Optimum Values for Mixing Ratio and Tire Shred Size of Sand Tire Mix

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Abstract

The increase amount of scrap tire is becoming an enormous concern. The large stockpiles causes an environmental issues, contamination and cause health issues, due to their non-biodegradable nature. So the effective use of scrap tire required a great concern .If these scrap tire is cutted in pieces of appropriate sizes called tire shred, then it can be used for increasing shear strength of sand which is used in mechanically stabilized Earth walls (MSE), earth embankments and for land fill . But using scrap tire for increasing shear strength of sand require a sound knowledge of size of tire shred, mixing ratio of tire shred with sand as well as size of tire shred. The sand gradation also effect the shear strength behavior. This paper present a number of modified proctor compaction test results and gradation test performed on sand of specified specific gravity mixed in different proportion with tire shred of different sizes range from 50mm to 100mm, from which then optimum water content, maximum dry density as well as the size of tire shred is determined. Using that optimum moisture content ,mixing ratio and tire shred size , the increased dry density and hence the increase shear strength can be achieved .If the above optimum characteristics are compromised, the tire mixed with sand will not effectively play its role in increasing the shear strength of sand.

Keywords: tire shred, mixing ratio, optimum compaction ratio, optimum mixing ratio

1. INTRODUCTION:

The shear strength of soil is mainly dependent on two independent parameters that is cohesion "c" and internal frictional angle "θ". Cohesion is due to binding effect of soil grain and frictional angle is due to friction between soil grains. Shear strength of soil is given by relations. $s = c + \sigma \tan \theta$ Where "s" is the total shear stress, "c" is cohesion, "σ" is normal or overburden stress and "θ" is the angle of internal friction . For pure clear sand cohesion is zero so shear strength also is zero at zero confining pressure and for unclear sand shear strength range between 0.5 to 2 kPa Similarly for highly plastic clay shear strength is about 200 kPa while it is between 10…100 kPa for medium plastic clay .If someone is using only sand in certain projects then its shear strength will be reasonably low .It has been observed that adding elastic materials like small pieces of scrap tires in addition with sand will reasonably increase the shear strength of sand. This pieces of scrap tires are referred as tire shred. Tire shreds basically the pieces of scrap tires cutted into suitable sizes that is ranges from 50mm to 100mm. Every year 13.5 million tons of scrap tires wasted by both developed and developing countries all over the world. if these accumulates in huge amount it becomes environmental unfriendly and may cause diseases in public .The problems due to shredded tires includes fire, polluting the environment and hazardous effect on health as well as effect the agricultural growth of plants .The waste tires can recycled and disposed of without causing any effect on environment . The use of tire shreds as aggregate have most important advantages which includes 1) Light weight having density range from 500 to 1040 kg/m^3. 2) Low Earth Pressure 3) Good Drainage 4) Increase the shear strength when used with sand due to the mechanical properties of rubber. Based on these advantages Tire shreds are used in many application such as landfill covers, slope stability structures, retaining wall backfill, road embankment, road bed support as a backfill in retaining walls.

