A REVIEW PAPER ON EFFECT OF SALINE WATER ON CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME AND FINE AGGREGATE WITH STONE DUST

[1]Satish Kumar Vishwakarma, [2]Dr. Syed Aqeel Ahmad, [3]Anwar Ahmad, [4]Rajiv Banerjee
[1]Student M. Tech (Structural Engineering), [2]Professor, [3] Associate Professor, [4]Associate Professor
[1]Department of Civil Engineering
[1]Integral University, Lucknow, India

***ABSTRACT*:** The fresh-fresh water situations occur in building constructed on hinterlands and main lands. The fresh-salt water situations are mainly in structures or building close to lagoon or sea. The salt-fresh water situations are very rare in practice, but are well pronounced in areas where there is scarcity of fresh water or the available surface water is salty. The salt-salt water situations are visible mostly in structures built in ocean or sea. In addition, higher concrete cover can be provided when designing the member with increased environmental awareness and its potential hazardous effects, utilization of industrial by products has become an attractive alternative to disposal. Silica fume(SF), which is by product of the smelting process in the silicon and ferrosilicon industry. Silica fume is very effective in the design and development of high performance concrete. This paper presents the results of an experimental investigations carried out to find the suitability of silica fume in High Performance concrete. The incorporation of silica fume into the normal concrete is a routine one in the present days to produce the tailor made high strength and high performance concrete. The design parameters are increasing with the incorporation of silica fume in conventional concrete and the mix proportioning is becoming complex.

***Index Terms*: Saline Water, Silica Fume, Cement, Sand, stone dust.**

I. INTRODUCTION

Concrete is the most widely used construction material all over the world. It is difficult to find out alternate material for construction which is as suitable as that of such material form durability and economic point of view. The quantity of the water plays an important role in the preparation of concrete. Impurities in water may interfere the setting of the cement and may adversely affect the strength properties. The chemical constituents present in water may participate in the chemical reactions and thus affect the setting, hardening and strength development of mixture. The IS: 456(2000) code stipulates the water quality standards for mixing and curing. Nowadays, as development strides increase, lots of engineering construction including high rise building, embankment walls, and bridges are going on along the coastal belt of many countries. In coastal areas, there has always been a deficiency of fresh water as the available water is contaminated by sea salts. But sea water contains large amount of sea salts, which may have adverse effects on the properties of concrete. Sea water has a salinity property because of the quantity of chlorides in the water which tend to cause persistent dampness and efflorescence on concrete. Most sea waters are fairly uniform in chemical composition, which is characterized by the presence of about 3.5% soluble salts by weight. However, from the standpoint of aggressive action to cement hydration product, the pH of seawater varies between 7.4 and 8.4. At exceptional conditions, pH value lower than 7.5 may be encountered and this occurs due to a higher concentration of dissolved CO2, which would make the seawater more aggressive to Portland cement concrete. Portland Cement Concrete production is the second only to the automobiles as the major generator of CO2, which pollutes the atmosphere. In addition to that large amount of energy is also consumed for the concrete production. With an increased global focus on environmental concerns such as global warming, sustainable development and recycling; alternatives to conventional concrete are being researched, such as Ceramic concrete. Pozzolans are siliceous and aluminous material which possess little cementitious properties which will in finely form with the presence of water, react chemically with calcium hydroxide (Cement) at ordinary temperatures to form compounds possessing cementitious properties

II. LITERATURE REVIEW

Asiwaju-Bello, Oladimeji Olalusi, Festus Olutoge (2017) In this study the cement has been replaced with ceramic waste powder accordingly in the range of 0%,5%, 10%, 15%, 20%, and 30% by weight for concrete which was cured for 56 days in two liquid media (fresh and salt water). The findings revealed that use of waste ceramic enhances the properties of concrete cured both in fresh and salt water media, based on the results from the compressive test, higher compressive strength occurred in concrete cured in salt water than fresh water. The results demonstrate that the use of ceramic powder as active replacement endows cement with positive characteristics like major mechanical strength and the economic advantages.

