WASTE MINIMIZATION USING REUSE, RECYCLE MATERIALS IN BUILDING CONSTRUCTION BY NMA AND TSMA METHODS

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ABSTRACT

In the current era of rapid urbanization, economy and environment are two important words by which we can make our construction project effective and eco-friendly. It projected that the construction sector would grow at a 7-8% rate over the next ten years, and it estimated that almost 75% of construction structures supposed to exist by 2035 are yet to build. For this construction work, we need many raw materials and a large part of the economy. However, as India is a developing country, we have limited resources regarding economic and materials availability. To cover this situation, we need to manage our resources using recycled and recuse construction waste generated by the construction and demolition of old structures. There are so many research works has been done to propose a various method to introduced recycled materials as virgin raw material in the construction industry our aim in this paper to review various methods of reuse and recycle of construction waste and suggest the best method for further use in construction so that we can maximize the use of construction waste in terms of profit and waste management.

Key Words: - Recycled Aggregate, Two Stage Mixing, Mechanical Properties,

I. INTRODUCTION

Construction and demolition waste management are some of the important steps in the redevelopment of any society. The improperly managed C&D waste has a great impact on the budget and natural environment in multiple ways. the best way to minimize the construction waste is to recycle and recuse aggregate which we got from C&D waste. Recycling of waste will provide us with a proper solution to manage our waste, and recycling will also help solve the problem of land space used to form dumping this waste. We will get many materials from C&D waste, which is utilized for recycling properly. The materials obtained from C&D waste are;

1. Concrete
2. Bricks
3. Aggregate

By improving the properties of recycled aggregate, we can reuse this aggregate in concrete. It has different properties from its original concrete in terms of its strength, durability, permeability, flexural strength and tensile strength. There are various techniques present by which we mix can recycled aggregate in the concrete mixture.

Two main techniques are:-

1. NORMAL MIX DESIGN
2. TWO-STAGE MIXING

By this review paper, we are going to discuss the comprehensive properties of both the technique in terms of strength permeability, durability and other structural characteristics of the resultant concrete from the different methods by the data and research work available presently.

II. LITERATURE REVIEW

In 2011 VIVAN W.Y. [1] examine the rates of reusable and recyclable waste for six primary building materials: plastic, paper, timber, metal, glass, and concrete. He defines the ratio of the actual rate of recyclable and reusable waste in total waste generated at a construction site. According to his analysis, out of all six building materials, metal has the highest rate of recyclable and reusable, and plastic has the lowest. According to him, we only used 87 per cent of total exported recyclable materials, which ferrous and non-ferrous metal, wood, and paper. In terms of cost, he said that it is 87.2 per cent. Author has found that recycling of C&D waste is affected by seven factors;

1. Site location
2. Types of equipment used
3. Type of operation
4. Skilled workers,
5. Information about supplementary material
6. Budget and risk
7. Awareness of environmental constraints

he concludes that it is very difficult to find a proper methodology that can always use as a static method to recycle and reuse the building material.

IN 2015 XIAOYANG JIA [2] worked on using C&D waste in the roads of ruler areas. He discusses research that looked at the technical characteristics of recycled building and demolition wastes and how they may build low-volume roads in rural regions. He selected concrete waste and clay crush brick for his work and conducted a field trial project to find the utilization of C&D wastes in road construction. The macrotexture and hydration products of Construction and demolish wastes were studied using scanning electron microscopy (SEM). Proctor and unconfined compression tests used to assess engineering properties such as compaction and strength. He conducted a sand cone test to assess in-place density and a Benkelman beam deflection test conducted to evaluate the stiffness of each compacted layer during the field evaluation. OMC of concrete mix dropped when we used recycled brick

In 2016 KODUKULA JAGANNADHA RAO [3] proposed using recycled aggregate as coarse aggregate. However, in his studies later, he found that the durability of recycled aggregate is limited. He explores and distinguishes between recycled aggregate concrete and natural aggregate concrete by using M50 aggregate, and he found that when RAC expose to an acidic environment, the weight loss, compressive, and tensile strengths of the specimens found to be higher than NAC. When RCA concrete replaced with conventional concrete, the relative density is 7 to 9% lower, and water absorption is 2 times higher. The durability of RCA concrete found to be superior to that of conventional concrete. However, concrete strength remains the same. He also finds that there is evidence that the beams' flexural rigidity has improved. The inclusion of industrial wastes such as Fly Ash, Micro silica, Blast Furnace Slag (GGBS), and others are important for long-term sustainability. Concrete using 50% RCA and 20% fly ash as a partial substitute for standard coarse aggregate and cement, respectively, fulfils the design strength. He revealed that when the proportion of fly ash content increases from 0 to 30%, deflections for the same weight are reduced compared to ordinary portland cement concrete.