2. LITERATURE REVIEW

The use of aggregates derived from Scrape tire/waste tire in civil engineering application (ASTM-D6270-08) can reduce the problems resulting from the disposal of tires. According to the Sunthonpagist and Duffy (Ghazavi, M. (2004)), all scrape tire product was investigated the least in terms of production and markets. As the tires are combustible material and can catch fire, there is no harm by using these scrape tires in buried form (Yoon & Kim, K. (2007)), As the tires are light weight aggregate having high strength and low backfill pressure it is used as lightweight material for embankment construction (Bernal, A..Salgado, R., Swan, R. H., & Lovell, C. W. (1997)) It has been observed in previous studies that sand when used with tires get reinforced and can provide greater shear strength than sand itself, having friction angle as large as 65.8 degree being obtained from the mixture of dense sand with 30% tire shreds by volume .Friction angle of sand alone is 34.8 degree (Ahmed, I. (1993)) Humphrey and Manion (Humphrey, D. N., & Manion, W. P. (1992)) evaluated that sand tire mixture can undergo significant compression at low normal stresses. However, most of the compression that occurs is plastic, i.e. compressibility decreases substantially once the tire shred experience load .So, preloading can be done to reduce plastic compression, when the fill has been constructed. Humphrey and Manion (Humphrey, D. N., & Manion, W. P. (1992)) observed that tire shreds and sand-tire mixture can be compacted by using common compaction procedures. It was found that unit weight in the mixture is mainly controlled by the soil content. Whereas, vibratory compaction effort and molding water content appear to have no significant effect. It is reported that the optimum size and sand-tire mix should be determined experimentally, as the shape and size of tire shreds is a main factor of the numerous processing techniques used in production (Edinçliler & Saygılı, A. (2010)). It is reported that by adding 10% of tire shreds by volume in a random arrangement in the dense sand cause a significant increase in shear strength (Edil & Bosscher, P. J. (1992)). From the last few years, recycling of waste tires as construction material (light weight backfill material, drainage layer and thermal insulation) have been considered important to solve the economic and technical problems for a sustainable environment (Bosscher and Eldin, (1992), Tandon, Nazarian, & Picornell, M. (2007). The waste tires, which are shredded into tire chips/granulated rubber, are mixed with sand, which can be used for vibration isolation. Geomaterials derived from Scrap tires are uses in several geotechnical application and important references to related paper can be found in Hazarika and Yasuhara (Hazarika & Yasuhara, K. (Eds.). (2007)). The investigation of the effect of different granulated tire sizes and tire content on shear strength of sand-tire is very limited in terms of details, whereas detail study has been recommended by Prumpotthangkoon and Hyde (Promputthangkoon, , A. F. L. (2007, November)). Foose studied the feasibility of the application of shredded waste tires to reinforce sand. (Foose & Bosscher, P. J. (1996).

From the above literature review, it can be concluded that those parameters which influence the shear strength and compressibility characteristics directly or indirectly are shape and size of tire shreds, tire shreds content, sand unit weight, mixing ratio, confining pressure and normal stress. However, many studies carried out to find the shear strength of the sand tire mixture by considering one particular size of tire or different size of tire shreds. For this purpose it was concluded that to first perform Proctor compaction tests and obtain the optimum compaction ratio (tire shreds/sand) from which maximum dry density is achieved for a particular moisture content.

3. TESTS FOR OPTIMUM CHARACTERISTICS

Modified compaction test were performed to find the optimum moisture content and maximum dry density. Compaction is the function of moisture content because there is some value of moisture content at we can achieve maximum dry density that valve of moisture content is optimum moisture content(OMC) and the corresponding dry density is maximum dry density. Sand are mixed with tire shred of varying sizes and water content are added with increment of 2% in each case. Numbers of compaction tests are conducted and in case we get dry density and moisture content. Graphs are constructed between dry densities and moisture content. Maximum dry density and optimum moisture content are obtained. This gives the compaction test ratio of maximum dry density which are used for direct shear test.

3.1. Apparatus, Materiel and Sample Preparation

Before performing the tests, first we need the constituent such as sand and tires. For sand, Sieve analysis test is conducted and sand of specific gravity 2.67 is taken. For tire shred the scrap tire are cutted into pieces of various sizes that is (50mm, 75mm and 100mm) shown in figure 1. Modified proctor tests are performed for this purpose in which we have mold and hammer. Mold of weight 10.87kg and volume 0.075ft^3 are used and hammer of weight 10lb are used. The height of rise of hammer is 1.5ft and number of layers of compaction is 5. Number of blows for each layer is 56. So, first of all the required amount of sand and tire shreds are mixed and then the calculated amount of water is added to the mix. And then added to the mold from time to time in 5 layers and compact it in each case.

After that modified proctor tests are performed for each size of tire shreds (50mm, 75mm and 100mm) mixed with different proportion to sand with increment of 2% water by weight. The different mixing ratio are tire shreds/sand (0/100, 20/80, 30/70, 40/60).

