RETHINKING CONSTRUCTION MANAGEMENT PRACTICES TO ATTAIN SUSTAINABLE DEVELOPMENT GOALS

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Chief Editor
Mohd Asim
Assistant Professor, Department of Civil Engineering, Integral University, Lucknow, Uttar Pradesh, India

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REVIEW ON THE CIRCULAR ECONOMY IN CONSTRUCTION WASTE MATERIALS: AN INITIATIVE TO ACHIEVE SDG-8 (DECENT WORK AND ECONOMIC GROWTH)

Bibidha Patel
M.Tech Research Scholar, Department of Civil Engineering, Integral, University, Lucknow, Uttar Pradesh, India

Mohd Asim
Assistant Professor, Department of Civil Engineering, Integral, University, Lucknow, Uttar Pradesh, India

Syed Aqeel Ahmed
Professor and Head, Department of Civil Engineering, Integral, University, Lucknow, Uttar Pradesh, India

Abstract

Construction and demolition waste (CDW) accounts for at least 30% of the total solid waste produced around the world. At around 924 million tons in the European Union in 2016 and 2.36 billion tons in China in 2018, the amount is expected to increase over the next few years. Dumping these wastes in sanitary landfills has always been the traditional approach to waste management but this will not be feasible in the years to come. To significantly reduce or eliminate the amount of CDW being dumped, circular economy is a possible solution to the increasing amounts of CDW. Circular economy is an economic system based on business models which replaces the end-of-life concept with reducing, reusing, recycling, and recovering materials. This paper discusses circular economy (CE) frameworks—specifically material recovery and production highlighting the reuse and recycling of CDW and reprocessing into new construction applications. Likewise, a literature review into recent studies of reuse and recycling of CDW and its feasibility is also

discussed to possibly prove the effectivity of CE in reducing CDW. Findings such as effectivity of recycling CDW into new construction applications and its limitations in effective usage are discussed and research gaps such as reuse of construction materials are also undertaken. CE and recycling were also found to be emerging topics. Observed trends in published articles as well as the use of latent Dirichl *et al.* location in creating topic models have shown a rising awareness and increasing research in CE which focuses on recycling and reusing CDW.

Keywords: Circular Economy, Construction and Demolition waste, Twin Towers, Autoclaved Aerated Concrete.

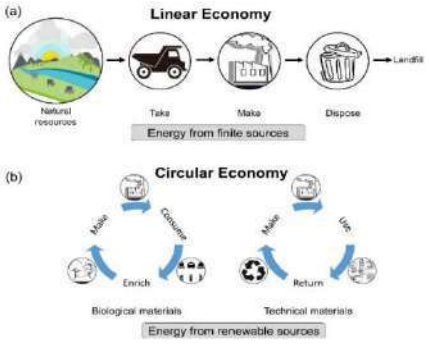
1. Introduction

Circular Economy (CE) has evolved as a novel solution to reduce the detrimental effects on the environment and increase economic growth within the construction sector for the practice of sustainable development.

The CE is comprised of a novel reformative framework that aids in optimizing the consumption of raw materials and ensures the value of materials throughout their lifecycle. In addition to this, CE prevents generation of excess waste, hence preserving natural resources. Essentially, the CE strategy demonstrates that everything that concluded project, promoting material efficiency by recycling/reusing the construction wastes, and avoiding the production of unnecessary wastes and consequently disseizing them to landfill. Generally, within the construction industry, the CE aims to add value to the materials that are conventionally discarded into landfill and make them usable for the construction firm or other developments.

To effectively implement CE in a construction firm, various dimensions, such as societal,

Governmental, economic, behavioural, technological, and environmental aspects, need to be fully elucidated.



