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# **ENGINEER**

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**TEXNIKA FANLARI DOKTORI, PROFESSOR  
MIRAXMEDOV MAXAMADJON MIRAXMEDOVICH  
TAVALLUDINING 80 YILLIGIGA BAG'ISHLANGAN  
“SAMARALI QURILISH MATERIALLARI, KONSTRUKSIYALARI VA  
TEKNOLOGIYALARI”  
MAVZUSIDAGI XALQARO ILMIY-AMALIY KONFERENSIYASI  
ILMIY ISHLARI TO'PLAMI**

Toshkent davlat transport universiteti RAASN akademigi, O'zbekistonda xizmat ko'rsatgan yoshlar murabbiyi, texnika fanlari doktori, professor Miraxmedov Maxamadjon Miraxmedovich tavalludining 80 yilligiga bag'ishlangan, ilmiy ishlar to'plami nashr etilishi ko'zda tutilgan «Samarali qurilish materiallari, konstruksiyalari va texnologiyalari» mavzusidagi Xalqaro ilmiy-amaliy konferensiyani o'tkazishni rejalashtirmoqda.

M.M. Miraxmedov kompozitsion qurilish materiallarining polistruktura nazariyasini rivojlantirishga salmoqli hissa qo'shgan. Uning qurilish materialshunosligi sohasidagi ilmiy hissi e'tirofi sifatida 1995-yilda Rossiya arxitektura va qurilish fanlari akademiyasining (RAASN) xorijiy a'zosi etib saylangan. M.M. Miraxmedov 6 ta monografiya, 200 dan ortiq ilmiy maqolalar va 25 ta ixtiroga mualliflik guvohnomalari muallifidir.

Ushbu konferensiyaning asosiy maqsadi - qurilish materialshunosligi, bino va inshootlarni loyihalash va qurilish sohasidagi ilmiy tadqiqotlar natijalarini, shuningdek, muhandislik ta'limini takomillashtirish yo'llarini muhokama qilishdan iborat.

Konferensiya ishida ishtirok etish uchun oliy o'quv yurtlari va ilmiy tadqiqot institutlari olimlari, O'zbekiston Respublikasi va xorijiy davlatlarning ishlab chiqarish vakillari, ilmiy tadqiqotlarda salmoqli natijalarga ega bo'lgan mutaxassislar taklif etiladi.

**“Samarali qurilish materiallari, konstruksiyalari va texnologiyalari”** mavzusidagi xalqaro ilmiy-amaliy konferensiyaning asosiy yo'nalishlari quyidagilardan iborat:

1. Resurs va energiya tejovchi qurilish materiallari va texnologiyalari.
2. Atrof-muhitning transport infratuzilmasiga ta'siri va uni himoya qilish usullari.
3. Bino va inshootlarning qurilish konstruksiyalari: hisoblash va loyihalashning zamonaviy usullari.
4. Arxitektura, shaharsozlik va shahar muhitini rivojlantirish.
5. Qurilishni tashkil etishning innovatsion usullari va qurilish jarayonlari texnologiyalari.
6. Transport obyektlarini loyihalash va qurishda raqamli texnologiyalar hamda sun'iy intellekt.
7. Temir yo'l transporti infratuzilmasi obyektlarini loyihalash, qurish va ekspluatatsiya qilish.
8. Zamonaviy muhandislik ta'limi tizimini takomillashtirish.

Mazkur konferensiya ilmiy hamjamiyatning turli vakillarini bir joyga jamlab, qurilish materialshunosligi sohasidagi zamonaviy muammolar va istiqbollarni muhokama qilish uchun qulay platforma vazifasini bajardi.

# The Effect of Heavy-Duty Pavement Concrete Mix Composition on its Physico-Mechanical Properties

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**Abstract:** This article examines the differences in strength and porosity throughout the entire thickness of the upper and lower layers formed by the vibratory compaction of a cement-concrete pavement mixture with a non-optimal composition. Research has also been conducted to determine the effect of the sand content in the aggregate on the physical and mechanical properties of concrete mixtures for roads designed for heavy loads. Based on these studies, recommendations have been developed for optimizing the composition of road concrete and determining the integral service life of cement-concrete road pavements.

