European Online Journal of Natural and Social Sciences 2024;
Vol.13, No 4 (s) Special Issue on Natural Hazards and the Ways of Resilience
ISSN 1805-3602
www.european-science.com

Presenting a Selected Method for the Industrial Use of Roller Concrete through Pavement

Mohammad Sadigh Sarabi[1*], Seyyed Arash Sohrabi[2], Samad Dehghan[2], Nima Gheitarani[4]
[1] Department of Civil Engineering, Islamic Azad University of Marand, Iran; [2] Department of Education, Construction Engineering Organization of East Azerbaijan Province, Iran;
[3] Arizona State University, School of Sustainability, Tempe, A.Z., United States.
[*]Email: s.research68@yahoo.com

Abstract

Several methods have been proposed by organizations and concrete committees to determine the mixing ratios of RCCP. These methods are generally experimental, semi-experimental, and based on theoretical methods. Although, generally, in different methods of mixing ratio design, two approaches of soil density and psychological (efficiency) approach are used. These two approaches are respectively defined based on the optimization of the dry density of the sample by the optimal moisture content and the mixing plan by the absolute volume. In this article, the various methods presented to determine the mixing ratios of roller concrete have been investigated. These methods are experimental and are based on making several test mixtures to determine the optimal design. In recent years and with the development of the application of mathematical models in the concrete mixing design, the use of semi-empirical and theoretical methods instead of experimental methods to determine the mixing design resulted in a significant improvement in the properties of the fresh and hardened roller concrete mixture, as well as reducing the number of experimental mixtures. In this article, the different stages of two recent methods of pavement roller concrete mixing design, including the optimal volume model of the paste (semi-experimental method) and the compressible compression model (theoretical method), are presented, and the assumptions, considerations, and achievements of each are discussed.

Keywords: pavement roller concrete, mixing design, optimal volume method of dough, compressible compaction model.

Introduction

Roller crushed concrete, which is called roller concrete for short, refers to concrete with zero slump. In its fresh state, it has a drier consistency compared to ordinary concrete and looks similar to wet sand, and in its hardened state, it behaves relatively similar to ordinary concrete. The use of roller concrete in paving as a new and advanced technology has expanded widely since 1990 (Gheitarani et al, 2024- b). The most experience is related to the implementation of road construction projects using this technology in the countries of America, Canada, Spain, and Sweden. The mixture design for the paving roller concrete is prepared in low water-cement ratios (Zaker Haghighi et al., 2014).

The roller concrete mix should be dry enough to bear the weight of the rollers and also should be wet enough to allow the cement paste to spread throughout the concrete mass during mixing (Norouzian & Gheitarani, 2024). The most important consideration in the plan of mixing concrete for pavement is to provide the required strength and durability of the plan. Also, according to the special feature of roller concrete (dry concrete mix), providing sufficient efficiency to enable the implementation and proper compaction of paving and reducing the possibility of separation, is always one of the most important points to consider in optimizing the plan of mixing roller concrete (Norouzian & Gheitarani, 2023).

So far, no standard method that has general acceptance has been provided for the plan of mixing concrete for paving. The primary methods of determining the mixing plan of roller concrete are mainly based on experimental methods that are associated with trial and error. In recent years, new methods have been presented and used under the title of semi-experimental and theoretical methods (Keleş et al., 2024).

Theoretical

Experimental methods of roller concrete mixing design. Although about 20 years have passed since the use of rolled concrete in a wide area for paving in the countries that have this technology, a specific standard for the mixing plan of rolled concrete has not been provided so far (Norouzian & Sarabi, 2023). The initial methods of mixing concrete for road pavement, which were proposed by various authorities until about a decade ago, are mostly based on the experiences gained from road construction projects (Maleki et al., 2024).

The common point in all these methods is the need to make experimental mixtures with the actual conditions of project implementation to achieve the desired conditions, including resistance, efficiency, and durability (Samami et al., 2024). In all these methods, usually, an initial estimate of the composition of the materials is proposed based on the design requirements, and after making experimental mixtures and performing the desired resistance, durability, and efficiency tests, the proposed initial ratios are modified by trial and error until the greatest convergence towards Obtain the desired parameters (Dizaji, 2024).

The first group of experimental methods of roller concrete mixing plan includes the method of mixing plan using a concrete consistency test (Khanian et al., 2013). This method is based on achieving optimal efficiency at the level of the desired resistance level. In this method, several experimental mixtures are made by changing the values of the ratio of water to cement materials and the ratio of sand to cement materials and sampling is done. Then the strength and durability of each mixture are measured (Sarabi, M., et al., 2023).