2. Literature Review

The circular economy and waste hierarchy share a joint philosophy, aiming to manage waste by rethinking, redesigning, and repurposing. The focus is to improve the resource effectiveness of a product and to reduce the generation and adverse impact of waste from lifecycle of pre-use, use and post use phase. Based on the regulatory framework, current situation, and challenges of C&D waste in the world as well as India, a conceptual model with 26 components has been developed. (Sanjay Choudhary, Harshita Kaur, Dr. Bhavna Tripathi, Dr. Tarush Chandra, 2022). The circular economy in the construction sector in emerging economies is one of the most promising concepts that aims to keep the value of the construction materials and structures as long as possible. It seeks to identify the construction trends and perform a barrier and opportunity analysis to develop circular economy principles in the construction sector. (Beibut Torgautov, Asset Zhanabayev, Aidana Tleuken, Ali Turkyilmaz, Mohammad Mustafa and Ferhat Karaca, 2021). Conventionally, in a linear economy, C&D (Construction and Demolition) waste was considered as zero value materials, and, because of that, most C&D waste materials ended up in landfills. In recent years, with the increase in the awareness around sustainability and resource management, various countries have started to explore new models to minimize the use of limited resources which are currently overused, mismanaged, or quickly depleting. (Callun Keith Purchase, Dhafer Manna Al Zulayq, Bio Talakatoa O'Brien, Matthew Joseph Kowalewski, Aydin Berenjian, Amir Hossein Tarighaleslami and Mostafa Seifan, 2021). Construction and demolition waste (CDW) accounts for at least 30% of the total solid waste produced around the world. At around 924 million tons in the European Union in 2016 and 2.36 billion tons in China in 2018, the amount is expected to increase over the next few years. Dumping these wastes in sanitary landfills has always been the traditional approach to waste management but this will not be feasible in the years to come. (Clarence P. Ginga, Jason Maximino C. Ongpeng and Ma. Klarissa M. Daly, 2020). A Review Paper on Construction and Demolition Waste Management. A large portion of solid waste management system is construction and demolition waste that are increasing worldwide due to the boom, housing and construction sector. C&D waste is an important portion of the system of solid waste management and is steadily increasing due to the boom in the building and housing sectors all over the world. The rise in building construction increases more worries about the management of C&D waste. The environmental pollution risk is a serious problem, as humanity is irreversibly exposed to the destruction of the environment in an alarming way. (Abdul Latif Hamid, Amit D. Raval, Dr. Jayesh Kumar R. Pitroda, 2019).

There were tremendous increments in construction and demolition activities in last two decades due to emergence of new technologies and materials. The old structures were demolished after completion of lifespan and replaced by new construction works. So that due to increase waste volume of demolished material and lack of the landfills, waste management is popping into innumerable vital subject of interest within the Asian Nations. (Anupam Rawat, A.K. Sachan and Rama shanker, 2018).

3. Principles of Circular Economy

1) Minimizing waste and pollution

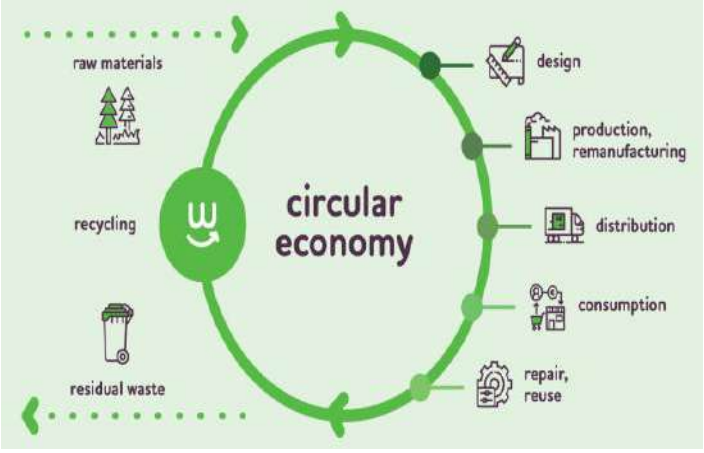
The concept proposes minimizing waste and pollution by reducing harm from economic activities.

2) Extending the useful life of products and materials

A circular economy aims to extend the useful life of products and materials by creating loops extend the materials and products circulating in the economy. The goal is achieved by actively reusing, repairing, and remanufacturing the products and materials used in the economy.

3) Regeneration of natural systems

Regeneration of natural systems is one of the fundamental concepts of a (circular) economy. It strengthens natural capital and creates the necessary conditions for the regeneration of natural systems.