**Keywords:** Optimal composition, delamination, vertical deformation, sand fineness, enriched sand, bulk density, granularity, ease of laying, volume of absorbed air, strength

## 1. INTRODUCTION

In the Republic of Uzbekistan, economic growth, the development of transport infrastructure, an increase in the intensity of traffic on roads, an increase in the volume of transportation of heavy goods, climate change are the causes of many defects on the roads. In addition to domestic and world experience, according to scientists of the republic, the large-scale use of cement concrete coatings is not only a solution to existing problems, but the use of local materials in the preparation of the mixture serves to save money[1]–[7].

Therefore, many of our highways are being reconstructed, and these roads are being changed from asphalt concrete to cement concrete. This, in turn, creates all-round convenience in the transportation of cargo and passengers. However, the construction of cement concrete roads is a somewhat complicated technological process.[1], [8].

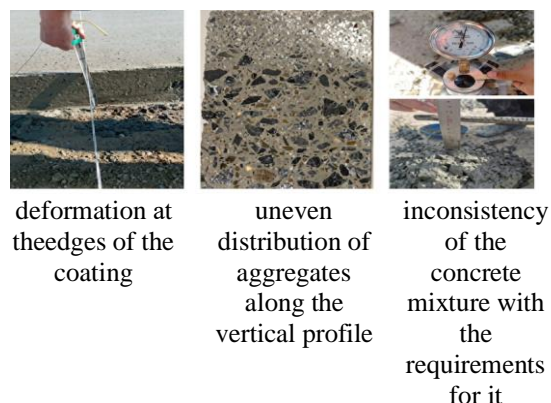
## 2. THE MATERIALS AND METHODS OF RESEARCH

Due to the low cost of operation, resistance to many deformations and high loads, resistance to external climatic factors (especially in dry-hot climates), increasing strength over time, high water permeability, cement concrete pavements are preferable to other types of concrete pavements.

As a result of the use of local materials in the design of the optimal composition of concrete, with the use of modern technologies, it is possible to increase the strength of concrete, the necessary mobility of the concrete mixture and the efficiency of concrete (minimum consumption of cement). When choosing the composition of the concrete mixture, it is necessary to correctly estimate the consumption of

cement and take into account several criteria of the water-cement ratio [9-13].

In the dry-hot climatic conditions of Uzbekistan, some disadvantages arose as a result of the use of a non-optimal composition of the road-concrete mixture used in the construction of roads with cement-concrete pavement (Figure 1).



**Fig. 1. Some of the disadvantages caused by the use of non-optimally selected concrete mix composition**

Concrete that is slipformed to form a stable structure requires small aggregates, especially to fill the voids left by large aggregates [7-8].

If the aggregates contain too many fine particles, the mixture may delaminate due to vibration during paving, which leads to layer of sand and cement on top of the pavement. This layer may lead to cracking within hours of application (plastic shrinkage cracks) and/or possible premature cracking.

According to the results of numerous tests, it can be said that the strength of the upper layer of the concrete pavement can be up to 10% less than the lower layer. In

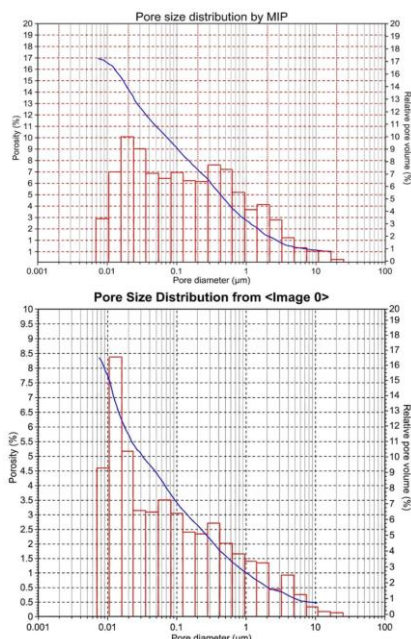
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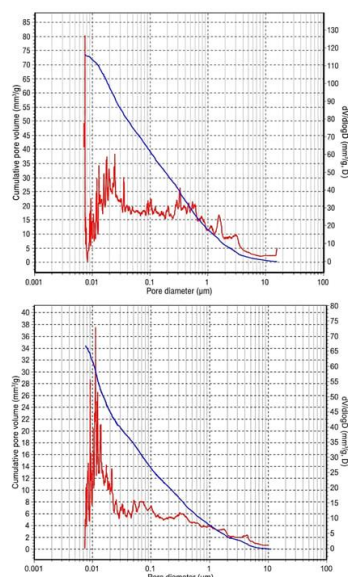


addition, the micro-porosity of the upper layer increases and becomes prone to destruction.