According to the obtained results, the amount of water in the cement materials and the amount of sand in the corresponding cement materials are selected to achieve the desired resistance (Ghadarjani et al., 2013- b). After determining these ratios, the ratio of course to fine aggregates (sand) is selected according to the desired consistency, so that the prepared mixture meets the durability and performance considerations (Gheitarani et al., 2020). A detailed description of the above method is given in ACI 211.3-92 under the title of mixing design for non-slump concrete.

In this report, three tests of VB, density ratio, and Tool slump table have been recommended and explained for the mixing design of the mentioned concretes (Gheitarani et al., 2013). Mix design methods that use concrete consistency testing usually have specific and fixed parameters for the mixture (Karimimansoob et al., 2024- b). Among these parameters, we can mention the amount of water, the amount of cement materials, or the amount of aggregate. Then, by changing a parameter, the desired consistency is obtained (Farrokhirad & Gheitarani, 2024). The second group of experimental methods are methods that have been expanded and developed based on soil compaction testing (Norouzian, M. M., 2024).

Since the initial idea of the implementation of paving concrete layers was presented to some extent under the influence of the implementation of fixed cement foundations, the use of the soil density method to determine the design of paving concrete mixing is justified (Dizaji et al., 2023).

This method is the result of the experience of geotechnical specialists in the successful design and implementation of roller concrete pavements (Sarabi et al., 2023- b; Naghibi Iravani et al., 2024- c). The general principles of this method include the use of the percentage moisture-density curve of fresh rolled concrete using the modified soil density test according to ASTM D1557 standard to determine the optimum moisture level in a fixed grade of cement material (Safaei-Mehr, 2024).

Then, by changing the grade of cement and making test samples, the optimal mixing design is selected considering the requirements of resistance and durability of the design. The optimal performance of the mixture can be achieved at the optimal moisture level (GHADARJANI & GHEITARANI, 2013). Like all the experimental methods of rolling concrete mixing design, this method also obtains the initial approximate proportions and the design should be optimized and finalized based on the construction of experimental mixtures in the laboratory and real conditions. The basic considerations and the most important factors affecting the determination of the mixing plan using the soil density theory include durability, resistance, and efficiency (Ghadarjani et al., 2013- b).

Among other experimental methods, we can refer to the method proposed by the Japan Road Association in the instructions for making pavement roller concrete, which is based on conducting the Marshall Compaction test to achieve the optimal mixing design. The use of this test is applicable in asphalt pavement mixtures (Sahdeo et al., 2024). However, due to the special characteristics of Japan in terms of climate, the road association of this country has presented this method of mixing plan for roller concrete pavements, taking into account all safety considerations (Kahvand et al., 2015).

Methodology

Semi-experimental method: mixing design using the optimal dough volume method. The basis of roller concrete mixing plan is based on adding a relatively small volume of dough (approximately 18 to 20%) to a mixture of fine and coarse aggregates to make concrete without slump. External compacting energy is needed to reduce the distance between the aggregates until the dough fills all the surfaces and the space between the aggregates (Zakerhaghighi et al., 2015).

In the method of determining the mixing plan of roller concrete with the method of optimal volume of dough, the above principle is used and the optimal mixing plan refers to a plan in which the amount of dough is enough to fill all the spaces between the aggregates. In this method, the basis of the work is to reduce the number of experimental mixtures by using a numerical model to optimize the mixing of granular components of the mixture with different sizes (sand, cement, mineral additives), (Safaei Mehr, M., 2023).

Therefore, this method requires less laboratory work (compared to other experimental methods) and an analytical model to determine the optimal mixed design. The optimal volume of dough is a semi-empirical method that obtains the optimal design based on the results of the experimental mixtures and the numerical model (Karimimansoob et al., 2024- a). In recent years, extensive laboratory research has been conducted to determine the optimization of this numerical model, which has led to the presentation of various models. Gagne, by summarizing the assumptions of this method and taking into account the special considerations of the paving roller concrete mixing plant, presented the optimal dough volume method for non-aerated mixtures (Khanian et al., 2019).

This method consists of three relatively simple steps that require very few test mixes (two or three test mixes) to ensure the performance and resistance of the project, which depends on the actual physical-chemical properties of cement materials and aggregates (Ghadarjani et al., 2013- a). To estimate the initial values of the volume of dough and the ratio of water to cement materials, simple graphs are presented in this method (Sengun et al., 2024). The optimal mixing plan for paving roller concrete should have enough paste to fill the space between the aggregates.