4) CDW Material Reuse and Recycling in CE

CDW reuse and recycling has already been studied since the late 20th century with papers published which examined the reuse of materials from

construction and demolition. While frameworks that promote reuse and recycling of CDW can be seen in the early 2000's in the paper published which acknowledges the amount of CDW that is sent to landfills and severely damages the Environment. The application of the framework of CDW material recovery and production specifically in the reuse and recycling of CDW can be seen as an emerging topic due to the number of experimentations and construction applications done. From 2016 to present, numerous papers have been published in the study of reuse and replacing materials with CDW alone. This does not account for other papers published from the late 20th century discussing CE and reutilization of CDW. Material reuse either by direct use or by repair/refurbishment as published that promotes CE by ensuring CDW is reused within the construction industry. This approach minimizes leakages that hinder sustainable reusing of CDW. Interventions for promoting reuse are already established:

1. Adaptive reuse—is a method that reuses whole or part of a structure that is redundant.
2. Deconstruction—is the careful dismantling to maximize the recovery of components to be reused.
3. Design for deconstruction (DfD)—is a designing method that closes construction component loops.
4. Design for reuse (DfR)—incorporates the use of reclaimed components in the design of new structures.

For better understanding of the enumerated interventions in promoting reuse specifically DfD which could also be related to the other three interventions mentioned, Figure 3 shows a simplified life cycle of a building comparing the conventional design, construction, and disposal of demolished structures as shown in grey. The conventional method involves a linear approach that does not minimize or lessen the production of CDW dumped in landfills or incinerated. This is compared to the method incorporating DfD, which promotes the design of building materials that are capable of being deconstructed, remanufactured, and reused in new construction applications. This circular approach to a conventional method promotes minimized production of CDW that burdens the environment and threatens the sustainability of the construction and demolition industry.

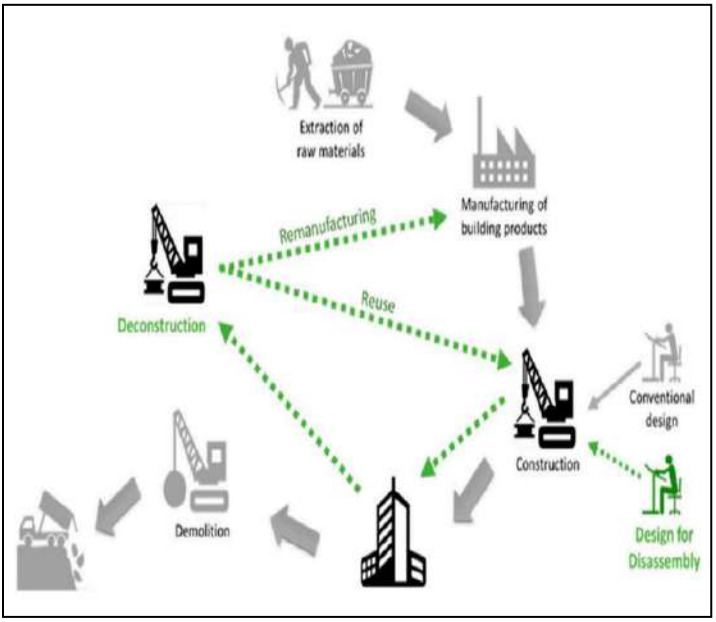


Fig 2: Building life cycle with conventional method and design for deconstruction (DfD).

4. Methodology

A comprehensive and modern method of literature review was done to address the research objectives previously stated. Relevant literature was found using a keyword-based search from electronic databases such as https://www.scopus.com and was explored by typing the keywords "circular economy" AND "construction" OR "demolition" AND "waste" OR "recycling". From the results, the search is narrowed down from documents published in 2016 to 2020 so as to review recent studies done in the field to avoid reviewing outmoded studies. A total of 360 documents were found. From the 360 documents, by manually reading the abstracts and parts of the entire article, and considering the following criteria:

Studies that assess and discuss the use of recovered materials in the manufacturing of new construction materials from a CE perspective.