Figure 1. Tire shred Sample

Figure 2. Sand Rubber Mix in Compaction Mold

3.2.Optimum moisture content, dry density, mixing ratio, and tire shred

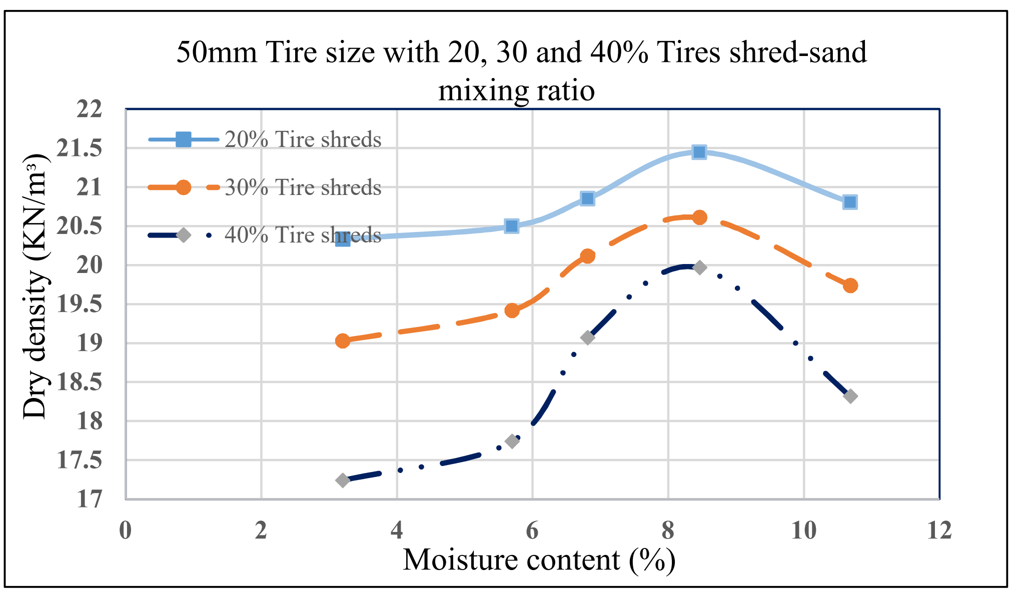

Figure 3. Combine graph for dry density of 50mm tire shred with 20%, 30%, and 40% of tire

The maximum dry density for different mixing ratio of 20%, 30%, 40%, for each size of 50mm, 75mm and 100mm is determined from their respective graph .For 50mm tire shred size, the maximum dry density for different mixing ratio is calculated as above, the graph in figure 3 shows that maximum dry density of 21.446 (KN/m^3) is achieved at moisture content of 8.46(%).

For 75mm tire shred. Data and graph shows that maximum dry density of 19.75 KN/m^{3}is achieved at moisture content of 8.46%.