Of course, the selection of the type and grading of aggregates should be such that under the applied compression, the volume density of aggregates reaches its maximum value. If the dough is less than this amount, the holes left after compaction will reduce the mechanical quality and increase the permeability of the concrete (Nasiri et al., 2024). If the granularity of the aggregates is not selected, even with the application of additional compressive energy, our holes between the aggregates will not disappear. If the amount of mixed dough is more than necessary we have increased the cost of production without creating any significant positive effect on the resistance and permeability of concrete, which reduces the economic justification of roller concrete (Aghazadeh et al., 2018).

Results

The optimal dough volume method consists of three steps:

• The first step: choosing the appropriate grading for aggregates (providing sufficient density)

• This step includes choosing a suitable granulation for the combination of fine and coarse aggregates.

• The purpose of proper grading of aggregates is to minimize the amount of voids after compaction.

The modified Fuller-Thompson formula can be used for the proper grading of aggregates (Aghazadeh et al., 2019).

$$P=(d/D)^{0.45}\times 100 \quad (1)$$

In this regard

d = sieve hole diameter or aggregate diameter in millimeters

D = maximum nominal size of aggregate in millimeters

P = calculated passing percentage for sieve size d

The gradation curve obtained from this formula is very similar to the gradation proposed by the American Concrete Association. Of course, this relationship provides a dense graining relationship for natural sand and coarse cubic grains (Hassoon & Abbas, 2024). The granulation resulting from this relationship has high amounts of very fine materials. So that the materials passed through the 160 mm sieve for the maximum nominal size of aggregates of 14 to 28 mm are obtained in the range of 10 to 15 percent (Ghourchi, M. et al., 2018).

It should be explained that this amount includes very fine materials, aggregates, and all cement materials used (Gheitarani et al., 2024- a). The granulation curve obtained from the modified Fuller-Thomson relation achieves the best compaction of aggregates when the shape, angle, and smoothness of the aggregate surface are suitable enough for the applied compaction method. Rounded natural aggregates (with smooth surfaces) and cubic aggregates create the highest density. While the sharp-cornered aggregates, which contain large amounts of flat or long particles, produce much less density (Sarabi et al., 2023- a).

Changing the characteristics such as the shape and smoothness of the surface of the grains affects the density of granular materials up to twenty percent. The density of grains is highly dependent on the shape and smoothness of the surface of the material passing through sieve No. 4. After choosing the amount of fine and coarse aggregates to create an ideal granulation, the volume of voids (Vvc) in the compacted granular model should be obtained (Aydin et al., 2020). This volume (based on liter per cubic meter of compacted aggregates) can be measured by using an overhead to compact a mixture of aggregates in a cylindrical sample on a vibrating table (Gheitarany et al., 2013).

For this purpose, a modified VB device can be used. The volume of holes after compaction is obtained from the final volume of compacted aggregates in the sample and the mixing ratio and specific weight of each type of aggregate. Usually, in an optimal mix plan, the amount of air voids of aggregates is less than 180 liters per cubic meter after compaction. To reduce this amount, natural sand or rounded materials can be used, or the presence of coarse aggregates containing flat or long materials can be avoided (Aghazadeh et al., 2017).

The second step: choosing the optimal volume of dough (to ensure efficiency). Many laboratory results indicate that the efficiency of the non-aerated concrete roller mix is a function of the Vp/Vvc ratio, which in this ratio:

Vp = volume of dough in liters per cubic meter of concrete mix (cement materials + water = dough)

Vvc = the volume of compacted aggregates in liters per cubic meter

In Figure 1, a relationship between the efficiency of the pavement roller concrete (in terms of VB time) and the Vp/Vvc ratio is presented based on the results of laboratory research. The presented relationship is only an initial estimate and the exact relationship between these two factors depends on the method of determining Vvc and the type of cement materials (Naghibi Iravani et al., 2024- b). For example, based on the actual results in a specific Vp/Vvc ratio, the VB time of the mixture containing fly ash is less than the time presented in the above figure. This figure can be used to estimate the required volume of dough (in liters per cubic meter of mixture) to achieve the desired efficiency. Based on this approximate relationship, it can be said that a Vp/Vvc ratio between 1 and 1.5 is needed to ensure efficiency in the range of 40 to 90 seconds. One or two test mixes should be made to accurately determine the volume of dough needed to provide the desired efficiency.

