International Journal of
Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

DOI: 10.31695/IJASRE.2021.33974

Volume 7, Issue 2
February - 2021

Subject Review: A Comparison of Using Recycled Rubber as Aggregate in Concrete

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ABSTRACT

Due to the growth of the population, waste tires have a significant effect on the environmental issue. Every year, the decomposition of waste tire rubber is rapidly rising. Also, recycle rubber scraps into concrete production the main issue could be decreased. Recycle rubber scraps could be combined in concrete by substituting with fine and/or coarse aggregate. Decreasing the fine and coarse aggregate and preserving these natural materials. Furthermore, recycling the rubber scraps avoids the need for tire landfilling, as one of the main environmental problems of the future. A lot of investigation has suggested the use of alternative materials in concrete production, one such material that has gained a lot of attention is the recycled waste tire rubber. This study investigates of existing efforts of the literature studying recycled rubber scraps used as sand and gravel substituting in concrete production and its effect on numerous concrete characteristics.

***Keywords*:** Lightweight concrete; Normal weight concrete; Rubber waste; Building materials; Rubber concrete; Rubberized concrete; Recycled rubber.

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1. INTRODUCTION

The amount of useless waste tires rubber from diverse types of vehicles is fast increasing as one of the significant environmental problems. About one-billion waste tires, rubber is reduced every year [1] and are predicted to be about 1.2 billion every year by 2030 [2].

Also, many ways of disposing of the waste tires, like landfilling and burning, may cause grave environmental problems, either because of the rapid reduction or air pollution, respectively [3-5]. Since waste rubber scraps have a relatively long lifetime, notice in substituting sand and gravel in concrete production mixtures with waste tires, to afford environmental-friendly concrete with waste rubber scraps. Because of self-compacting rubberized concrete's high ductility, enhanced impact resistance, and energy dissipation characteristics [6], concrete mixed with rubber was used in numerous applications, such as road barriers, sidewalks, pavement [7–9], sports courts, and non-structural applications [10].

The major advantage of this study is to offer an outline of the characteristics of concrete production with substitute sand and gravel with rubber scraps. The fact that sand and gravel make around 50% of the concrete weight can be used as an encouragement to investigate the effect of substituting sand and gravel with rubber scraps, not only to provide lightweight concrete but also to sustain or even develop the mechanical properties and energy properties.

2. LITERATURE SURVEY

Recently, many techniques concerning in recognition have been studied. In this section, we discuss some of these researches.

Rahman et al. [1] and Ganesan et al. [11] pre-treated rubber scraps aggregate with poly-vinyl alcohol and replace15% of rubber content volume of fine aggregate. A negligible decrease of 3.87% and 1.12% in compressive strength of concrete was calculated. In most experimental surveys the substituting level was 15% [12]. AbdelAleem [13] replaced sand in concrete production mixtures with tires rubber aggregates (with diverse size 0 to 4.75 mm). Topcu and Avcular [14] proposed the use of waste tires rubber mixed with concrete. Comparable perceptions were similarly made by Fattuhi [15] and Zhu [16]. Hernandez-Olivares et al. [17] discovered that waste tire rubber volume divisions up to 5% in a concrete outline did not yield a critical difference of the concrete mechanical characteristics.

G.Senthi Kumaran et al. [18] displayed that waste tires and replacement with fine and/or coarse aggregate will make a better value of lightweight concrete. The compressive strength of lightweight concrete decreases with the replacement of waste tires rises [19]. The split tensile of lightweight concrete reduces at the limit of 25% when rubber substitutes up to 10% in the sand. The flexural value of lightweight concrete raises when waste tires rubber increases up to 10%. O Youssef [20] suggested that his model can assistance structural designers who are trying to using rubber as a hopeful option in concrete production. R.Bharathi [21] stated that 15% waste tire rubber is the ideal substituting amount, yet the compressive strength of lightweight concrete is rising, there are a couple of interesting points. Rubber aggregate concrete is concerned with strength, ductility, deflection, and durability [22]. Rubber lightweight concrete is giving better ductility properties than normal concrete.