In 2007 VIVAN TAM, C.M. TAM, KHOA LI [4] notified that the grade of recycled aggregate had reduced because of a high proportion of cement mortar on the aggregate's surface, affecting the porosity and rate of water absorption. As a result of the increased porosity and water absorption rates, thus interfacial zone between fresh cement mortar and aggregates gets weaker, reducing the strength of Recycled aggregate concrete. He tries to study the presoaking approach in which he treats RA with reporter HCL, reporter H2SO4, reporter H3PO4. to remove cement mortar, he firstly soaks recycled aggregate in an acidic medium which generated with the help of the mixture of 0 .1M of HCL H2SO4 and H3PO4 at 20* Celsius for 24 hours after that, to remove to acidic solvent from RA, he put the aggregate in the distilled water. Moreover, properties like compressive strength, flexural strength, and modulus of elasticity of concrete indicated significant improvements in quality compared to all those prepared using old techniques.

in 2005 X F GAO et al. [5] suggested a new approach of design mix, called two-stage mixing [TSMA], to increase the compressive strength of RCA. TSMA split the mixing process into two-part based on water needed at various stages of mixing. TSMA utilizes half of the needed water during the first stage of mixing, leading to the development of a thin layer of cement slurry on the surface of RA that will penetrate the porous old cement mortar, filling up the existing cracks and cavities. The remaining water added in the next stage of mixing to finish the mixing process. By analyzing the result of TSMA with the scanning electron microscope, he found the cracks porosity filled up completely, which are the major problem of using RCA in a normal mixing approach. this result provides us larger range to use RCA in the mixture

III. METHODOLOGY

we discuss the different type of research work regarding the recycled aggregate and find how different the RCA behave in compression to virgin aggregate, and we study various method by which we can use recycled aggregate in construction so that we can minimize the construction waste

we go through the process of TSMA and find out how it behaves differently from other mixing processes with the help of various results and data available we consider the only portion of data that helps in determining the properties of any structure like flexural strength, compressive strength, workability, tensile strength,

we discussed with the local authority about the estimation of waste generated and gave them some suggestion on how can we apply this TSMA process over NMA where recycle aggregate reused as a construction material by showing the comparison of the result of both mixing approach

A. NORMAL MIX APPROCH

This is a technique of representing the proportion of ingredients in a concrete mix in terms of parts of rations of cement, coarse and fine aggregates, and cement as unity. First, the pan filled with about half of the CA [raw aggregate], then with sand, cement, silica fume, and finally with the remaining CA than water, added just before mixing occurred.

Table 1: Normal Mix Approach

Grade of concrete	Aggregate (kg)	Water content (lt)	Pro of FA and CA by mass
M10	480	34	1:2
M15	350	32	1:1.5
M20	250	30	1:2.5

B. TWO STAGE MIXING

In TSMA, the whole process separates into two-part which is called the first stage and second stage Half of the needed water for mixing used during the first stage of the mixing, resulting in the development of a thin layer of cement slurry on the surface of the Recycled aggregate with a low w/c ratio, which will penetrate the porous old cement mortar, filling up the existing cracks and voids. The remaining water is pumped during the second stage of the mix to complete the concrete mixing process. The thick coating of mortar reinforces the Interfacial transition zone and fixes the weak sections of Processed recycled aggregate covered with old adhesive mortar. FA and CA mixed for 60 seconds before 50% of the needed water added and mixed for the next 60 seconds later, and cement added and mixes for 30 seconds until the remaining portion of the required water is added and mixed for 120 seconds.

Table 2: Comparison between NMA and TSMA Workability

RCA %	TOTAL A/C RATIO	SLUMP (MM)		% IMPROVEMENT
		NMA	TSMA	
0	4.65	67		
30	4.57	62	64	3.23
50	4.51	64	67	5.56
100	4.36	61	64	5.88