Prakash R. (2017) In this study the compressive strength of HPC with silica fume of 15% replacement by the weight of cement and quarry dust as partial and full replacement of fine aggregate is investigated. Results were found that the silica fume is beneficial to concrete in increasing the compressive strength of concrete and quarry dust replacement further increasing the compressive strength of high performance concrete. A compressive strength of 23% is increased due to inclusion of silica fume and 12.4 % is increases due to the replacement of quarry dust.

P. Ramya Sree, Arunika Chandra, B.L.P Swamy, M. Bhaskar (2016) Change has been a constant parameter within the concrete industry in view of increasing construction activities and most importantly an increased thrust in high quality yet economic structures. This change has thus, brought along with it, different trends in concrete technology with respect to the way in which it is perceived and more technically, its composition, its handling, mixing etc. As a result, we have today, different types of ordinary concrete. In this report, we focus and emphasize on Triple Blended Concrete, its meaning, materials involved, process of casting, testing, salient features etc.

Ram Kumar, Er. Jitender Dhaka (2016) The aim of this study is to evaluate the performance of Silica Fume an industrial by product as a admixture in concrete keeping in view the increasing market demand of cement which compel production of cement at large scale resulting in environmental problem and depletion of natural resources on one hand and rising prices on the other hand. To overcome these problem ideas developed to investigate the use of industrial by product/waste. The silica fume industrial by product found to be an attractive cementations material which is by product of smelting process in the silicon and ferrosilicon industry. The partial replacement of silica fume and its effects on concrete properties has been studies by adopting M-35 concrete mix in this dissertation. The main parameter investigated in this study M-35 concrete mix with partial replacement by silica fume with varying 0, 5, 9, 12 and 15% by weight of cement The paper presents a detailed experimental study on compressive strength, flexural strength and split tensile strength for 7 days and 28 days respectively. The results of experimental investigation indicate that the use of silica fume in concrete has increased the strength and durability at all age when compared to normal concrete.

Praveer Singh, Mohd. Afaque Khan, Abhishek Kumar (2016) This research review represents the collection of data from various previous studies done on the compressive strength, flexural strength, tensile strength testing of concrete incorporating silica fume by optimum replacement of cement. Portland cement is now days partially replaced by silica fume, a by-product from silicon alloy factories. From various studies Silica fume is a non-metallic and nonhazardous material having very large surface area which is suitable for concrete mix. This concretes such as triple blended concrete, self-compacted concrete, bacterial concrete etc. which have, in their own respective manner, succeeded in enhancing the serviceability of the structure with which they are built, in comparison to review paper is a good source for understanding the effect on optimum replacement of cement by silica fume.

Mr. K. J. Kucche, Dr. S. S. Jamkar, Dr. P. A. Sadgir (2015) describes this paper reviews the literature related to quality of water for making concrete. The allowable limits of physical and chemical impurities and the test methods of their evolution are compiled. The limits of impurities as per Indian, Australian, American and British standards are presented. From the literature it is seen that, the reaction between water and cement affect the setting time, compressive strength and also lead to softening of concrete. All the impurities may not have adverse effect on the properties of concrete. The use of impure water for concrete mixing is seen to favorable for strength development at early ages and reduction in long term strength.

Nasratullah Amarkhail (2015) The main objective of this study was to determine the optimum percentage of silica fume to replace cement in order to improve the properties of hardened high-strength concrete. To fulfill the objective, some properties of concrete containing silica fume were evaluated after 7, 28 and 60 days of curing. Furthermore, comparison between regular concrete and silica fume concrete containing different levels of silica fume content (5%, 10% and 15%) was conducted. The water/binder ratio was kept constant at 0.3 throughout the mixing process. The results of this research work indicate that compressive strength and flexural strength exhibited the highest improvement with 10% and 15% silica fume replacement respectively. This paper can be a useful source of information for other researchers to understand the benefits and adverse effects of silica fume and have an overview of its optimum percentage when dealing with concrete.

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Anurag Jain, & Anurag Jain (2015) This paper reports the results of compressive strength data on 4- to 6-year-old cores obtained from well-documented field experiments and innovative materials. Based on the proportion of ingredients used in concrete, its properties can also be changed. In most of the building works normal concrete is used. This project work concentrates on the effective use of Silica Fume and Quarry Dust in concrete mix. The main parameter investigated in this study is M20 grade concrete with partial replacement of cement by silica fume by 0, 10 and 15%and Quarry dust by 20, 30, and 40%.