3. COMPARATIVE ANALYSIS OF THE LIGHTWEIGHT CONCRETE

Table 1 Demonstrate the Comparison of using Rubber Waste Replacement (% by Volume) as Fine Aggregate and Coarse Aggregate In Concrete. Table 2 (% by weight).

Table 1. Summary of Previous Studies for A Comparison of using Rubber Waste Replacement (% by Volume) as Fine Aggregate and Coarse Aggregate in Concrete

Ref.	Year	Rubber Size mm	Replacement of Material	Comp. St. N/mm^2	Research Findings
Bignozzi and Sandrolini [23]	2006	0.5–2.0 and 0.05–0.7	22.2 and 33.3 % by volume of fine aggregate	33	Reduction of comp. strength (%) 25 and 39
Turatsinze and Garros [24]	2008	4–10	10, 15, 20 and 25 % by volume of coarse aggregate	45	Reduction of comp. strength (%) 33, 54, 65 and 73
Uyguno˘glu and Topçu [25]	2010	1–4	10, 20, 30, 40 and 50 % by volume of fine aggregate	25	Reduction of comp. strength (%) 12, 32, 42, 44 and 48
Güneyisi [26]	2010	0–4	5, 15 and 25 % by volume of fine aggregate	73.1	Reduction of comp. strength (%) 21, 40 and 64
Rahman et al. [1]	2012	1–4	28 % by volume of fine aggregate	21.4	Reduction of comp. strength (%) 30
Ganesan et al. [11]	2013	0–4.75	15 and 20 % by volume of fine aggregate	58.86	Reduction of comp. strength (%) 7 and 13
Yung et al. [27]	2013	sieve no. 30 (0.6)	Sand replaced by volume with 5, 10, 15 and 20 % rubber waste	32.07	Reduction of comp. strength (%) 10, 22, 16 and 29
		sieve no. 50 (0.3)	Sand replaced by weight with 5, 10, 15 and 20 % rubber waste		Reduction of comp. strength (%) 4, 27, 27 and 32
		sieve no. 30 and no. 50	Sand replaced by volume with 5, 10, 15 and 20 % rubber waste		Reduction of comp. strength (%) 19, 25, 40 and 40
Ismail et al. [28]	2015	<4.75	5, 10, 15, 20, 30 and 40 % by volume of fine aggregate	53.5	Reduction of comp. strength (%) 12, 19, 28, 39, 50 and 61
Khalil et al. [29]	2015	0–2	10, 20, 30 and 40 % by volume of fine aggregate	27	Reduction of comp. strength (%) 17, 26, 37 and 40