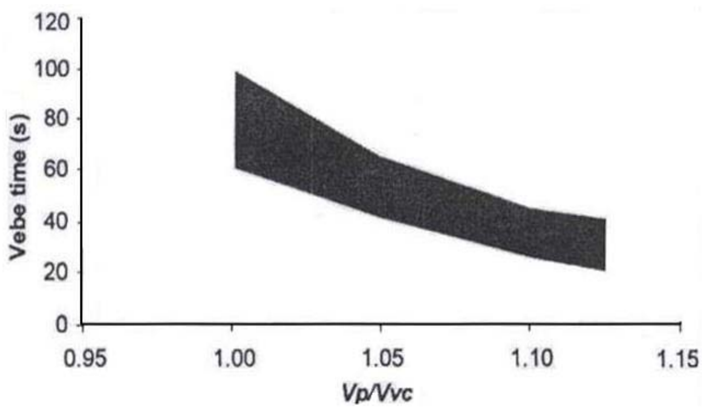

Figure 1. The relationship between the efficiency of the pavement roller concrete (in terms of VB time) and the Vp/Vvc ratio

The third step: choosing the ratio of water to cement materials (providing strength). After choosing the amount of dough volume to ensure the required efficiency, the third step of this mixing plan method includes choosing the ratio of water to cement materials (w/cm) and the type of cement materials to ensure the desired compressive strength. In general, reducing the ratio of water to cementitious materials increases the strength in all ages of concrete, and increasing the use of fly ash as part of cementitious materials decreases the short-term strength (28 days) but increases the long-term strength (91 days) of rolled concrete. The minimum required strength is usually considered based on the short-term properties (7 to 14 days) of concrete so that there is a possibility of passing on the pavement after this period. The approximate ratio of water to cement materials required to provide the desired 28-day strength level can be extracted from Figure 2.

These data have been collected from the results of numerous laboratory research and implementation projects of rolled concrete paving. For a fixed amount of water to cementitious materials, the highest compressive strength is usually obtained in mixtures containing 100% Portland cement as cementitious materials or mixtures containing silica fume. The use of fly ash in the amount of 10 to 25% of cement usually reduces the compressive strength of 28 days by 15 to 20%. The exact ratio of water to cement materials (w/cm) needed to ensure the required strength (compression and bending) depends on the physical and chemical properties of cement and aggregates (mechanical properties, surface texture, etc.). Two or three trial mixes may be needed to determine the optimum amount of water for cementitious materials.

All these experimental mixtures should be made with the same optimal volume of dough as determined in the previous step. A very important point in this field is the high dependence of the mechanical properties of paving concrete on the degree of density of the samples. In such a way the lack of sufficient compaction (less than 98%) causes a significant decrease in the mechanical properties of rolled concrete, especially in high-strength concrete. Therefore, it is very important to ensure the complete density of the manufactured samples, so that changes in mechanical properties occur only as a result of changing the mixing design, and the density of the samples does not cause these changes.

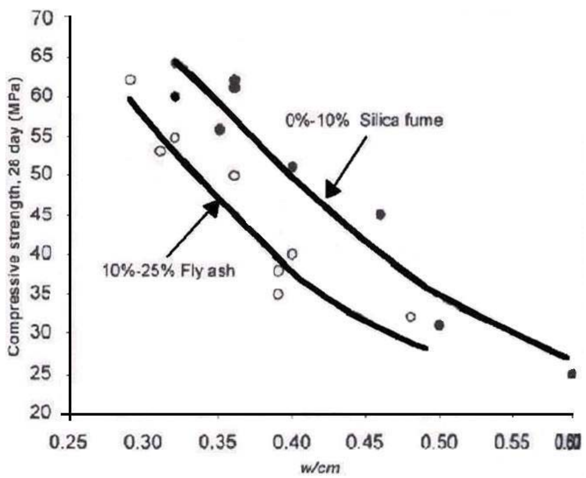

Figure 2. Approximate relationship between the ratio of water to cement materials and the 28-day strength of rolled concrete

Theoretical method: Mixing design using a compressible compression model. As mentioned above, the common experimental methods of pavement roller concrete mixing design are based on the construction of trial mixes to determine the optimal mix design. In recent years, the presentation of theoretical models has led to considerable progress in the field of concrete mixing design. By optimizing the ratio of different solid materials (including sand, gravel, cement materials, and mineral additives), these models bring the compressibility of the mixed aggregate skeleton to the maximum possible value.

These models take advantage of the simultaneous investigation of the effect of several factors on the properties of fresh and hardened concrete. The compressible compression model, which was previously known as the suspended solid model, was first presented by the researchers of the French National Organization for Applied Research and Development to optimize the design of conventional concrete mixing by maximizing the compressibility of aggregates.

After the successful application of this model in the construction of high-strength concrete, the Laval University Infrastructure Research Center in Canada applied changes to consider the differences between roller concrete and normal concrete and used this model for the design of roller concrete mixing. The results of several laboratory research projects as well as roller concrete pavement construction projects in America and Eastern Canada have proven the successful performance of the above model.