G. R. Otoko (2014) Results of laboratory investigation are presented to show that plasticity index decreased from 13 using tap water to 5 using salty water for the clay, from 10 using tap water to 4 using salty water for the clayey sand and from 6 using tap to 1 using salty water for the base course. The maximum dry unit weight was in the order of 20.9, 22.5 and 19.5kN/m3 for the clay, clayey sand and base course respectively when mixed with tap water. Using salty water, decreased the maximum dry unit weight for the clay from 20.9kN/m3 to 17.5kN/m3, but increased that of clayey sand and base course from 19.1kN/m3 to 20.4kN/m3 and from 22.5kN/m3 to 23.2kN/m3 respectively. The unconfined compressive strength increased from 30kN/m2 to 57kN/m2, 83kN/m2 to 130kN/m2 and 40kN/m2 to 63kN/m2 respectively, for the clay, base course and clayey sand when mixed with salty water, in comparison with when mixed with tap water. It is therefore concluded that the Atlantic Ocean salty water could be a good stabilizing agent, particularly when construction work is close to the Atlantic shore.

Preeti Tiwari, Rajiv Chandak, R.K. Yadav (2014) describes this research work, the effect of salt water on the compressive strength of concrete was investigated. This paper therefore presents the result and findings of an experimental research on the effect of salt water on compressive strength of concrete. For this concrete cubes were cast using fresh with and salt water for a design mix of M-30 1:1.8:3.31 by weight of concrete, and 0.45 water- cement ratio. Half of concrete cubes were cast and cured with fresh water and remaining half cubes were cast and cured with salt water. The concrete cubes were cured for 7,14 and 28 days respectively. The result of the average compressive strength of concrete obtained using fresh water ranges from 27.12 - 39.12N/mm2 and using salt water ranges from 28.45 – 41.34N/mm2.

Vishal S. Ghutke, Prof. Pranita S.Bhandari (2014). It has been seen that when cement is replaced by silica fume compressive strength increases up to certain percentage (10% replacement of cement by silica fume). But higher replacement of cement by silica fume gives lower strength. The effect of Silica fume on various other properties of Concrete has also been evaluated. This paper is a very good tool for the beginners to understand the effect and have an overlook of Silica Fume on Concrete.

Olutoge, F. Adeyemi and Amusan, G. Modupeola (2014) This paper presents the experimental investigations on the effect of sea water on the compressive strength of concrete. Cement concrete cubes of 150mm x 150mm x 150mm were cast using fresh water and sea water with mix ratio 1:2:4. All the mixes were prepared using constant water cement ratio (w/c) of 0.6 by weight. A total of 140 concrete cubes were made in two batches; half of the cubes were made using fresh water and the other half using sea water. They were cured in fresh and sea water respectively. The curing was done for 7, 14, 21, 28 and 90days, then crushed using the Compressive Strength Test Apparatus at prescribed ages. The study shows an increase in the compressive strength of concrete for concrete specimens mixed and cured with sea water. Compressive strength of the concrete was also affected when the concrete was cast with fresh water and cured with salt water and vice-versa.

Lakshmi Kumar Minapu, M K M V Ratnam, Dr. U Rangaraju (2014) These may relate of both structural integrity & serviceability. More environmental and economic benefits can be achieved if waste materials can be used to replace the fine light weight aggregate. The new sources of Structural aggregate which is produced from environmental waste is Natural aggregates, synthetic light weight aggregate The use of structural grade light weight concrete reduces the self-weight and helps to construct larger precast units. In this study, an attempt has been made to study the Mechanical Properties of a structural grade light weight concrete M30 using the light weight aggregate pumice stone as a partial replacement to coarse aggregate and mineral admixture materials like Fly Ash and Silica Fume. For this purpose, along with a Control Mix, 12 sets were prepared to study the compressive strength, tensile strength and flexural strength. Each set comprises of 4 cubes, 2 cylinders and 2 prisms. Slump test were carried out for each mix in the fresh state.