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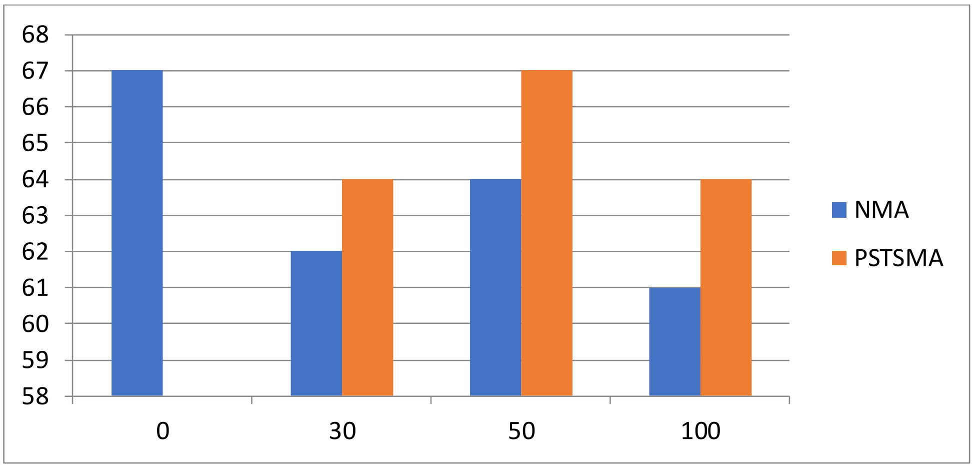

Figure 1: Comparison between NMA and TSMA for Workability

Table 3: Compressive Strength

Mixing Method	**RCA %**	**Compressive Strength (MPa)**			**Improvement**		
Curing days		3	7	28	3	7	28
NMA	30	21.11	34.74	46.96			
	50	18.89	32.15	39.37			
	100	17.26	30.89	38.44			
PSTSMA	30	22.82	37.03	48	8.1	6.59	2.21
	50	19.63	33.85	41.78	3.92	5.29	6.12
	100	18	32.67	40.88	4.28	5.76	6.35

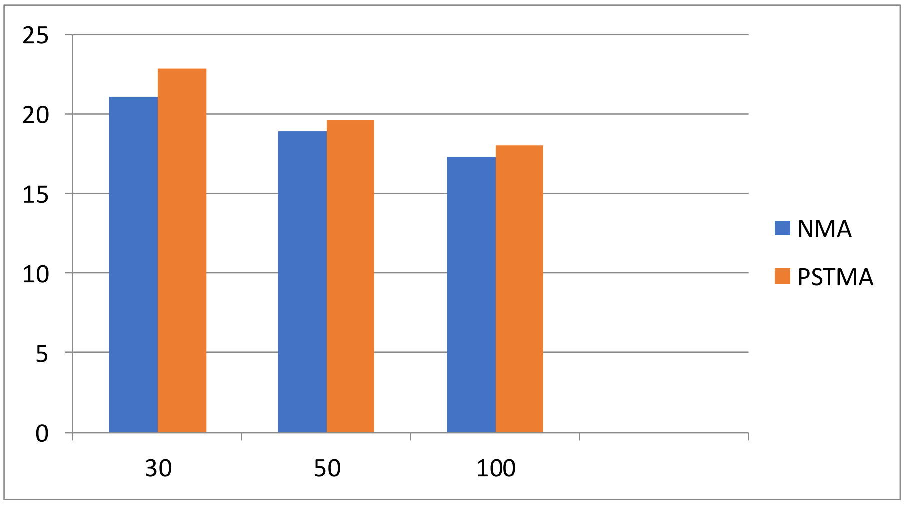

Figure 2: Comparison Strength between NMA Vs PSTSMA with curing days 3.

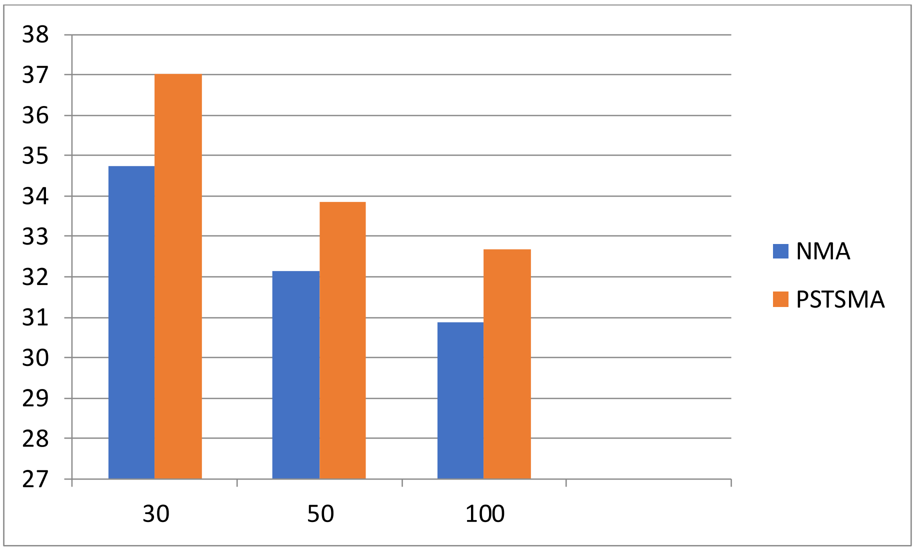

Figure 3: Comparison Strength between NMA Vs PSTSMA with curing days 7.

