# A STUDY OF PRESENT STATUS OF WASTE MATERIALS IN THE STATE OF ORISSA FOR UTILIZATION IN MAKING A GREEN BUILDING

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**Abstract**
The mineral rich state of Orissa is producing a lot of industrial wastes as well has agricultural wastes. The industrial belts are highly polluted without effective utilization of its industrial wastes. The present paper focuses on utilization aspects of these solid wastes for making eco-friendly and affordable green buildings.

**Key words**
Industrial wastes, Agricultural wastes, Affordable housing, Green buildings, Sustainable

## INTRODUCTION

The components of building block of traditional materials such as brick, stone, natural river sand, Ordinary Portland cement, wood, paints, steel etc. have some environmental effects during their life cycle from manufacturing, transportation, uses to demolish for contaminating air, water, soil and reducing the natural resources day by day. The spiraling cost of such traditional building materials makes the housing unaffordable or a distant dream for an average income salaried person in a tier-2 or tier-3 cities, forgetting about the tier-1 and Metros. This leads to have more and more R&D to find out alternative low cost, energy saving, eco-friendly, recyclable solid wastes from industries, agricultures, mines for effective utilization as a partial or full replacement of such components for uses in buildings and infrastructures. Though the research has been well established time and again of the benefits of these waste materials but it is the mind set and conservative approach of our Planners, Engineers and Architects for coming out with a novel way or making some changes in their perspective for which the common man or the society is not able to reap the harvest out of these research works. So, it is the high time for all of us to leave aside our traditional conservative approach to move forward for using such alternative eco-friendly green building materials and techniques for a sustainable development.
Fig.1 gives the details of current status of solid waste (non-hazardous and hazardous waste) generation from different sources in India [1, 2].

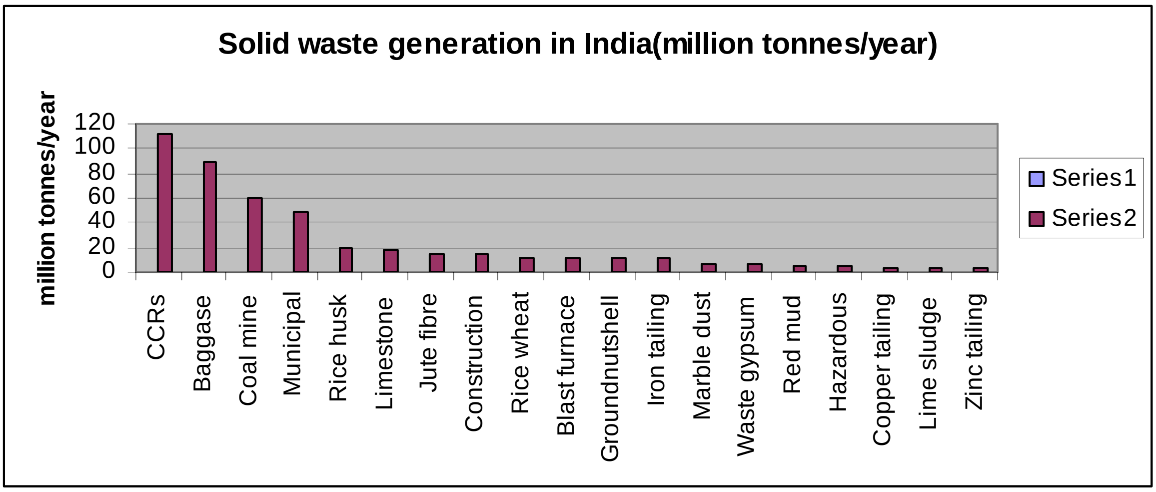


**Figure1.** Solid waste generation in India [3].

The major quantity of wastes generated from agricultural sources are sugarcane baggase, rice husk, jute fibre, coconut husk, cotton stalk etc. The major industrial non-hazardous inorganic solid wastes are coal combustion residues, bauxite red mud, tailings from aluminum, iron, copper and zinc primary extraction processes.
The state of Orissa has huge deposits of iron ore in the predominantly tribal regions of the mineral-rich State. Besides iron ore (32.9 per cent of the country's reserves), it accounts 26% coal and 67.6 per cent manganese reserves of the country. About 98% of the total proved chromites (chromium ore) reserves of the country, of which about 97% occur in the Sukinda Valley, over an area covering approximately 200 sq. km., in the Jajpur district which is used for production of iron-chromium alloys (ferroalloys).The state has world’s fourth-largest bauxite reserves of a total deposit of 1805 million tones constituting about 58% of the country’s total reserves of the ore that is used to make aluminium .All these facilitates for setting up mainly Steel, Aluminium and power plants in the state with a proactive state government policies but without any road map for optimization it’s mineral resources and natural resources such as land and water.