Devaraj P Kumbar and V D Gundakalle (2013) describes the sand and gravel has increased at an annual rate of less than 1 percent. In essence the amount of crushed stone to be produced in the next 20 years will equal the quantity of all stone produced during the previous century, i.e., about 36.5 billion metric tons. Therefore, the use of alternative sources for natural aggregates is becoming increasingly important (NSA, 1982). In the present study the mechanical properties of concrete by replacing cement with different percentages of Silica fume and aggregate by different percentages of Steel slag are studied. The results thus obtained are analyzed using Regression analysis. Results indicated that the replacement of cement by silica fume to the extent of 15% exhibited improved mechanical properties. Further, it has been also observed that with 15% replacement of cement by silica fume and replacement of natural aggregates by steel slag aggregates to the extent of 25% to 50% have shown improved strength compared normal concrete i.e. the concrete with 0% silica fume and 0% steel slag aggregates. Regression analysis has been carried out to compare the experimental results.

T. Shanmuga priya, Dr.R.N.Uma (2013) The concrete used in this investigation was proportioned to target a mean strength of 60 MPa and designed as per ACI 211.4R-08. The water binder ratio (W/B) adopted was 0.32 and the Super Plasticizer used was CONPLAST SP 430.Specimens such as cubes, beams and cylinders were cast for various mix proportions and tested at the age of 7,14and 28 days. The investigation revealed that the partial replacement of cement by silica fume will develop compressive strength, flexure strength and split tensile strength sufficient for construction purposes. The optimum dosage of silica fume found to be 7.5% (by weight), when used as partial replacement of ordinary Portland cement. Its use will lead to a reduction in cement quantity required for construction purposes and hence sustainability in the construction industry as well as economic construction.

Debabrata Pradhan, D. Dutta (2013) The main objective of this paper has been made to investigate the different mechanical properties like compressive strength, compacting factor, slump of concrete incorporating silica fume. In this present paper 5 (five) mix of concrete incorporating silica fume are cast to perform experiments. These experiments were carried out by replacing cement with different percentages of silica fume at a single constant water-cementitious materials ratio keeping other mix design variables constant. The silica fume was replaced by 0%, 5%, 10%, 15% and 20% for water-cementitious materials (w/cm) ratio for 0.40. For all mixes compressive strengths were determined at 24 hours, 7 and 28 days for 100 mm and 150 mm cubes. Other properties like compacting factor and slump were also determined for five mixes of concrete.

Darun S K & Dr. D. Sharmila (2013) The problem with this technology is that it is expensive and uses a lot of energy. Scientists are working toward better processes where inexpensive fuels can heat and evaporate the water before running it through membranes with microscopic pores to increase efficiency. My idea is that when (Nano Graphene Pores) When water molecules (red and white) and sodium and chlorine ions (green and purple) encounter a sheet of graphene (pale blue, center) perforated by holes of the right size, the water passes through, but the sodium and chlorine of the salt are blocked. So by using my idea we can get the pure water and block the unwanted sea water. So by using this method the result achieved is that we can convert the salt water into pure water by this method easily instead of the Desalination method which are been used in the several countries.

Dilip Kumar Singha Roy, Amitava Sil (2012) This paper features an experimental study on the nature of SF and its influences on the properties of fresh and hardened concrete. In the present study, an attempt has been made to investigate the strength parameters of concrete made with partial replacement of cement by SF. Very little or no work has been carried out using silica fume as a replacement of cement. Moreover, no such attempt has been made in substituting silica fume with cement for low/medium grade concretes (viz. M20, M25). Properties of hardened concrete. Ultimate Compressive strength, Flexural strength, Splitting Tensile strength has been determined for different mix combinations of materials and these values are compared with the corresponding values of conventional concrete. The present investigation has been aimed at to bring awareness amongst the practicing civil engineers regarding advantages of these new concrete mixes. Hassan A. Mohamadien (2012) The possibility of using it and silica fume (S.F) separately as partial replacement of cement on mortar were studied and evaluated based upon the percentage of the partial cement replacement with both marble powder and silica fume separately. Four types of mortar mixture with same workability, cement to sand ratio of 1:3 and water to cementitious materials ratio of 0.4 were prepared marble powder and silica fume used in mixes separately, once as a partial replacement of cement content and another as an addition to the mix proportion. Replacement and addition ratio of both marble powder and silica fume with cement content separately at 0%, 5%, 10%, 15%, 20%, 30% and 50 % by weight were investigated. The mechanical properties of mortar were measured in terms of compressive strength at 7 and 28 days and it was observed that the strength developments at 7, and 28 days and the highest development rate of compressive strength was observed at 15% replacement ratio for each the marble powder and silica fume separately. Results showed that the compressive strength increased by 31.4%, 48.3% at 7, and 28 days respectively at 15% replacement ratio of silica fume with cement content and in case of replacement marble powder with cement content the compressive strength increased by 22.7%, 27.8% at 7, and 28 days at 15% replacement ratio of marble powder with cement content respectively.

