UTILIZATION OF RECYCLED AGGREGATE IN RIGID PAVEMENT

Gunda Manideep[1], K.Ramu[2]

M. Tech Scholar[1], Asst Professor[2], Department of Civil Engineering, A.M.REDDY Memorial College of Engineering and Technology, Narasaraopet (M),Guntur, Andhra Pradesh, India

---

Abstract : Construction and demolition waste accounts for a sizable portion of global waste generation. Massive quantities of aggregates are required for construction. When the structure's useful life is up, it will be demolished, and all of the debris from the demolition will end up in landfills. It is becoming increasingly difficult to find large areas for landfills, while continuous extraction and quarrying of natural aggregates for construction is depleting natural resources. There is intense development all over the world due to the rapid rate of global urbanisation and industrialization. This necessitates an insatiable demand for resources (both natural and man-made), resulting in massive waste piles. C&D waste is generally disposed of in an unorganised manner in developing countries such as India, resulting in environmental issues. However, worldwide research on recycling and the development of new applications to create a more sustainable environment is being conducted. Concrete is the world's most popular building material, and it is used in virtually every type of civil engineering project. Aggregates were once widely available at low prices and in a variety of qualities to suit all applications. However, uncontrolled quarrying and use of aggregates derived from natural resources has resulted in the depletion of primary aggregates and raised environmental awareness in recent years. This paper delves into the theme of recycled concrete aggregates and highlights their potential use as aggregate in rigid pavement construction, as well as the various techniques and applications involved in the process.

Keyword's: Recycled Aggregate, Compressive strength, Flexural Strength

1. INTRODUCTION

1.0 General

Transportation is critical for the economic development of any region because every commodity produced, whether food, clothing, industrial products, or medication, requires transportation during the manufacturing and distribution stages. The country's socioeconomic progress is hampered by a lack of suitable transportation facilities. The state of a country's transportation system reflects its economic and social development. The most difficult reality is that this country must provide road connections for a large number of communities, as well as well-defined centres such as significant vital routes, significant structures, school and hospital destinations, and so on. India has the second-largest road network in the world. The most difficult reality is that this country must provide road connections for a large number of communities, as well as well-defined centres such as significant vital routes, significant structures, school and hospital destinations, and so on. India has the second-largest road network in the world. The road network expanded from 4 lakh kilometres in 1947 to 20 lakh kilometres in 1993 and nearly 55 lakh kilometres as of March 31, 2015. In India, there are fewer than 3.8 kilometres of road per 1000 people, including both paved and unpaved roads. In terms of quality, all-season, and four-lane highways, India had less than 0.07 km per 1000 people in 2010. Because road construction requires a significant financial investment, proper maintenance of these assets is critical. The level of maintenance has a large impact on the cost, comfort, and safety of road users. Because a poor road transportation system can stymie economic Road quality is a critical indicator of a country's economic vitality because it can influence the location of economic activity, impede the integration of economic markets, limit the gains from specialisation, and eventually become a major barrier to growth and competitiveness. Large road networks built at a high cost in India have been poorly maintained and used far beyond their design values. Aside from insufficient capacity and pavement thickness, our highway system's major flaws are poor ride quality, worn and distressed bridges/culverts, congested stretches, excessive axle loading, and a lack of wayside services and enforcement. Road transportation has come to dominate the system among the various modes of transportation.

1.2 Road Development in India

Excavations in the Indus Valley have revealed the existence of designed highways in India dating back to 2500-3500 BC. The Maryann kings also built excellent roads. During the Munhall Empire, India's roads were vastly improved. During this time, roads were built through the genetic plains to connect the North West and the East. The British contributed significantly to the development of the Grand-Trunk road, which connects North and South.

2. LITERATURE REVIEW

2.1 Use of Recycled Concrete

Many countries have been attempting to use recycled concrete for many years. Because RCA is still not widely used, those who use it face some limitations. There may be some guidelines for using RCA. Selected international experience has been outlined here based on the research of Mr. Tushar R Sonawane and Prof. Dr. Sunil S. Pimplikar.

2.2 previous literature studies

Manish Kumar Singh, Dilip Kumar (2014) Use of Demolished Concrete and Construction Waste as Coarse Aggregate in Concrete." Construction and demolition debris are used as coarse aggregate in new concrete. According to research, 0 to 15% replacements of recycled aggregate as natural aggregate yields a good comparatively result. Construction and demolition waste concrete may be a viable alternative to traditional concrete. The amount of water required to produce the same workability increases as the percentage of demolished waste increases. The use of waste aggregate in new concrete as recycled concrete aggregate reduces pollution while also providing an economic value for the waste material. The use of recycled aggregates not only helps to preserve finite raw materials, but it also helps to reduce energy consumption and overall construction costs. The density of concrete will decrease as the percentage of demolished and construction waste is replaced.