Studies that assess reuse, recycling, and recovery of CDW from an environmental perspective.

Studies that assess and discuss the effectivity of recovered, reused, or recycled CDW from a mechanical/performance perspective.

Studies that discuss effective CE framework in CDW material recovery and production.

Papers that qualified to at least one of the mentioned criteria, were not redundant to other articles, and were critiqued as papers focusing only on CE, CDW, and reuse and recycling of CDW in new construction applications were included, which gave a total of 34 papers. Early studies and published papers were also included in this review article, thus showing that studies in CE in CDW were made as early as the 20th century. A review of the research articles was conducted to review existing CE frameworks focusing on material recovery and processing and to assess the present reuse and recycling strategies of CDW and its competitiveness with its virgin counterparts. Utilizing Matlab text data analytics, a software that makes data science easy with tools to access and pre-process data, build machine learning and predictive models, and deploy models to enterprise IT systems, the abstracts were pre-processed applying a Latent Dirichlet location model or LDA, which is a particularly common method for fitting a topic model and is a kind of algorithm that is a three-level hierarchical Bayesian-modelling process which groups a set of items into topics defined by words or terms to discover the underlying topics among the articles. Using LDA, four primary topics were obtained and are as follows:

Topic 1: demolition, waste, material, recycling

Topic 2: circular economy, construction, environment, transition

Topic 3: research, potential, reuse, building

Topic 4: aggregate, concrete, strength, mechanical

The topics from the 34 included papers focus on the four primary topics as shown above and in Figure 1. Topic mixtures and probabilities are shown in Figure 2. Topic 1 primarily focuses on waste produced in the construction and demolition industry and the recycling of such materials to new applications. Topic 2 focuses on the circular economy, the transition into and the environmental impacts of CE. Topic 3 focuses on the research on the potential of reuse in building materials. Lastly, topic four focuses on the research of mechanical properties or performance of reused or recycled materials. Figure 4 demonstrates the trend and number of papers published from 2016 to 2020 on the topic showing the increasing awareness on CDW among researchers.

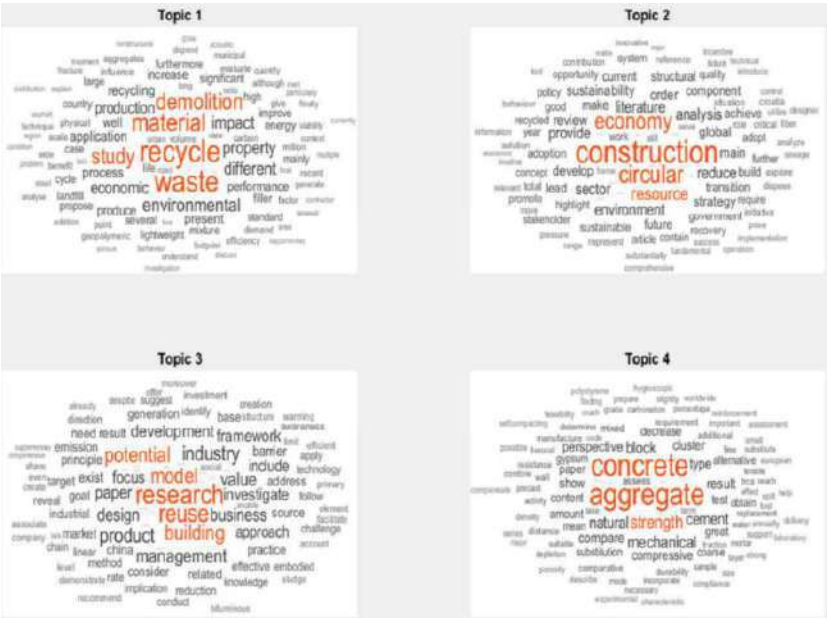


Fig 3: Primary topics found in the 35 included papers using text data analytics.