Fig. 2 and 3 show a comparative histogram of the porosity of samples taken from the upper and lower layers of the cement-concrete pavement and a graph of the distribution of porosity at different sizes.



**Fig. 2. Comparative histogram of porosity in samples taken from the upper and lower layers of cement-concrete pavement: a) upper layer; b) lower layer**

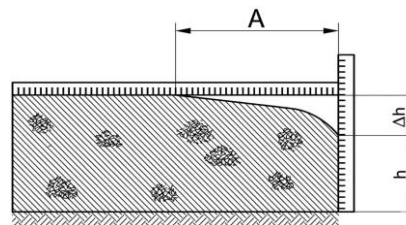


**Fig. 3. Distribution graph of pore sizes in samples taken from the upper and lower layers of cement-concrete pavement: a) upper layer; b) lower layer**

After the passage of the sliding formwork, stresses and deformations occur in the newly formed concrete slab due to its own weight. This causes the vertical edges and edges of the coating to bleed. The value  $\Delta h$

and the actual thickness- $h$  of the edges of the newly formed concrete pavement are measured after the spreading of the edges of the slab is completed (Fig. 4). The relative vertical deformation of the edge of the coating [14] is determined by the following formula (1):

$$\varepsilon = \frac{\Delta h}{h} 100 \quad (1)$$



**Fig. 4. Scheme for measuring the deformation of the edges of the pavement**

These technological properties of the concrete mixture are significantly positively affected by the relative proportion of sand in the aggregates, the fineness of the sand and the amount of entrained air. In addition, with a decrease in the mobility of the concrete mixture and the size of the flint (gravel), the stability of the edges and side faces of the newly formed concrete slab increases. The consumption of the concrete mixture is selected in accordance with the accepted speed of laying the concrete paver.

In Central Asia, for the manufacture of concrete, mainly river, mountain or barren sands are used. The composition of the sand used for concrete must be clean. Dust with clay particles covers the surface of the grains of sand and prevents their adhesion to the cement stone, reduces the strength of concrete [15-17].

### 3. RESULTS AND DISCUSSION

According to the composition we have chosen, 2 types of sand produced by “POMEGRANATE” LLC and “GRANITE-MINING” LLC were taken as a fine aggregate. Although these sands meet the requirements of GOST 8736-2014 and GOST 31424-2010 in certain parameters, they do not meet the requirements of GOST 26633-2012. Therefore, by mixing these sands in a certain amount, sand was created that meets the requirements of GOST 26633-2015 [18-20].

When used as a cement concrete filler, sand must comply with the requirements of GOST 26633-2015 (Fig. 5).

When checking the properties of sand obtained by mixing both sands in an amount of 60/40%, the test results showed that the sand meets the requirements of GOST 26633-2015 for fine aggregates for cement concrete (Fig. 5).

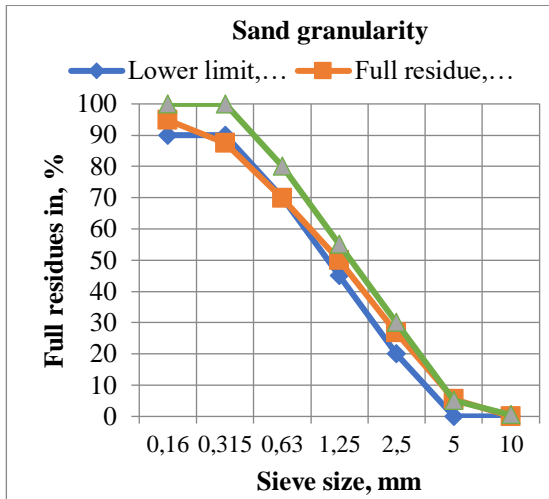


Fig. 5. Grain composition of enriched sand according to GOST 26633-2015

As can be seen from the graph, some fractions of the enriched sand do not meet the requirements of GOST 26633-2015, but since the composition was selected on the basis of this enriched sand and laboratory tests were carried out, the concrete samples showed the required strength results and did not significantly affect the properties of the mixture.

