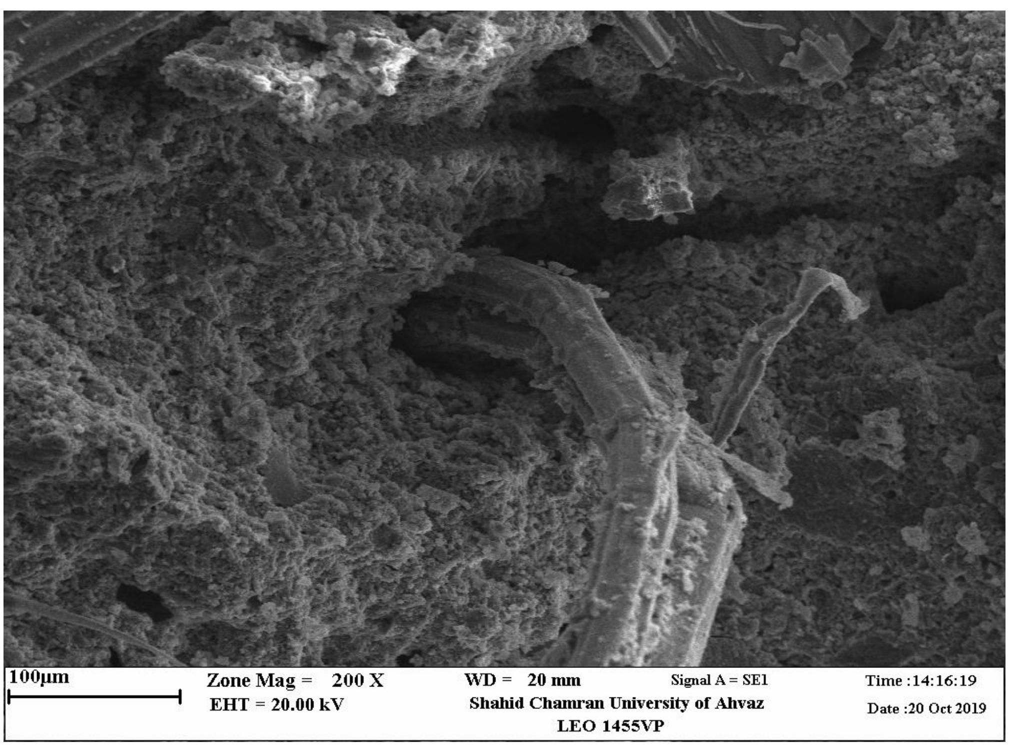

Figure 7. S980701C20 Cotton Fibers inside the TSFC (CENLAB 2019).

5 CONCLUSION

Table 1 is described μ_{Turk} and ζ_{Turk} that both are interpreted the TSFC behaviors. The salt ratio to other materials such as cement, bentonite and clay is increasing. Modulus of elasticity with salt ratio has been rising. Tri-axial tests result show that the lateral pressures greatly improve the elasticity and other properties of the TSFC more than 200%. It is therefore recommended that high-pressure injection be performed at several stages to remove excess TSFC water contain. This method can increase the injection efficiency in aquifers near the shorelines. Sea water makes a great disaster with intrusion into the underground fresh water. Based on the laboratory outcomes, TSFC has the ability to retrieve itself cracks after the initial breaking, and the TSFC regains its initial strength after a few days. This fact is illustrated by Figure 4 (curve 37RT-TA1-7-32). This property can be very useful in salty desert stabilization and coastlines layers that are restored after TSFC cracking. Scanning Electronic Microscopic -SEM- images can be used to show better adhesion of TSFC materials. The samples are remarkably mixed and difficult to separate. The salt penetrates into the cotton (or reedy) fibers and ties with them. Salt crystallization is shown by SEM, which means that the ions are uniformly arranged. Based on the study and behavior of laboratory specimens as well as SEM images, it can be claimed that TSFC is made as same as an ancient secret mummy.

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