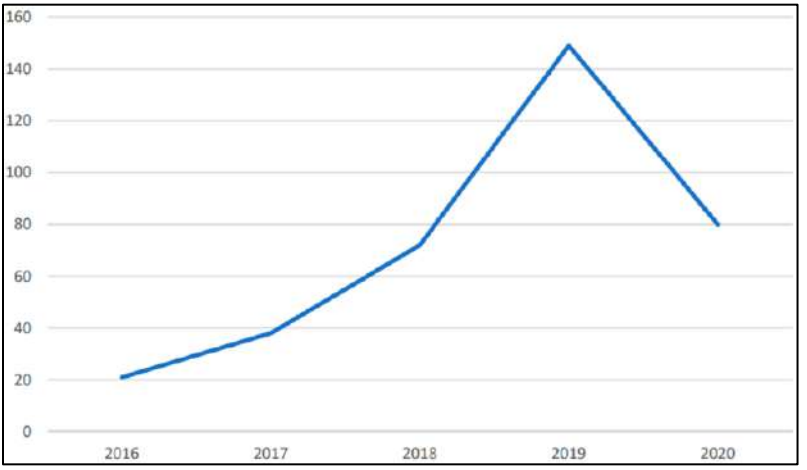


Fig 4: Number of papers published per year on the topic.

Systematic Framework to Demonstrate Circular Economy

Demolish concrete can be reused for purpose of recycling as shown in figure.

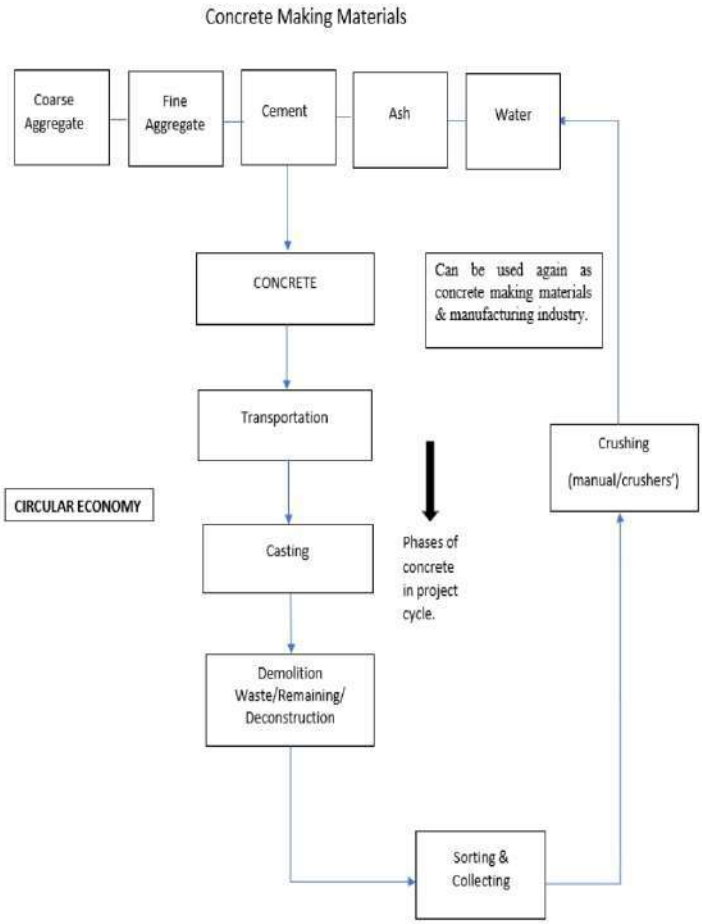


Fig 5: Circular economy towards concrete making materials (Author made)

5. Introduction Sdg-8

Sustainable Development Goal 8, along with ten targets, two enablers and seventeen international indicators, aims at promoting sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all.

Sustained economic growth along with productive employment for all provide the much-needed base and support for realising the seventeen ambitious SDGs. As such, prioritising SDG8 is but imperative as the pace of the global economic growth has been slow in recent years and is also marred by frequent fluctuations and instabilities. There are reports that currently, the rate of unemployment is rising, particularly among the youth.

India, being the sixth largest economy in the world, achievement of SDG8 here is likely to contribute significantly to the progress of SDGs at the global level. India strives to provide every citizen of the country, decent work, and full and productive employment to contribute towards the GDP growth of the country.