DOI: 10.31695/IJASRE.2021.33974

Ismail and Hassan [4]	2016	0–4	5, 10, 15, 20, 25, 30 and 40 % by volume of fine aggregate	52.95 and 40	Reduction of comp. strength (%) 16, 21, 29, 42, 46, 53 and 67
Zaoiai et.al [30]	2016	0/3 3/8	5 % by volume of fine aggregate 20 % by volume of coarse aggregate	37.9	Reduction of comp. strength (%) 37 Reduction of comp. strength (%) 36
Güneyisi et al. [31]	2016	<1 1–4 <4 10–40 length	5, 10, 15, 20 and 25 % by volume of coarse aggregate	62.8	Reduction of comp. strength (%) 7, 18, 24, 31 and 39 Reduction of comp. strength (%) 15, 21, 29, 42 and 50 Reduction of comp. strength (%) 13, 20, 27, 35 and 42 Reduction of comp. strength (%) 17, 29, 36, 45 and 51
Ismail and Hassan [32]	2016	<4.75	coarse aggregate replaced by volume with 5, 10, 15, 20 and 25 % rubber waste	75.65	Reduction of comp. strength (%) 12, 29, 41, 49, 51 and 58
Bideci et al. [12]	2017	Length–25 Length–50 Length–75	5, 10 and 15 % by volume of coarse aggregate	53.8	Reduction of comp. strength (%) 17, 20 and 47 Reduction of comp. strength (%) 52, 54 and 52 Reduction of comp. strength (%) 60, 61 and 58
Hilal [33]	2017	0–1 1–4 0–4	5, 10, 15, 20 and 25 % by volume of fine aggregate	72.44	Reduction of comp. strength (%) 6, 12, 16, 21 and 31 Reduction of comp. strength (%) 38, 18, 26, 37 and 46 Reduction of comp. strength (%) 0, 10, 15, 21 and 32
Aslani et al. [34]	2018	5–10	20 % by volume of coarse aggregate	50.39	Reduction of comp. strength (%) 56
Si et al. [8]	2018	1.44–2.83	15 and 25 % by volume of fine aggregate	65	Reduction of comp. strength (%) 33 and 52
AbdelAleem et al. [35]	2018	<4.75	Sand replaced by volume with 5, 10, 15, 20 and 25 % rubber waste	75.7	Reduction of comp. strength (%) 12, 29, 41, 49, 51 and 58
Aslani et al. [36]	2018	2 5	Sand replaced by volume with 10, 20, 30 and 40% rubber waste Sand replaced by volume with 10, 20, 30 and 40% rubber waste	50.39	Reduction of comp. strength (%) 29, 41, 49 and 61 Reduction of comp. strength (%) 19, 34, 41 and 48

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		10	coarse aggregate replaced by volume with 10, 20, 30 and 40% rubber waste		Reduction of comp. strength (%) 38, 56, 62 and 67
AbdelAleem and Hassan [13]	2019	<4.75	Sand replaced by volume with 5, 10, 15 and 20 % rubber waste	80.15	Reduction of comp. strength (%) 22, 39, 48 and 58

Table 2. Summary of Previous Studies for A Comparison of using Rubber Waste Replacement (% by Weight) as Fine Aggregate and Coarse Aggregate in Concrete

Ref.	Year	Rubber Size mm	Replacement of Material (% by Weight)	Comp. Strength N/mm^2	Research Findings
Topçu and Bilir [37]	2009	0–4	8, 16.90 and 26.87 % by weight of fine aggregate	50.3	Reduction of comp. strength (%) 23, 40 and 71
Najim and Hall [38]	2012	2–6	5% by weight of fine aggregate 10% by weight of coarse aggregate 15% by weight of fine and coarse aggregate	55	Reduction of comp. strength (%) 33, 42 and 53 Reduction of comp. strength (%) 18, 40 and 58 Reduction of comp. strength (%) 18, 31 and 49
Emiro˘glu et al. [3]	2012	5–12	15, 30, 45 and 60 % by weight of coarse aggregate	71.6	Reduction of comp. strength (%) 11, 34, 54 and 65
Mishra and Panda [39]	2015	5 and 10	5, 10, 15 and 20 % by weight of coarse fine aggregate	65.4	Reduction of comp. strength (%) 11, 31, 39 and 47

4. CONCLUSIONS

In this research article, various approaches have been reviewed for lightweight concrete made with rubber within the period (2006-2019). Using sawdust becomes very significant in the production of lightweight concrete. The previous investigations have established that the combination of waste tire rubber in concrete as substituting for sand and gravel decreases the compressive quality. Researches similarly show that the mechanical properties of tire rubber aggregate concrete are extremely influenced by the size, extent and surface of the waste tire rubber and the type of cement, also the size of the sand and gravel utilized. Rubber is considered a waste material and can use to make lightweight concrete and which possesses heat transfer of long duration. Moreover, it is the perfect way to reduce sold wood waste and produce lightweight concrete to be used in industrial construction. Every experimental study has some disadvantages and benefits and thus novel technologies have been sophisticated.

Acknowledgments

The author would like to thank Mustansiriyah University, in Baghdad, Iraq, for their help in this work.

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DOI: 10.31695/IJASRE.2021.33974