Since this method is based on mathematical calculations, a computer code has been prepared to perform the calculations. This model can be used to determine the mixing plan of industrial pavements that are under heavy loads. By optimizing the amount of cement materials in the mixing plan, this model can be used for pavements with less design load such as urban pavements and agricultural roads. This model can be modified quickly based on possible changes in the type of materials available at the project site.

Discussion

The most important advantage of this model is that there is no need to make multiple test mixtures, so in most cases, only one test mixture is needed. The compressible compression model is based on the optimization of the mixing of granular materials of different sizes, which directly affects the porosity of the mixture in such a way that with the specified efficiency for the design, the maximum compressibility of the dry mixture of materials is achieved. By using this model, the short-term and long-term mechanical properties of rolled concrete are significantly improved and the amount of cement required is reduced.

The compressibility of granular materials including gravel, sand, and cement materials depends on the size distribution of the materials, the shape of the aggregate, and the interaction between the particles. The input data of the model for each of the mixture components (cement materials, mineral additives, sand) includes particle size distribution, specific mass, and porosity index. Any type of aggregate, if the above information about it is available, can be used in this model. The compressible compaction model determines the optimal ratio between fine and coarse aggregates for the desired amount of cement and the ratio of water to cement.

For this purpose, this method provides the possibility of evaluating the density of different granular materials with different diameters di (d1>d2>...>dn) based on the following:

- Specific density (□i) of each granulation group, which expresses the density of an aggregate group with the same diameter.
- The weight ratio (yi) of each granulation group, is calculated based on the total volume of mixed solid particles.

- The model is derived based on Mooney's research on the viscosity of thick suspension of solid particles.

Based on the hypothesis of this research, the relative reference viscosity (r*) of a compacted aggregate group is a limited value. The reference viscosity is determined based on the energy index required for the complete consolidation of concrete (Dizaji, 2024). The more energy used in pouring concrete, the higher the reference viscosity will be. The reference viscosity for each group of particles with size di is calculated using equation 2:

$$\eta_{r,j}^{*} = \exp\left(\frac{2.5}{\frac{1}{\alpha_i} + \frac{1}{\beta_i}} \right) \quad (2)$$

In this regard, i is the virtual density and □i is the real density for the desired particle size. In theory, if spherical particles of the same size are placed on top of each other, the density will be equal to 0.74, which is called the virtual density. But in practice, it is not possible to reach this number, and the maximum density that can be achieved with spherical particles of the same size is 0.64, which is used as the true density in the above relationship. By replacing the values of i and □i in the relationship, the maximum viscosity for the desired particle size is obtained as 136,000 (Naghibi Iravani et al., 2024- a).

According to equation 2, the more compact the mixture is, the more viscosity increases, and the real compaction density is closer to the virtual compaction density. In practice, the actual density of each granular material of rolled concrete with a certain particle size can be easily calculated by experimenting. For this purpose, the VB table can be used to measure the porosity index. Another method is provided to measure the density of materials such as cement, fly ash, and fillers, in which a certain amount of cement is poured into the mixer and then a certain amount of water is added to it.

The density of the tested material is equal to the volume of water added to change the state of the material from dry to pasty. If the desired maximum relative viscosity is 136000 (which corresponds to a mixture of spherical particles of the same size), equation 2 can be used to calculate I for each aggregate group. After the values of i have been determined for each group of aggregates, the virtual density can be obtained based on the virtual density of different groups of aggregates using the following equations:

γ = the minimum value for all γi when γi ≠ 0 (3)

The value of i is calculated based on the following equation:

$$\gamma_i = \frac{\beta_i}{1 - \sum_{j=1}^{i-1} \left[1 - \beta_i + b_{ij}\beta_i \left(1 - \frac{1}{\beta_j} \right) \right] y_i - \sum_{j=i+1}^{n} \left[1 - a_{ij} \left(\frac{\beta_i}{\beta_j} \right) \right] y_i} \quad (4)$$

As mentioned earlier, yi is equal to the weight ratio of each group of grains in the mixture, which is formed based on the size of the grains. This value is determined using the grading curve for each material. In this method, the placement of grains, the phenomenon related to the effect of loosening, and the effect of the wall are taken into consideration in deriving equation 4 and are included in the equation with the values of aij and bij. The relaxation effect, aij, occurs when a particle is not small enough to fit in the void space between larger particles (Figure 3). The wall effect (Figure 4) causes the particle density to decrease when it is placed in the vicinity of a larger particle.