Crushed stone is used as a coarse aggregate for the preparation of road-concrete mix. Crushed stone is mined in the mountains and by crushing stones formed as a result of natural weathering of hard rocks. The surface is sharp, jagged, and usually contains a mixture of sand, clay, dust, and organic matter. Crushed stone is a loose material capable of crushing various hard rocks into large pieces, as well as broken bricks, slag, etc [11-16].

In the composition we have chosen, crushed stone of 5-20 mm fraction are used by "BUKHARTOSH" LLC and 20-40 mm fraction by "GRANITE-MINING" LLC (Fig. 6).

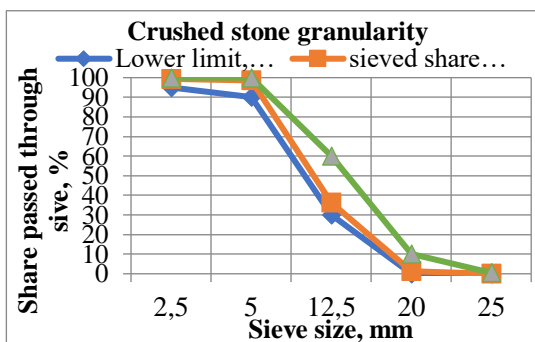


Fig. 6. Graph for determining the grain size of the shank fraction 5-20 mm

The crushed stone of 20-40 fraction produced by "GRANITE-MINING" LLC also met all the requirements when tested, like the 5-20 mm fraction.

Studies conducted at the selected site showed various changes in the concrete mixture when

changing the percentage of sand in the aggregate mixture to 0.25, 0.26, 0.27, 0.28, 0.29 and 0.30. Sand in a concrete mixture is a fine aggregate that serves to fill the space between large aggregates (together with water + cement + air).

Therefore, it was found that the percentage of sand in the mixture of aggregates directly affects the properties of the concrete mixture. Without changing the amount of water, cement and SAM additives, when the percentage of sand in the filler mixture was increased, the changes as shown in Figures 7 and 8 were observed.

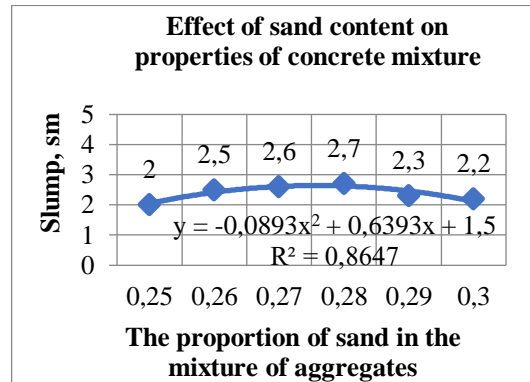


Fig. 7. The effect of the proportion of sand in the aggregate mixture on the slump grade of the mixture

It is stated that the requirement for the P1 grade of the concrete mix for the selected object should be in the range of 1-4 cm.