Employment Generation and Economic Growth

Employment generation and economic growth are complementary. Employment must be generated to accelerate economic growth. To be gainful and sustainable, employment has also to be productive in character, providing decent work conditions.

While a high rate of output growth is necessary, it is not always a sufficient condition for high growth of employment. A structure of growth with larger contribution of sectors having high employment content and use of production techniques favouring the use of labour, greatly enhance the employment generation potential of growth.

SDG 8: Progress so far at the Global Level

The Report of the UN Secretary-General, titled, 'Special edition: progress towards the Sustainable Development Goals', 1 state that' globally, labour productivity has increased, and unemployment is back to pre-financial crisis levels. However, the global economy is growing at a slower rate.' More progress is, therefore, needed to increase employment opportunities, particularly for young people, reduce informal employment and the gender pay gap and promote safe and secure working environments to create decent work for all.

As regards economic growth and employment generation, some of the highlights are:

Economic growth rates for least developed countries, measured in terms of real GDP growth per capita, was about a third of the 2030 Agenda target of 7 per cent.

The Asia-Pacific Regi energy but notable headway on poverty, quality education and affordable and clean energy, but has also gone backwards on clean water and sanitation, decent work and economic growth and responsible consumption and production.

In sub-Saharan Africa, access to electricity is increasing and efficiency in energy use is improving, but the region’s abundant renewable energy potential remains largely untapped. Africa is also the fastest urbanizing region globally, and its potential benefits have yet to be fully realized.

As regards employment, Africa has the highest rate of estimated informal employment in the world, at 85.8 per cent of total employment, and the highest rate of vulnerable employment globally, averaging 66 per cent.

Landlocked developing countries face infrastructure deficits – only 52 per cent of their populations have access to electricity, compared with the world average of more than 87 per cent.

In 2018, one-fifth of the world's youth were not in education, employment or training, meaning that they were neither gaining professional experience nor acquiring or developing skills through educational or vocational programmes in their prime years. There is a stark gender difference.

Many workers around the world are exposed to undue risks in their workplace.

Youth unemployment in the Arab region exceeds 30 per cent and reaches 48 per cent among young women.

Informal employment, which has an impact on the adequacy of earnings, occupational safety and health and working conditions, remains pervasive.

Disparities between developed and developing countries are also apparent along other dimensions – while Europe and Northern America spend 2.21 per cent of GDP on research and development, this figure falls below the global average of 1.68 per cent in most developing countries.

6. SDG 8 in INDIA

To measure India's performance towards SDG8 (Decent Work and Economic Growth), forty national indicators have been identified to capture the SDG targets and regularly measure the progress. The NITI Aayog identified four broad national indicators based on availability of data at the national level to measure the progress so far3.

Indicators Selected for SDG INDIA INDEX (2018)	National Target Value for 2030	Progress so far
Annual growth rate of GDP per capita (at constant price of 2011-12)	10 %	6.5 %
Average unemployment rate per 1000 persons for males and females	14.83	63.5
Percentage of household with a Bank account	100	99.99
Number of ATMs per 1,00,000 population	50.95	16.84

THE SUSTAINABLE DEVELOPMENT GOALS REPORT 2022: UNSTATS.UN.ORG/SDGS/REPORT/2022/

7. Flagship Government Schemes for Achieving Sdg8.

India aims at achieving SDGs by 2030 through its visionary and prudent initiatives involving every citizen. To accelerate economic growth, it is

striving hard to generate decent employment opportunities and enhance the GDP of the country. Some of the notable flagship programmes include:

The Mahatma Gandhi National Rural Employment Guarantee Scheme- It is aimed at enhancing livelihood of rural poor by guaranteeing 100 days of wage employment in a financial year. As on 1630 September 2019, 120.1 million active workers are enrolled in MGNREGA.

Pradhan Mantri Rojgar Protsahan Yojana – It has been initiated by the Ministry of Labour and Employment in the year 2016-17 for incentivizing employers for employment generation. Till 16th September 2019, benefits have been given to 1.52 lakh establishments covering 1.21 crore beneficiaries. The last date of registration under PMRPY was 31stMarch, 2019.