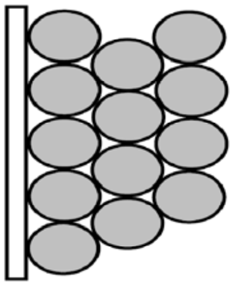

Figure 4. Effect of wall

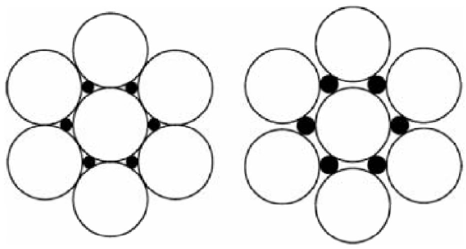

Figure 3. Effect of loosening of particles

Coefficients aij and bij are calculated using the following equations:

$$a_{ij} = \sqrt{\frac{d_j}{d_i}} \tag{5}$$

$$b_{ij} = \frac{d_i}{d_j} \tag{6}$$

After calculating the virtual density of the mixture the actual compressive density of the mixture is obtained using equation 7:

$$\eta_r^* = \exp\left(\sum_{i=1}^{n} \frac{2.5 y_i}{\frac{1}{C} - \frac{1}{\gamma_i}} \right) \tag{7}$$

To use the above equation, the reference viscosity value, r*, must be predetermined. In conventional concrete mixing design, the concept of viscosity is related to the slump of the mix. When normal concrete is poured with a vibrator, its viscosity is 2600, while without a vibrator, its viscosity is 460 (Selvam et al., 2024). The reference viscosity for the roller concrete mixture with the desired efficiency should be determined based on previous experiences. The average reference viscosity for pavement roller concrete mixtures designed with the suspended solid model is equal to 3000000.

Conclusion

Based on what has been presented so far, the initial methods of mixing concrete roller are mainly based on the experience of soil and concrete specialists, and based on the conditions of each project, the initial design is optimized by making trial mixes. The most important consideration in the plan of mixing concrete for paving is to provide the required strength and durability of the plan. Also, according to the special feature of roller concrete (dry concrete mix), providing sufficient efficiency to enable the implementation and proper compaction of paving and reducing the possibility of separation, is always one of the most important points to consider in optimizing the plan of mixing roller concrete.

In recent years, with the introduction and application of semi-empirical methods (optimal dough volume model) and theory (compressible compression model) that use mathematical calculations to optimize the granulation of aggregates, an attempt has been made to reduce the number of required experimental mixtures. To determine the final design, the concrete is rolled. In such a way that in the theoretical method, determining the optimal mixing plan is usually only possible by making a test mixture. Based on the presented methods, it can be said that the provision of conditions such as the proper grading of aggregates, the amount of water and cement consumed, and the energy applied to the compaction of roller concrete play the main role in optimizing the mixing plant.

References

Aghazadeh, M., Karimzadeh, I., & Ganjali, M. R. (2019). Dextran grafted nickel-doped superparamagnetic iron oxide nanoparticles: Electrochemical synthesis and characterization. Journal of Nanostructures, 9 (3), 531-538.

Aghazadeh, M., Karimzadeh, I., Ganjali, M. R., & Malekinezhad, A. (2017). Al3+ doped Fe3O4 nanoparticles: a novel preparation method, structural, magnetic and electrochemical characterizations. International Journal of Electrochemical Science, 12 (9), 8033-8044.

Aghazadeh, M., Karimzadeh, I., Ganjali, M. R., & Maragheh, M. G. (2018). Electrochemical fabrication of praseodymium cations doped iron oxide nanoparticles with enhanced charge storage and magnetic capabilities. Journal of Materials Science: Materials in Electronics, 29, 5163-5172.

Aydin, A. C., Yaman, Z., Ağcakoca, E., Kiliç, M., Maali, M., & Aghazadeh Dizaji, A. (2020). CFRP effect on the buckling behavior of dented cylindrical shells. International Journal of Steel Structures, 20, 425-435.

Dizaji, A. A. . (2024). Dynamic analysis of high-rise residential structures through the cone method. Edelweiss Applied Science and Technology, 8(6), 1895–1914. https://doi.org/10.55214/25768484.v8i6.2355

Dizaji, A. A. (2024). Dynamic analysis of high-rise residential structures through the cone method. Edelweiss Applied Science and Technology, 8(6), 1895–1914. https://doi.org/10.55214/25768484.v8i6.2355.

Dizaji, A. A., Kiliç, M., Maali, M., & Aydin, A. C. (2023). Buckling behaviour of dented short cylindrical shells retrofitted with CFRP. Proceedings of the Institution of Civil Engineers-Structures and Buildings, 176 (1), 62-75.

Farrokhirad, E., & Gheitarani, N. (2024). How Green Wall Imploratory Strategies Can be Facilitated and Optimized through Public Engagement?. European Online Journal of Natural and Social Sciences, 13 (2), pp-128.