The major industrial belt in the states of Orissa are Kanhia-Talcher-Angul, Jharsuguda-Brarajnagar-IB valley, Kalinga Nagar-Jajpur Road, Damanjodi, Rourkela and Choudwar region for producing industrial waste slag as well as fly ash and making an environmental hazard to a complete catastrophe without any effective utilization of these precious wealth from the waste for a more sustainable development. It includes fly ash & bottom ash from thermal power plants, chemical slags from Iron Steel plants and red mud from Aluminium industries. Some of the wastes are designated as hazardous because of their composition and hazard potential. There is about 80000 MT/annum of hazardous waste being generated in the state of Orissa. The most polluted belt in Orissa is Talcher (Fig.2) and Jharsuguda (Fig.3) region as per the report of Orissa State Pollution Control Board.Table.1 presents the installed capacity of different plants in the region. The satellite map of Talcher region (Fig.2) clearly shows the loss of green cover and creating an environmental disaster in the region. This has become pot boil in the country where temperature goes up to 50$^{o}$ C in the summer making the life of the people miserable.

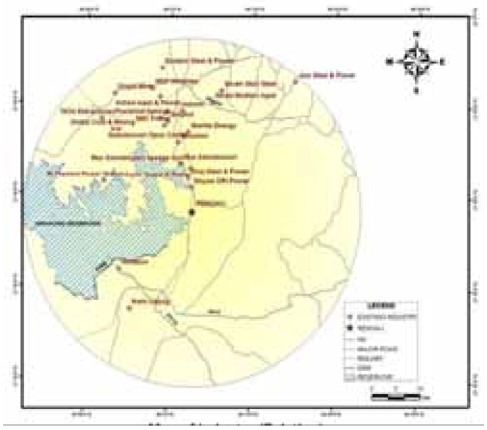

**Fig.2** Satellite map of Talcher region **Fig.3** Map of Jharsuguda region

**Table-1 :** Industrial scenario in Talcher-Angul and Jharsuguda-IB valley area [4]

| | | Ib valley-BrajarajNagar-Jharsuguda | | Kanhia-Talcher-Angul | |
|---|---|---|---|---|---|
| Sl. No | Industrial sector | Numbers | Capacity | Numbers | Capacity |
| 1. | Coal mines | 13 | 44 MTPA | 15 | 81 MTPA |
| 2. | Thermal power plants | 6 | 2012 MW | 4 | 1713 MW |
| 3. | Iron and Steel including sponge iron plants | 11 | 2.85 MTPA | 3 | 2 MTPA |
| 4. | Ferro alloys | - | - | 3 | 0.2 MTPA |
| 5. | Aluminum smelter | 1 | 0.25 MTPA | 1 | 0.345 MTPA |
| 6. | Coal Washeries | 3 | 6.0 MTPA | 4 | 9.456 MTPA |
| 7. | Other Red - B industry | 72 | - | 13 | - |
| | Total | 106 | | 43 | |

Orissa State Pollution Control Board has given a dead line of a short term of 31$^{st}$ March and 31$^{st}$ March 2012 and a long term by 31$^{st}$ March,2014 to all the polluting industries in these two regions to take effective steps for controlling the pollution as follows [4]:

**Action Plan to be taken by Thermal Power Plant** [4]

- All TPPs to install ESP/BF to meet the emission standard of 50 mg/m$^3$ with one spare field.
- All lean slurry disposal system to be converted to (High Concentration Slurry Disposal) HDSD.
- Silo to be created for a capacity of at least 7 days ash generation for its dry storage and subsequent utilization for cement and after fly ash based products.
- Real time ambient air quality monitoring (SOx, NOx, CO, PM10, PM5 ).
- All the thermal power plants shall adopt zero discharge

**Action Plan to be taken by Iron & Steel and Ferro alloys Plant** [4]

- All DRI plants to install ESPs, in the kiln, bag filter in dust generating points and pneumatic dust handling system.
- All steel plants and sponge iron plants to develop collection and treatment facility for mineral char and coal pile run off during monsoon.
- Installation of online stack monitoring system with real time display system

- Real time ambient air quality monitoring (SOx, NOx, CO, PM10, PM5 )
- Use of SMS slag and Ferro alloys slag for haul road construction in the mine area.