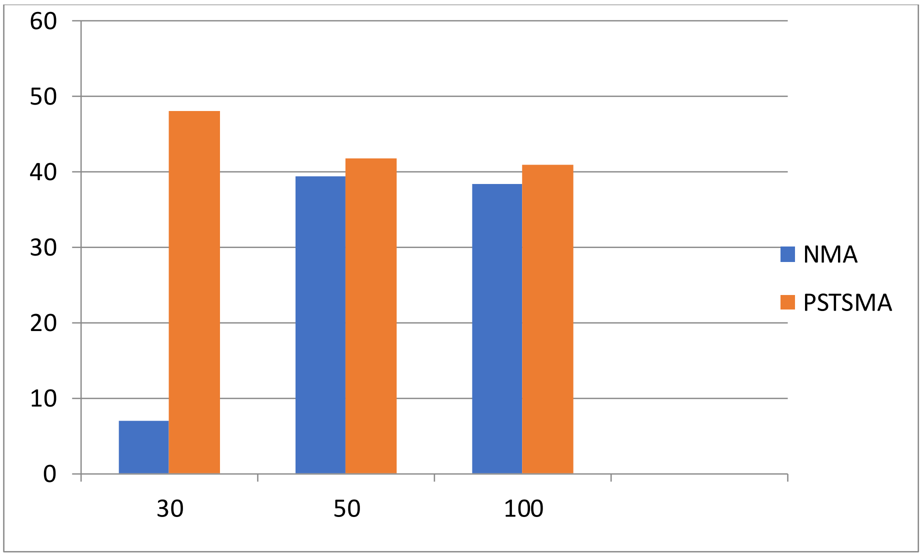

Figure 4: Comparison Strength between NMA Vs PSTSMA with curing days 28.

Table 4: Flexural Strength

Curing age	RA %	Flexural strength		IMPROVEMENT (%)
		NMA	**PSTSMA**	**-**
28 days	**0** **30** **50** **100**	**5.85** **5.55** **5.50** **4.85**	**-** **5.80** **5.77** **5.00**	**-** **4.50** **4.91** **3.10**

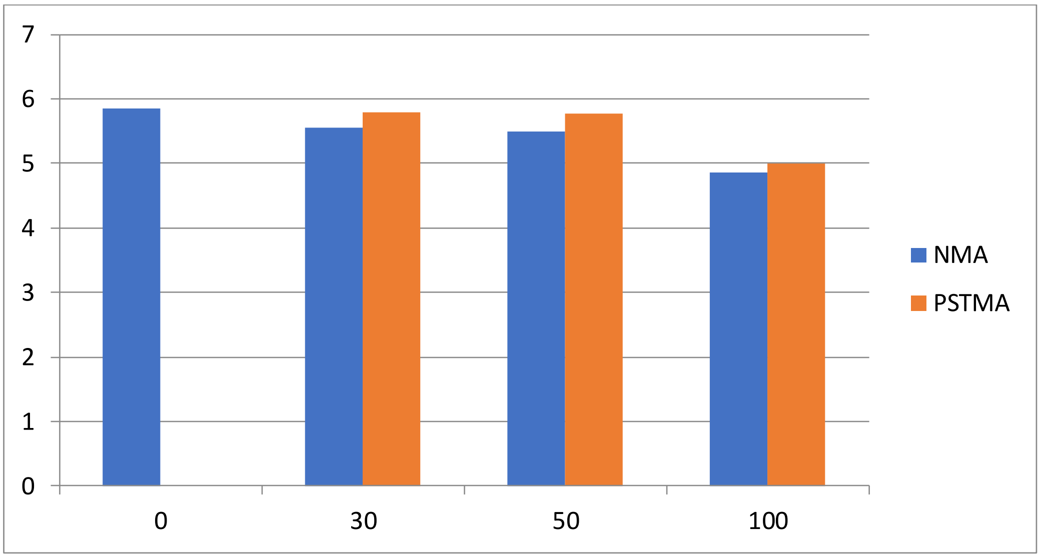

Figure 4: Comparison between Flexural Strength for NMA with PSTSMA

Table 5: Split Tensile Strength on hard concrete by NMA and TSMA

Mixing method	**% OF RA**	**SPLIT Tensile strength (MPa)**		**Improvement**	
Age of curing		7	28	7	28
NMA	30 50 100	2.76 2.59 2.33	3.59 3.30 2.92		
PSTMA	30 50 100	2.93 2.76 2.48	3.80 3.19 3.13	5.07 6.96 6.44	5.83 5.75 7.19