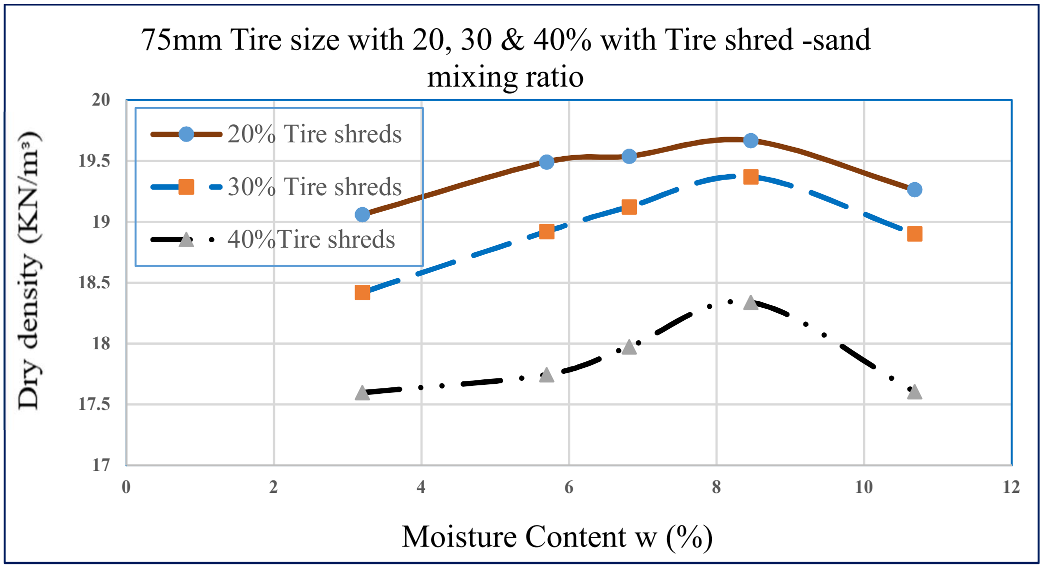

Figure 4. Combine graph for dry density of 75mm tire shred with 20%, 30%, and 40% of tire

For 100mm tire shred the maximum dry density for different mixing ratio is calculated as below. The graph in figure 4 shows that maximum dry density of 17.811 (KN/m^3) is achieved at moisture content of 8.46(%).

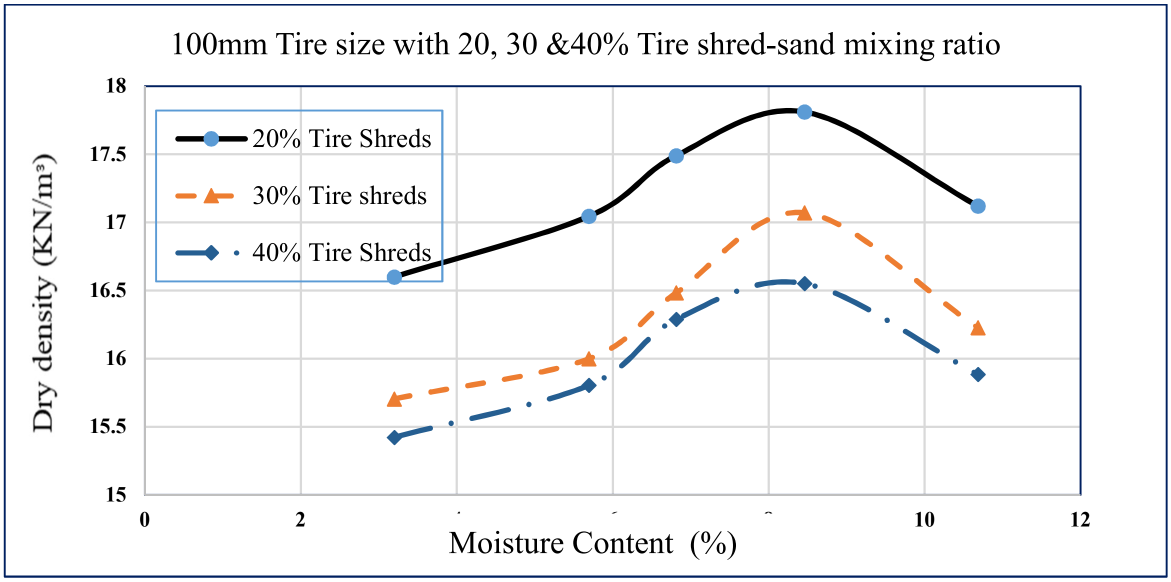

Figure 5. Combine graph for dry density of 100mm tire shred with 20, 30, and 40% of tire

If the combine graph for different sizes of tire shred is plotted for the mixing ratio of 20/80 percent by weight at different moisture content then it can be deduced that for 50mm the dry density will be maximum as shown by the graph below.