**Action Plan to be taken by Alluminium Plant** [4]

- Pot line of Smelter Plants to be upgraded to meet the emission norm of 0.3 kg of fluoride per ton of Aluminum by revamping the fume treatment plant.
- Online stack emission monitoring system with display system shall be installed.
- Installation of fluoride removal (Fume treatment) system from bake over plant.
- Construction of secured landfill within plant premises.
- Conducting a comprehensive wastewater audit for the smelter plant including runoff management.
- Real time ambient air quality monitoring (SOx, NOx, CO, PM10, PM5 )
- Installation of hazardous waste incinerator.

## GREEN BUILDING MATERIALS AND PRACTICES

There is also large quantities of agricultural wastes such as rice husk, coconut coir etc. which need to be effectively utilized for a sustainable approach. Buildings account for 33% of all energy consumption, 12% of all water use, 30% of all greenhouse gas emission, 65% of all waste out put and 70% of all electricity consumption [5].Green Building concept and sustainable development has recently emerged as important areas in India and have caught the imagination of builders, planners and environmentalists. Green Building, also known as sustainable building, is the practice of making structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Some common features of green buildings are:

- Minimize the demand for non-renewable resources and energy.
- Maximize reuse, recycling and utilization of renewable resources like water, energy and other materials.
- Utilize locally available low cost building materials and environment friendly construction practices
- Optimize the use of on site sources and sinks by bioclimatic architectural practices.
- Use efficient equipment to meet its lighting, air conditioning and other needs.
- Use renewable energy (like solar, biomass, wind energy) to the maximum extent possible.
- Are embedded with efficient water saving devices.
- Recycle wastewater and treat it in environment friendly way using minimum energy.
- Consider the many types of environmental impacts (e.g., global warming, resource depletion) at the many different life cycle stages of a product (e.g., manufacturing, transportation, use, disposal);
- Eliminate the use of materials that pollute or are toxic during their manufacture, use or reuse.

It has become a major challenge before the green building developers to adopt green construction techniques including recycling of construction debris. This certainly calls for more R & D.

**Some of the identified green materials**
Fly ash cement, Recycled aluminum, Recycled tiles, Bamboo based products, Green Roofs, Fly ash block, Recycled steel, Low VOC paints, HFC based high efficiency chillers, Recycled wood.

To elaborate on green building materials and practices bamboo and straw, lumber from forests certified to be sustainable managed, stone, recycled metals and other products that are non-toxic, that are renewable, reusable, and recyclable. Building materials if extracted and manufactured locally are desirable from the point of view of least energy consumption in their transport to the site. Table 2 gives the present and Fig.4 gives the future recycling and utilization potential of some of the solid wastes from different sources in the country.

**Table 2**.Types and nature of solid wastes and their recycling and utilization potentials [3].

| Sl. No | Types of solid wastes | Source details | Recycling and utilization in building application |
|---|---|---|---|
| 1 | Agro waste (organic nature) | Baggage, Rice and wheat straw and husk, Cotton stalk, Saw mill waste, ground nut shell, banana stalk and jute, sisal and vegetable residues. | Particle boards, insulation boards, wall panels, printing paper and corrugating medium. roofing sheets, fuel, binder, fibrous building panels, bricks, acid proof cement, coir fibre, reinforced composite, Polymer composites, cement board. |
| 2 | Industrial wastes-inorganic | Coal combustion residues, steel slag, bauxite red mud, Construction debris | Cement, bricks, blocks, tiles, paint, aggregate, concrete, wood substitute products, ceramic products |
| 3 | Mining/ Mineral waste | Coal washeries waste, mining overburden waste Tailing from iron, copper, zinc, gold, aluminium industries | Bricks, tiles, lightweight aggregates, fuel |
| 4 | Non hazardous other process waste | Waste gypsum, lime sludge, lime stone waste, marble processing residues, broken glass and ceramics, kiln dust | Gypsum plaster, fibrous gypsum boards, bricks, blocks, cement clinker, super sulfate cement, Hydraulic binder |
| 5 | Hazardous Waste | Metallurgical residues, galvanising waste Tannery waste | Cement, bricks, tiles, ceramics and board |