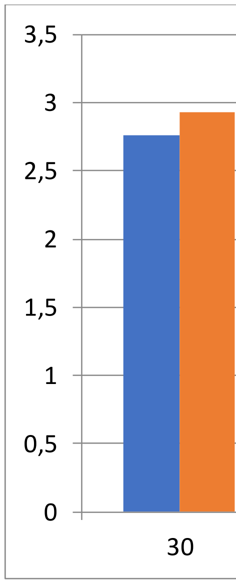

Figure 5: Split Tensile Strength on hard concrete by NMA and TSMA After 7 days

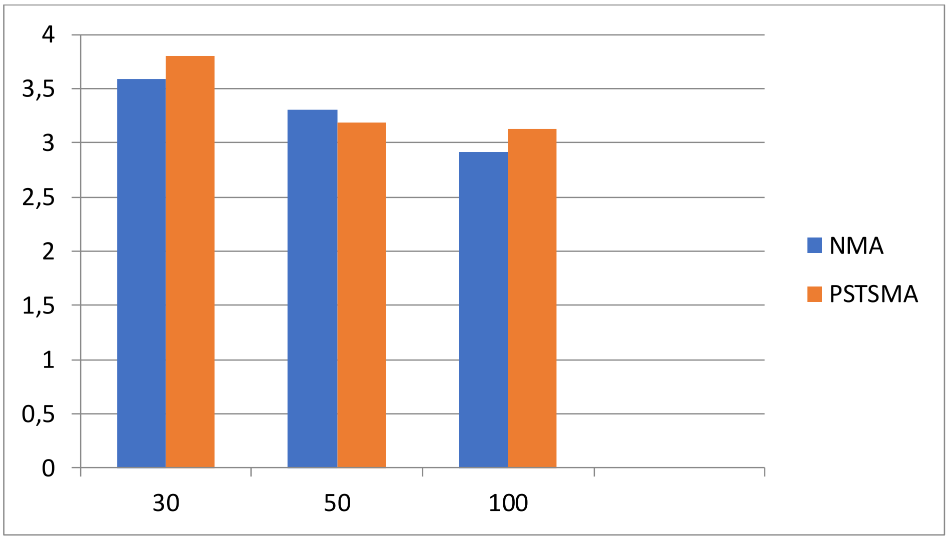

Figure 5: Split Tensile Strength on hard concrete by NMA and TSMA After 28 days

Mixing Time

For NMA, the whole mixing time was 180 seconds, and for TSMA, the total mixing time was 300 seconds. The whole mixing process occurs in one step in NMA, but in two-stage mixing techniques, the total mixing time was divided into two phases, I-stage and II-stage, with individual mixing timings of 180 and 120 seconds, respectively.

RESULT AND DISCUSSION

From all the data which we collected from various experiments and research work; we have concluded the following result;

1. Workability increases in TSMA
2. Compressive strength improves in TSMA
3. Flexural strength improves in TSMA
4. TENSILE strength increases in TSMA
5. Water absorption decreases in TSMA
6. ITZ is become thinner due to the low w/c ratio in TSMA
7. Durability increases in TSMA

We can modify the TSMA by adding silica fume in the premix. The result of this modification is that silica fume can easily form Ca(OH)2 in a hydrated paste, and we normally see that silica fume has accelerated the hydration of silicate. For up to 75MPa concrete, we can replace the original coarse aggregate replaced by 100% RCA for more than 75MP Original coarse aggregate replaced by 60% of its total quantity by TSMA

CONCLUSION

In this circular economy era, we need to develop methods to decrease waste, which is especially essential in the built environment. On-site waste recycling may provide huge benefits, not just in terms of improved planning and regulatory compliance but also in terms of cost savings on waste disposal. All the points discussed in the result section will give us a clear method by which we can recycle our waste aggregate effectively so that we can minimize the waste at any building construction. Waste minimization can increase Optimized manufacturing processes, resulting in a higher output of product per unit of raw material input, economic returns, product quality, and environmental responsibility. The techniques of reusing, recycling, and minimizing materials have been promoted and advised for use in construction operations, and all of these are beneficial in decreasing project costs. Reduce pollution and lowering the risk and likelihood of worker exposure and industrial injuries.

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