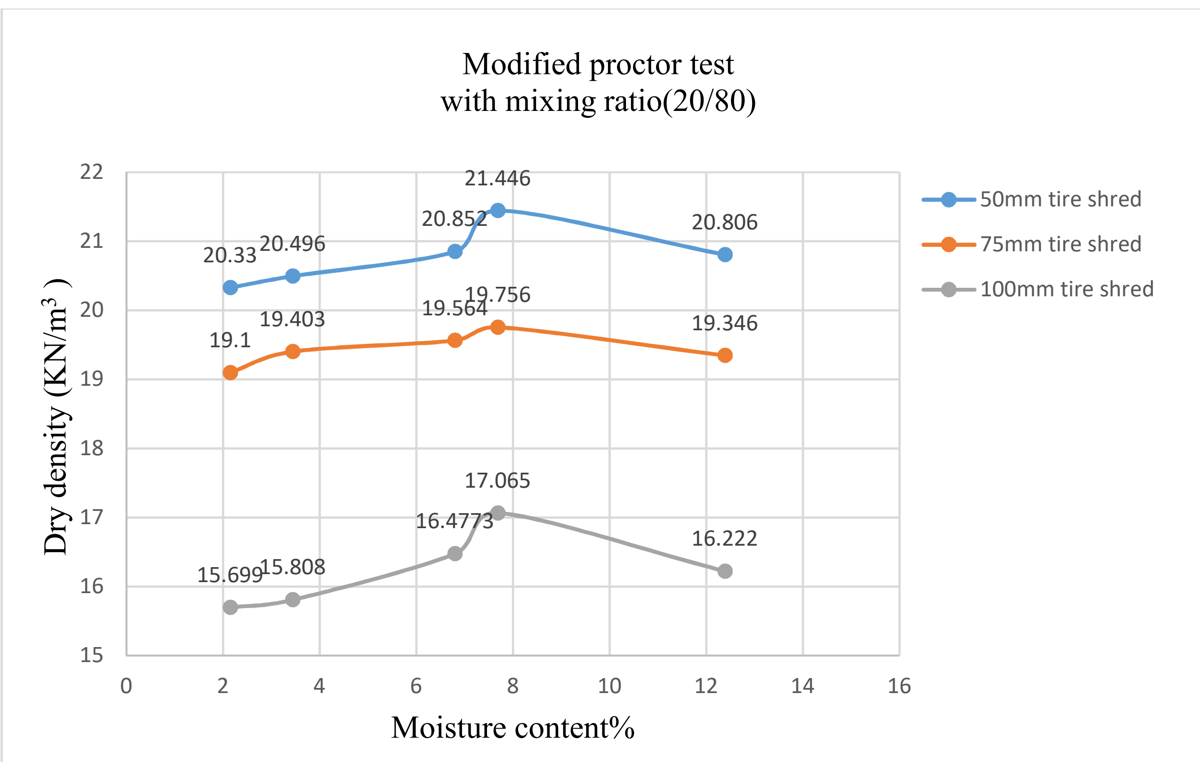

Figure 6. Final graph showing the maximum dry density for 50mm, 75mm, and 100mm tire shred using 20% of tire shred and 80%of sand

3.3. Discussion

From the above graphs it is determined that

For 50mm tire shred maximum dry density 21.446 KN/m^3 is achieved at moisture content of 8.46% with mixing 20% of tire shred and 80% of sand by weight and for 75mm shred maximum dry density 19.75 KN/m^3 is achieved at moisture content of 8.46% with mixing 20% of tire shred and 80% of sand by weight .similarly for 100mm tire shred maximum dry density 17.811 KN/ m^3 is achieved at moisture content of 8.46% with mixing 20% of tire shred and 80% of sand by weight. At optimum mixing ratio 20%by weight of sand segregation is negligible.

4. CONCLUSION

For sand tire mix to have maximum dry density they must be mixed at a certain optimum mixing ratio and optimum moisture content containing particular size of tire shreds. From the above experimental data, compaction tests it is clear that by keeping mixing ration 20/80 that is 20% of tire shred and 80% of sand, moisture content of 8.46% and tire shred size of 50mm we get maximum dry density of 21.446KN/m^3 which is quite greater then that of 75mm and 100mm tire shred for the same mixing ratio of 20/80 which is 19.75KN/m^3 and 17.811KN/m^3 respectively.

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