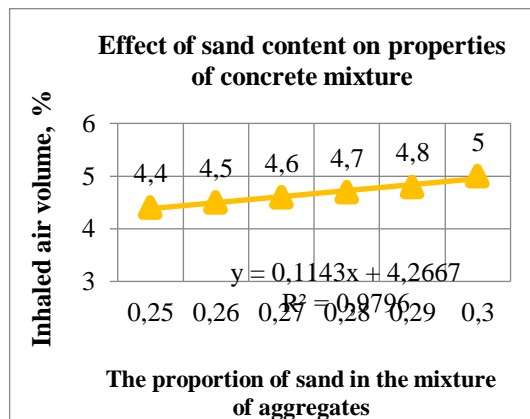
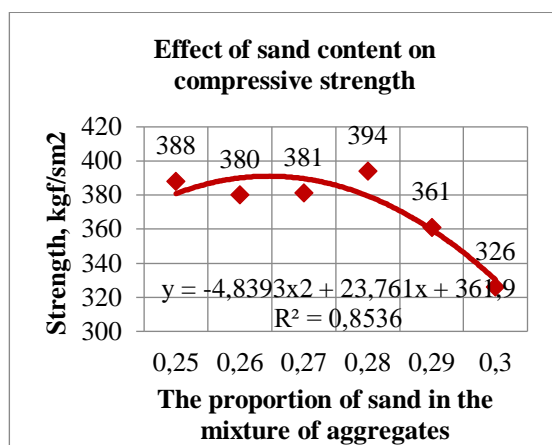


Fig. 8. The effect of the percentage of sand in the mixture of aggregates on the amount of absorbed air in concrete

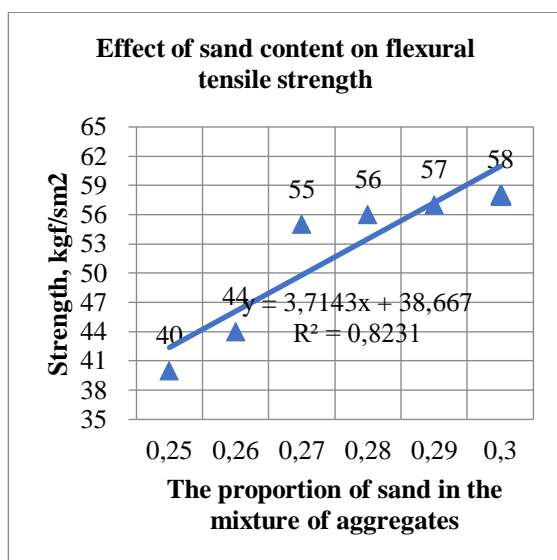
The effect of the value of the sand content in the aggregate mixture on the compressive strength of concrete depends on the size of the sand: for concrete with coarse sand, the strength does not depend significantly on the sand content in the aggregate mixture, when the sand is fine, the strength decreases proportionally with the increase in the sand content in the aggregate mixture (Fig. 9).





**Fig. 9. The effect of the percentage of sand in the aggregate mixture on the compressive strength of concrete at the age of 28 days**

It was found that increasing the value of the percentage of sand in the mixture of aggregates from 0.25 to 0.30 has a positive effect on the tensile strength of road concrete (Fig. 10).



**Fig. 10. The effect of the proportion of sand in the aggregate mixture on the flexural tensile strength of concrete at the age of 28 days**

The percentage of sand in concrete can affect its density, but it is not the only factor. Usually, the greater the percentage of sand, the lower the density of the concrete mixture. This is due to the fact that the sand does not provide sufficient density and does not completely fill the volume of the concrete mixture [18-20].

#### 4. CONCLUSION

However, a small amount of sand in the concrete mixture can cause the concrete to have a high density and be more difficult to handle during pouring and

placing. To achieve an optimal balance between the density and workability of concrete, it is necessary to balance the proportion of sand in the concrete mix according to the requirements of a particular project.

The proportion of sand in the mixture of aggregates has a significant effect on the physical and mechanical properties of concrete. When the percentage of sand in the aggregate mixture increases, the average volume of open pores decreases, and the volume of conditional closed reserve pores in concrete increases to 4.4-5.0%. This ensures high cold resistance of concrete. During our research, it was found that concrete achieves its optimal properties when the value of the percentage of sand in the mixture of aggregates for the selected object is 0.28. Moreover, when the amount of sand is increased, the price of the concrete mixture decreases, because sand is a large aggregate for this object. It is cheap. For this reason, we recommend taking the percentage of sand in the filler mixture at a value of 0.28 for the selected object.

Furthermore, introducing a structural coefficient that characterizes the composition of road concrete, and using it in an integrated durability model, will bridge the existing gap between microstructural concepts of concrete and engineering methods for calculating road pavements. This will also allow for a more accurate description of failure accumulation processes and better forecasting of service life.

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