Sourabh Jain, Shaleen Singhal & Nikunj Kumar Jain: The top down up material flow analysis strategy was applied in this investigation. According to the findings, India produced between 112 and 431 million tonnes of C&DW in 2016, based on calculations that are orders of magnitude greater than official data. Despite the fact that rural areas generate less garbage per capita than urban areas, rural areas as a whole generate more waste than urban areas, as India's rural population is still more than twice that of the country's urban population. Furthermore, while formal C&DW recycling is expected to save 2–8% of natural minerals such as sand and aggregate in metropolitan areas, energy and carbon savings were negative, showing that recycled C&DW materials are more resource and environmentally intensive than natural materials.

3. RECYCLED AGGREGATE

3.0 General

In 2002, an estimated 12 billion tonnes of global waste were generated, with 11 billion tonnes of industrial waste accounting for 11 billion tonnes and 1.6 billion tonnes accounting for 1.6 billion tonnes. Over 19 billion tonnes of solid municipal waste are expected to be generated annually by 2025. 790 million tonnes (MT) of solid wastes and municipal solid wastes are generated in India, accounting for approximately 48 (6%) of the total (4.4 billion Tonnes). Municipal solid waste generation in India is expected to reach 300 MT by 2047, with a land requirement of 169.6km2 for disposal, compared to only 20.2km2 in 1997 for management of 63548MT. According to studies conducted by various researchers, construction and demolition waste accounts for approximately 25% of Municipal Solid Waste.

3.1 Need for Recycled Aggregate

Because of industrialization, India's urbanisation rate is very high. India's GDP growth rate has surpassed 9%. Rapid infrastructure development necessitates a large quantity of construction materials, as well as land and site requirements. Concrete is preferred for large construction projects because it has a longer life, lower maintenance costs, and better performance. Smaller structures are demolished and new towers are built to achieve the GDP rate. The preservation of the environment is a fundamental factor that is inextricably linked to the survival of the human race. Environmental consciousness, natural resource protection, and sustainable development are all important factors in today's construction requirements. As a result of modernization, demolished materials are dumped on land and are not reused. Such circumstances have an impact on land fertility. According to a March 2007 report in the Hindu online, India generates 23.75 million tonnes of demolition waste each year. Only 0.0024 million tonnes of carbon are produced by recycled aggregate. Given a global aggregate consumption of 10 billion tonnes per year for concrete production, the carbon footprint of both natural and recycled aggregate can be calculated.

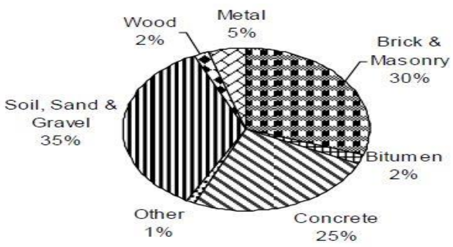


Figure 1. Solid waste produced in India

3.2 Problem Statement

Concrete is the world's premier construction material and is widely used in all types of civil engineering projects. In the past, aggregates were readily available at lower prices and in a variety of qualities to suit all applications. However, in recent years, uncontrolled quarrying and use of aggregates from natural resources has resulted in the depletion of primary aggregates and raised environmental awareness. Concrete was long trucked to landfills or heaped on the side of the road for disposal, but recycling has a number of advantages that have made it a more appealing option in this era of increased environmental awareness. Environmental consciousness, stringent environmental regulations, and a desire to keep building at a low cost.

Figure 2 .Demolished Concrete Blocks and it's recycling

3.3 Proposed Solution

Concrete recycling entails crushing, sizing, and blending to achieve the desired product mix. Crushing and sieving of C&D waste can be done in a variety of ways, but the most common is to use mobile or stationary recycling plants. To process natural sand or gravel, separate concrete and asphalt recycling plants are used. Construction waste contains metal and other waste materials that must be screened and removed before processing begins, either manually or mechanically.