GHADARJANI, R., & GHEITARANI, N. (2013). Methods for enhancing public participation in the rehabilitation and renovation of deteriorated housing (case study: Joulan neighborhood in the Hamedan City).

Ghadarjani, R., Gheitarani, N., & Khanian, M. (2013). Examination of city governorship pattern and citizen participation as a new approach to city management in region 5 of Isfahan municipality using T-test in SPSS. European Online Journal of Natural and Social Sciences, 2 (4), pp-601.

Gheitarani, N., Arash Sohrabi, S., Naghibi Iravani, S., & Dehghan, S. (2024). Analyzing the Mechanism of the Possible Effect of Place Attachment of Residents of Iranian Neighborhoods in Improving the Level of Quality of Life (Study Example: Joolan Neighborhood in Hamedan City). European Online Journal of Natural and Social Sciences, 13 (1), pp-42.

Gheitarani, N., El-Sayed, S., Cloutier, S. et al. "Investigating the Mechanism of Place and Community Impact on Quality of Life of Rural-Urban Migrants". Int. Journal of Com. WB 3, 21–38 (2020). https://doi.org/10.1007/s42413-019-00052-8

Gheitarani, N., Ghadarjani, R., Kahvand, M., & Mehrabadi, S. A. M. (2013). Explaining the effective measures in decreasing the vulnerability of urban area against earthquake using AHP model (case study: Tehran, a metropolis). Journal of Basic and Applied Scientific Research, 3 (8), 675-681.

Gheitarani, N., Norouzian, M. M., Safaei-Mehr, M. (2024). Space Configuration and Identity of Urban Neighborhoods. European Online Journal of Natural and Social Sciences, 13 (3), 290-308.

Gheitarany, N., Mosalsal, A., Rahmani, A., Khanian, M., & Mokhtari, M. (2013). The role of contemporary urban designs in the conflict between vehicle users and pedestrians in Iran cities (case study: Hamedan City). World Applied Sciences Journal, 21 (10), 1546-1551.

Ghourchi, M., Safaeimehr, M., Kazemian, G., & Sadeghi, F. (2018). ASSESSING THE FUNCTION OF NEW SHOPPING CENTERS IN FORMATION OF GLOBALIZATION OF CONSUMPTION (CASE STUDY: MUNICIPAL DISTRICTS 1 AND 2 OF TEHRAN). Вісник Національної академії керівних кадрів культури і мистецтв, (1).

Hassoon, H. R., & Abbas, Z. K. (2024). Analyzing Lab and Field Compaction Methods for designing Roller Compacted Concrete Pavements (RCCP) with Different Curing Processes. Engineering, Technology & Applied Science Research, 14(5), 17488-17493.

Kahvand, M., Gheitarani, N., Khanian, M. O. J. T. A. B. A., & Ghadarjani, R. A. Z. I. E. H. (2015). Urban solid waste landfill selection by SDSS. Case study: Hamadan. Environment Protection Engineering, 41 (2), 47-56.

Karimimansoob, V., Mahdaviparsa, A., Sadigh Sarabi, M., & Safaei-Mehr, M. (2024). Application of BIM in Energy Conservation in Low-Cost Housing in Case of Study in Dallas Independent School Residential District, Texas. European Online Journal of Natural and Social Sciences, 13 (3), pp-188.a

Karimimansoob, V., Safaei-Mehr. MM., Norouzian. M., Gheitarani. N. (2024). Scrutinizing of City Taxes Effects on Final Housing Price in Hamedan. European Online Journal of Natural and Social Sciences, 13 (3), pp-235. b

Keleş, Ö. F., Bayrak, O. Ü., & Bayata, H. F. (2024). Experimental investigation on mechanical properties of sustainable roller compacted concrete pavement (RCCP) containing waste rubbers as alternative aggregates. Construction and Building Materials, 424, 135930.

Khanian, M., Bolouhar, B., Gheitarany, N., & Nezhad, S. M. (2013). Studying the causes of vitality in traditional markets of Iran (Case Study: Shoemaking Order of Central Market of Hamadan). World Applied Sciences Journal, 22 (6), 831-835.

Khanian, M., Serpoush, B., & Gheitarani, N. (2019). Balance between place attachment and migration based on subjective adaptive capacity in response to climate change: The case of Famenin County in Western Iran. Climate and Development, 11 (1), 69-82.

Maleki, M., Gheitaran, N., El-Sayed, S., Cloutier, S., & Gaelle Giraud, E. (2024). The development and application of a localised metric for estimating daylighting potential in floor plate. International Journal of Ambient Energy, 45 (1), 2277310.