Make In India - The Programme aims at making India a manufacturing hub to facilitate job creation and skill development across various sectors of the Indian economy. It will facilitate investment, foster innovation, enhance skill development, protect IPR and build best in class manufacturing infrastructure.

Skill India Mission - Launched on 15 July 2015, the Skill India Programme is a comprehensive programme that aims at training and developing industrial, entrepreneurial skills among Indians to create jobs in the country.

National Career Service (NCS) - National Career Service Project brings employers, trainers and unemployed on single platform. As many as 1.05 crores active job seekers and 7797 active employers are on the portal as on 23rd September 2019.

Pradhan Mantri Matsya Sampada Yojana – It has been proposed to address infrastructure gaps in the fisheries sector. 10,000 new Farmer Producer Organisations will be setup over the next five years. • Pradhan Mantri Fasal Bima Yojana (PMFBY) - provides insurance cover for all stages of the crop cycle including post-harvest risks in specified instances. Claims of Rs. 8,665 crores were paid to 553.01 lakh farmers in the year 2018-19.

Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) - The scheme aims to provide a payment of Rs. 6000/- per year, in three 4-monthly instalments of Rs. 2000/- to the farmers, subject to certain exclusions relating to higher income groups. An amount of Rs. 12646.579 crore has been distributed to 632.32895 lakh farmers in the year 2018-19.

Pradhan Mantri Jan Dhan Yojana - Launched on 28 August 2014, this scheme is promoting financial inclusion and ensuring access to the various

financial services, particularly covering the weaker sections and low-income groups. As on4 September 2019, there are 36.89 crores beneficiaries under the scheme.

MUDRA Yojana4 - The objective is to create an inclusive, sustainable and value based entrepreneurial culture, in collaboration with our partner Institutions in achieving economic success and financial security. For the financial year 2019-2020 number of PMMY loans sanctioned is 17989639and the amount disbursed is Rs 90565.18 crore.

Digital India Mission - Launched on 1 July 2015, this Programme aims at transforming Indian economy by focusing on three core components which include - creation of digital infrastructure, delivering services digitally and digital literacy.

8. Twin Towers Demolition Waste Materials Re Sustainability to Start Recycling of Twin Towers Demolition Waste (Case Study)

Re Sustainability said it is likely to start recycling of 30,000 tonnes of waste generated from the demolition of Supertech's twin towers.

The company has bagged the contract from Noida Authority to recycle waste generated from the demolition of Supertech's twin towers over the next three months. The waste will be converted into construction materials. Total waste generated from the demolition is estimated at 80,000 tonnes. The twin towers, nearly 100 metres tall, were demolished on 28 August 2022, Sunday. More than 3,700 kilograms of explosives were used in the operation. Nearly Rs 20 crore were spent to demolish the twin towers, although Supertech said it suffered an Rs 500 crore loss in the development of these two towers. "We have got the mandate to recycle 30,000 tonnes of waste into construction materials like sand, aggregators and tiles," Re Sustainability CEO Masood Mallick told reporters here. He said the company is likely to start recycling work and it will take 3 months to complete the process.

Re Sustainability will get Rs 156 per tonne from the authority to complete the work order. "We are targeting to achieve 100 per cent recycling of these 30,000 tonnes of waste. We will convert waste into 9,000 tonnes of sand (fine and coarse), 18,000 tonnes of aggregator of 10 mm, 20 mm and 40 mm sizes," Mallick said, adding that the remaining 3,000 tonnes would be tiles and paver blocks.

The company has not been engaged for transportation of waste from twin towers site to its plant at Sector 80, Noida, he said, the waste materials will be delivered at the factory by Noida authority. Mallick said the recycled construction materials are sold at discount in the market. Re Sustainability Ltd (RE), a KKR-backed company, offers a whole gamut of environmental services and infrastructure solutions under various categories such as waste management -- hazardous, municipal, and biomedical, construction waste and e-waste; waste to energy; recycling -- wastewater, paper, plastic, and integrated waste; environmental solutions; automated car park management and facilities management.

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