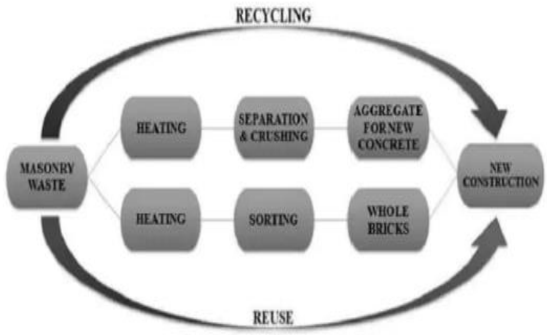


Figure 3. Recycling Process

3.4 Advantages of Recycled Aggregate Concrete

- It reduces the amount of CO2 in the atmosphere by absorbing a large amount of carbon dioxide while crushing into smaller particles.
- It expands the recycling industry's employment opportunities.
- According to a few research studies, using recycled aggregate concrete reduces construction costs.
- It is regarded as a 'green' building material.
- Using recycled aggregate reduces the number of virgin aggregates produced, resulting in less use of natural resources.
- Recycled aggregate concrete can be used for a variety of applications. It is appropriate for use in a variety of construction projects, landscaping, and home improvements.
- As a natural aggregate, it is dependable and safe to use.
- Reduces the need for new landfills by conserving landfill space.

Mix Proportion	Cement	Fine Aggregate	Coarse aggregate
	1	1.30	2.94

4. MATERIAL AND PROPERTIES

4.1 MATERIALS USED

In this investigation, the following materials were used:

- Ordinary Portland Cement of 53 Grade cement conforming to IS: 169-1989
- Fine aggregate conforming to IS: 2386-1963.
- Coarse aggregate conforming to IS: 2386-1963.
- Water.
- Recycled coarse aggregate.

4.2 Recycled Coarse Aggregate

Demolished concrete waste of coarse aggregate getting from local crushing plant Crushed aggregates of 20mm and down size produced from plant were used. The aggregate exclusively passing through 20mm sieve size and retained on 6.3mm sieve is selected.

MIX CALCULATION FOR NATURAL COARSE AGGREGATE (NCA)

Cement = 438 kg/m^3

Water = 175.33 kg/m^3

Fine Aggregate = 571.52 kg/m^3

Coarse Aggregate = 1289.8 kg/m^3

Water-Cement ratio = 0.40

MIX CALCULATION FOR RECYLCED COARSE AGGREGATE (RCA)

Cement = 438.3 kg/m^3

Water = 175.33 kg/m^3

Fine Aggregate = 575.25 kg/m^3

Coarse Aggregate = 1225 kg/m^3

Water-Cement ratio = 0.40

	Cement	Fine Aggregate	Coarse aggregate
Mix Proportion	1	1.31	2.79

5. EXPERIMENTAL RESULT

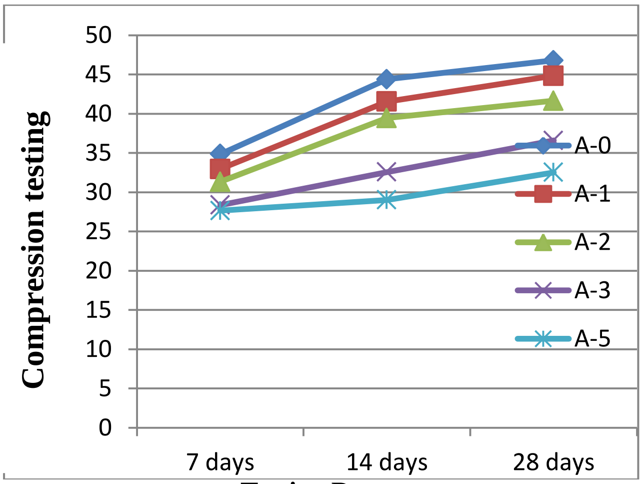
5.1 Compressive Strength Result

A total of 45 cubes of size 150 x 150 x 150mm were casted and tested for 7 days and 28 days. The test results are tabulated below:

Figure 4. Compressive testing machine

Table 1.Compressive strength results

S.No	Mix Designation	Aggregate Replacements % (RCA)	Compressive strength of M40 grade in N/mm²		
			7 days	14 days	28 days
1	A-0	0	34.86	44.38	46.79
2	A-1	25	32.95	41.54	44.84
3	A-2	50	31.12	39.44	41.65
4	A-3	75	28.37	32.56	36.58
5	A-4	100	27.65	29.02	32.52



Testing Days

Graph 1 .Compressive strength graph

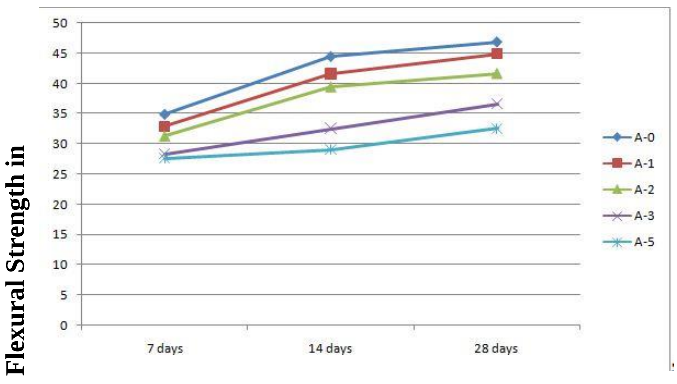
Result: From the graph above it is seen that compressive strength at 50% RCA concrete is providing better result.