MM Norouzian, MS Sarabi. (2023). Analyzing the dynamic data of Mashhad metro line 1 tunnel using seismic table. ISAR Journal of Science and Technology. 1 (2), 1-9.

MM Norouzian; N Gheitarani. (2023). The Impact of Commercial Sectors on Environmental Quality: A Case Study of Tabriz's Ecosystem and Financial Landscape. International Journal of Advanced Multidisciplinary Research and Studies, 3 (6), 1553-1559.

MSS Mohammad., Mehdi Norouzian (2023). Analyzing the dynamic data of Mashhad metro line 1 tunnel using seismic table. ISAR Journal of Science and Technology 1 (1), 1-9.

Naghibi Iravani, S., Arash Sohrabi, S., Gheitarani, N., & Dehghan, S. (2024). Spatial Configuration as a Method to Measure the Actual and Potential Ability of Spaces Used by Indoor and Outdoor Users. European Online Journal of Natural and Social Sciences, 13 (2), pp-90. a

Naghibi Iravani, S., Karimimansoob, V., Arash Sohrabi, S., Gheitarani, N., & Dehghan, S. (2024). Applying Fuzzy Logic and Analysis Hierarchy Process (AHP) in the Design of Residential Spaces; Case of Study: Arak City. European Online Journal of Natural and Social Sciences, 13 (2), pp-144. b

Naghibi Iravani, S., Sohrabi, S. A., Gheitarani, N., & Dehghan, S. (2024). Providing a Pattern and Planning Method for Footpaths and Sidewalks to Protect Deteriorated and Vulnerable Urban Contexts. European Online Journal of Natural and Social Sciences, 13 (1), pp-1. c

Nasiri, A., Eslami, A., Fahimifar, A., & Akbarimehr, D. (2024). Laboratory and Field Study of Construction and Demolition Waste for Roller-Compacted Concrete Pavement. International Journal of Geomechanics, 24(12), 04024290.

Norouzian, M. M. (2024). Investigating the qualitative components of meaning and the role of the endowment tradition in Iranian urban spaces. Edelweiss Applied Science and Technology, 8(6), 477-490. https://doi.org/10.55214/25768484.v8i6.2104.

Norouzian, M., Gheitarani, N. (2024). Analysis and Determination of Factors Affecting Flexibility (UR) and Urban Sustainability (US). European Online Journal of Natural and Social Sciences, 13 (3), 333-349.

Safaei-Mehr, M. (2024). The Impact of Artificial Intelligence on Gender Equality in the Workplace: An Economic Geography Perspective. European Online Journal of Natural and Social Sciences, 13 (3), 309- 332.

Sahdeo, S. K., Ransinchung, G., & Nandi, S. (2024). Investigating the suitability of agricultural and industrial wastes for production of RAP inclusive pervious concrete pavement mixes: a sustainable approach. International Journal of Pavement Research and Technology, 17(5), 1309-1326.

Samami, H., Naghibi Iravani, S., Arash Sohrabi, S., Gheitarani, N., & Dehghan, S. (2024). Evaluation and Optimization of Building Greening Methods in Four Different Climates Using Building Information Modeling (BIM). European Online Journal of Natural and Social Sciences, 13 (1), pp-27.

Sarabi, M. S., Norouzian, M. M., & Karimimansoob, V. (2023). Analyzing and investigating the effects of Naqadeh earthquake aftershocks in West Azerbaijan on the results of probabilistic seismic risk estimation using clustering analysis. ISAR Journal of Science and Technology, 1(1), 38-45. a

Sarabi, M. S., Sohrabi, S. A., Dehghan, S., & Gheitarani, N. Impact on Seismic Risk Analysis of Possible Pulse in Nearby Areas. b https://doi.org/10.62225/2583049X.2023.3.6.3285

Selvam, M., Kumar, M. N., & Singh, S. (2024). Comparative analysis of jointed plain concrete pavement and roller-compacted concrete pavement. Transportation Research Record, 2678(5), 196-210.

Sengun, E., Kim, S., & Ceylan, H. (2024). A comparative study on structural design of plain and roller-compacted concrete for heavy-duty pavements. Road Materials and Pavement Design, 25(2), 392-422.

Zaker Haghighi, K., Gheitarani, N., Khanian, M., & Taghadosi, R. (2014). Examination of effects of urban street configuration on the amount of commercial buildings establishment (according to natural movement theory), Case study: Hamedan. European Online Journal of Natural and Social Sciences, 3 (1), pp-20.

Zakerhaghighi, K., Khanian, M., & Gheitarani, N. (2015). Subjective quality of life; assessment of residents of informal settlements in Iran (a case study of Hesar Imam Khomeini, Hamedan). Applied research in quality of life, 10, 419-434.