N. K. Amudhavalli, Jeena Mathew (2012) describes the Portland cement is the most important ingredient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. This threat to ecology has led to researchers to use industrial by products as supplementary cementations material in making concrete. The main parameter investigated in this study is M35 grade concrete with partial replacement of cement by silica fume by 0, 5, 10,15and by 20%. This paper presents a detailed experimental study on Compressive strength, split tensile strength, flexural strength at age of 7 and 28 days. Durability study on acid attack was also studied and percentage of weight loss is compared with normal concrete. Test results indicate that use of Silica fume in concrete has improved the performance of concrete in strength as well as in durability aspect.

Md. Moinul Islam, Md. Saiful Islam, Md. Al-Amin and Md. Mydul Islam (2011) describes the Construction officials in coastal areas have long been facing the challenge of building and maintaining durable concrete structures in a saltwater environment. Gradual penetration of sea salts and the subsequent formation of expansive and leachable compounds lead to disintegration of structural concrete. As a part of durability study, this paper describes the effect of sea water on compressive strength of concrete when used as mixing and curing water. Concrete specimens were cast from four different grades and plain water as well as sea water was used as mixing water in making the test specimens. Test specimens were cured under sea water as well as plain water up to 180 days. Test results indicate that sea water is not suitable for mixing as well as curing of concrete. Concrete specimen made and cured with sea water exhibits compressive strength loss of about 10% compared to plain water mixed and cured concrete.

E.M. Mbadikea, A.U. Elinwab (2011) In this research work, the effect of salt water in the production of concrete was investigated. A total of ninety (90) concrete cubes were cast for compression strength test i.e. forty-five cubes were cast using fresh water and the other forty-five cubes were also cast using salt water. Similarly, a total of ninety (90) concrete beams were cast for flexural strength test i.e. forty-five beams were cast using fresh water and the other forty-five beams were also cast using salt water. The concrete cubes and the beams were cured at 7,21,28,60 and 90 days respectively. The result of the average compressive strength of concrete obtained using fresh water of mix ratio (1: 1.51: 4.01), water cement ratio (0.47) ranges from 27.35-42.34N/mm2 while that of salt water ranges from 25.24-38.81N/mm2 for the hydration period of 7, 21, 28, 60 and 90 days. The flexural strength of concrete obtained using fresh water of the same mix ratio and water cement ratio ranges from 6.60 - 11.20N/mm2 for 7, 21, 28, 60 and 90 days' hydration period while that of salt water ranges from5.98-11.04N/mm2 for the same hydration period. For the mix ratio (1: 1.61 :4.03) and water cement ratio (0.55), the average compressive strength of concrete obtained using fresh and salt water ranges from 27.26 - 40.80N/mm2 and 24.68 -39.13N/mm2 respectively while the flexural strength ranges from 6.55 - 11.13N/mm2and 6.26 - 10.76N/mm2 for fresh and salt water respectively. For the mix ratio (1: 1.66 4.24) and water cement ratio (0.50), the average compressive strength of concrete obtained using fresh and salt water ranges from 25.05 - 38.13N/mm2and 23.58 - 36.03N/mm2 respectively while the flexural strength ranges from 6.18- 9.88N/mm2 and 6.15 - 10.39N/mm2 for fresh and salt water respectively. The initial and final setting time of cement using fresh water is 50mins and 587minswhile that of salt water is 55mins and 605mins respectively.