5. 2 Flexural Strength Results

The flexural test was conducted for all the mix a total of 45 beams was casted and tested as follows:

Table 2. Flexural strength results

S.No	Mix Designation	Aggregate Replacements % (RCA)	Compressive strength of M40 grade in N/mm²		
			7 days	14 days	28 days
1	A-0	0	5.2	6.83	7.28
2	A-1	25	5.06	6.75	7.32
3	A-2	50	5.02	5.91	7.25
4	A-3	75	4.28	5.16	6.92
5	A-4	100	4.91	5.52	6.84



Testing Days

Graph 2. Flexural strength Graph

Result: From the graph above it is seen that flexural strength at 25% RCA concrete is providing better result.

6. APPLICATIONS OF RECYCLED AGGREGATE

6.0 APPLICATIONS

Traditionally, the application of recycled aggregate is used as landfill. Nowadays, the applications of recycled aggregate in construction areas are wide. The applications are different from country to country.

A) Concrete Kerb and Gutter Mix

In Australia, recycled aggregate has been used in the mix for concrete kerbs and gutters. Stone claims that 10mm recycled aggregate and blended recycled sand are used for concrete kerb and gutter mix in the Lenthall Street project in Sydney, according to Building Innovation & Construction Technology (1999).

Figure 5. Recycled Aggregate as Road Kerb

B) Granular Base Course Materials

In road construction, recycled aggregate is used as granular base course. When used as granular base course in road construction, recycled aggregate outperformed natural aggregate. When the road is built on wet subgrade areas, recycled aggregate will stabilise the base and provide a better working surface for the construction of the pavement structure. Sydney-based project

C) Embankment Fill Materials

Recycled aggregate can be used in embankment fill. When the embankment site is on the wet sub grade areas, recycled aggregate can stabilize the base and provide an improved working surface for the remaining works.

D) Paving Blocks

In Hong Kong, recycled aggregate has been used as paving blocks. Recycled aggregate is used as typical paving blocks, according to the Hong Kong Housing Department.

Figure 6. Typical Paving Blocks

E) Backfill Materials

Backfill materials can be made from recycled aggregate. Following laboratory testing, the Norwegian Building Research Institute stated that recycled concrete aggregate can be used as backfill materials in the pipe zone along trenches.

Figure 7. Recycled Aggregate as Backfill Materials

F) Building Blocks

Recycled aggregate is used as a building material. The masonry sound insulation blocks were made with recycled aggregate. During laboratory testing, the masonry sound insulation blocks that were produced met all of the requirements.

Figure 8. Recycled Aggregate used as Building Blocks

7. CONCLUSION

- The use of recycled aggregates from construction and demolition wastes is showing promise as an alternative to primary (natural) aggregates in construction.
- When compared to natural aggregate, recycled aggregates have a lower bulk density, higher crushing and impact values, and higher water absorption. • The compressive strength of recycled aggregate concrete is lower than that of natural aggregate concrete. These variations, however, are dependent on the original concrete from which the aggregates were obtained.
- In comparison to normal concrete, the replacement of coarse aggregate with 50% demolished waste has good compressive and flexural strength. The use of demolished waste aggregate in concrete can be a viable alternative to traditional concrete.
- Usage of recycled concrete aggregate can not only preserve the finite raw material, but also reduce energy consumption and overall construction cost. Use of Demolished waste aggregate in the concrete as the recycled aggregate reduces the environmental pollution as well as providing economic value for the waste material.

REFERENCES

1. Manish Kumar Singh, Dilip Kumar (2014):- "utilization of demolished concrete and construction waste as coarse aggregate in concrete". Ijret: international journal of research in engineering and technology
2. Vikas Srivastava, Mohd Monish, Raushan Ranjan and P.K.Mehta (2015):- "demolished waste in concrete". Ijret: international journal of research in engineering and technology
3. Angha Kalpavalli, Dr.S.M.Naik (2015):- "use of demolished concrete waste as coarse aggregate in high strength concrete production".ijret: international journal of research in engineering and technology
4. Prakash Somani, Brahmtosh Dubey, Laukesh Yadav, Jitendra Kumar, Abhishek Kumar, Manipal Singh (2016):-"use of demolished concrete waste in partial replacement of coarse aggregate in concrete".ijret : international journal of research in engineering and technology