K. Perumal, R. Sundararajan, (2004) In the recent past, there has been considerable attention for improving the properties of concrete with respect to strength and durability, especially in aggressive environments. High performance concrete (HPC) appears to be better choice for a strong and durable structure. Suitable addition of mineral admixtures such as silica fume (SF), ground granulated blast furnace slag and fly ash in concrete improves the strength and durability of concrete due to considerable improvement in the microstructure of concrete composites, e specially at the transition zone Very few studies have been reported in India on the use of SF for development of HPC and also durability characteristics of these mixes have not been reported. In order to make a quantitative assessment of different cement replacement levels with SF on the strength and durability properties for M60, M70 and M11 0 grades of HPC trial mixes and to arrive at the maximum levels of replacement of cement with SF, investigations were taken. This paper reports on the performance of HPC trial mixes having different replacement levels of cement with SF.

Pedro Nel Quiroga and David W. Fowle (2003) describes the aggregate shape, texture, and grading have a significant effect on the performance of fresh concrete. Aggregate blends with well-shaped, rounded, and smooth particles require less paste for a given slump than blends with flat, elongated, angular, and rough particles. At the same time, uniform grading with proper amounts of each size Result in aggregate blends with high packing and in concrete with low water demand. Optimized aggregate blends have high packing, requiring low amounts of paste. As a result, they are less expensive and will have less durability problems caused by the paste such as heat generation, porosity, and drying shrinkage

Obi Lawrence E. (2000) describes this research empirically investigated on how the compressive strength of concrete can be affected when they were produced with water of different qualities and sources. The water collected was of different qualities and sources and presented as salt water from Abnormal, runoff water from University farm catchment and fresh water from Onumiri Spring water. The chemical compositions of these water qualities were analyzed while 48 concrete cubes were produced at a ratio of 1:2:4 using each water quality type. The cubes were cured and crushed at 7, 14, 21 and 28 days with the resulting compressive strength. It was observed that the concrete produced with salt water and run-off water had their compressive strengths gradually increased in 7 days but decreased drastically at 14 and 21days age. However, concrete cubes obtained from fresh water gained appreciable strength with age. With the result of this research, it is recommended that fresh water and water without obvious concrete- inimical substances are used in concrete batching.

James M. Aldred, S. Swaddiwudhipong, S. L Lee, And T. H. Wee (2000) Silica fume reduced water transport under all test regimes and regardless of initial moisture condition. Ten percent silica fume replacement in concrete with a water-binder ratio (w/b) of 0.6 was found, in general, to have water transport properties similar to ordinal Portland cement (OPC) concrete with a w/b of 0.4. Unlike OPC concrete, however; the rate of wick action and moisture flow in silica fume concrete was relatively unaffected by initial moisture content. This suggests that its lower rate of desorption may limit the rate of water transport through saturated silica & me concrete. While water transport properties of silica fume concrete were generally detrimentally affected by the inclusion of a drying cycle and any resultant micro cracking, any detrimental influence was similar to or less than that observed with the reference OPC concrete. Accordingly, silica fume concrete did not appear particularly sensitive to micro cracking, although it was affected by limited early curing.

Donald F. Griffin and Robert L. Henry (1964) describes the purpose of this investigation was to determine the effects of sodium chloride and sea-water salts separately in concrete. The investigation covered the effects of salt on the compressive strength and water vapor transmission (WVT) of concrete, as well as the corrosive effects of salt on mild reinforcing steel. Variables included water-cement ratio, salinity of mixing water, and diameter and thickness of the specimens. The test environments included 20, 50, and 75 percent RH at 73.4 F. The data presented herein supports the general conclusion stated in a previous report, namely, that at a mixing-water salinity of approximately 25 grams• of salt per kilogram of solution, compressive strength is increased, WVT is minimized, and corrosion of mild steel is not significant.

III. CONCLUSION

It is concluded that the performance of silica fume concrete with respect to the cube and cylinder compressive strength is superior when the percentage replacement of cement with silica is 5%, 10%, 15%, 20%. The compressive strength attained in 7 days was 33% of its maximum strength attained in 28 days. The use of salt water should be welcome and not feared for casting and curing of concrete during construction most especially in coastal environment. Water/Cement ratio that will give the minimum value of slump with adequate workability as well as minimum cement content should be used with maximum aggregate size in order to minimize the shrinkage cracking. It is concluded that the performance of silica fume concrete with respect to the cube and cylinder compressive strength is superior when the percentage replacement of cement with silica fume is 13%. The compressive strength attained in 7 days was 44.4% of its maximum strength attained in 28 days.

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