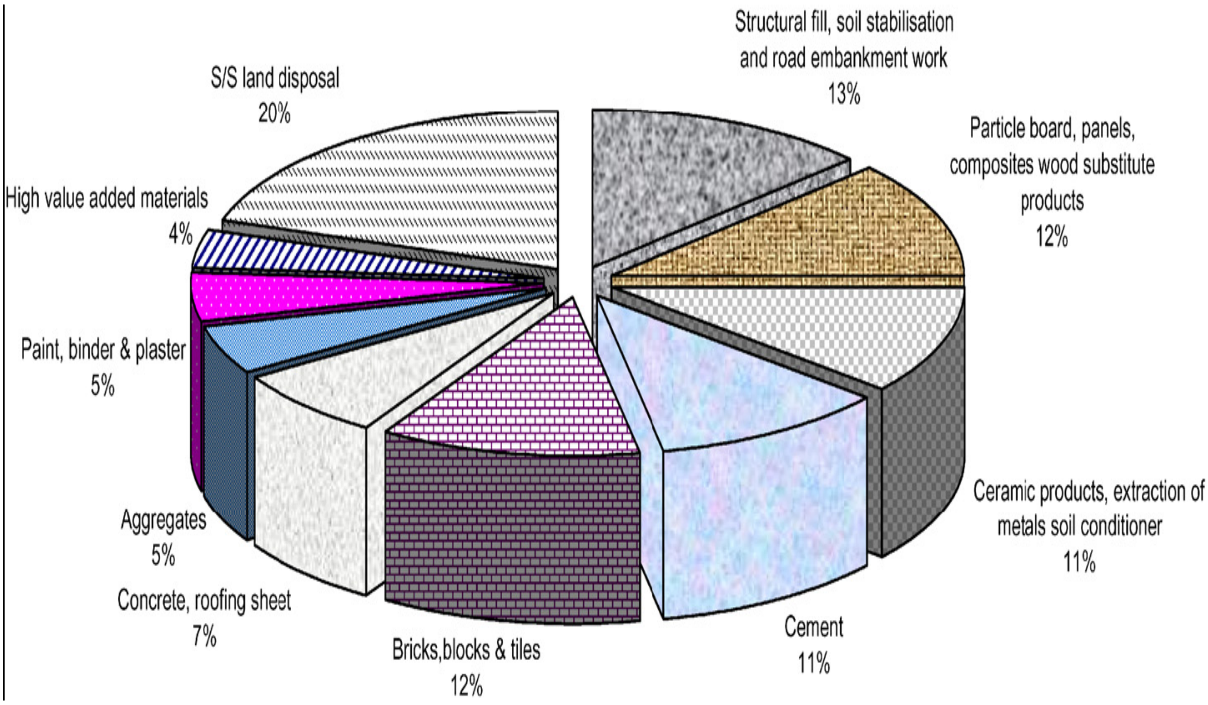


**Fig.4** Future Potentials for solid waste recycling and utilization [3].

It is always desirable to utilize locally available low cost building materials and environment friendly construction practices. The following materials and techniques which are available can be utilized in making a green building.

**Utilization of fly ash**

There has been a constant increase in the utilization of fly ash yet the unutilized fraction is also growing considerably increasing from 39 million tones in 1993-94 to 70 million tones in 2006-2007 in India. This has grave environmental consequences. A lot still needs to be done. Some of these include use of fly ash in mine filling, construction of roads/ flyover embankments, hydraulic structures, raising of dykes, manufacture of several building components like bricks, blocks, tiles and use in agriculture. Use of fly ash for RCC (reinforced cement concrete) structures with in-fill walls and load bearing structures, mortar, and binders are other uses of fly ash. The IS code limits the pozzolanic fly ash to 15% in blended cement, where as Code also allows up to 35% replacement of cement for uses in concrete mix. Hence there is every scope for additional uses of 20% in concrete mix with a blended pozzolanic fly ash based cement which not only gives a durable and high strength concrete but also more environment friendly for restricting the green house gas emissions. High volume fly ash concrete also can go beyond 50% replacement of cement in concrete [6].

**Utilization of ground granulated blast furnace slag (ggbs)**

Granulated blast furnace slag when properly grinded can be used as partial replacement of cement up to 50% in concrete. The blast furnace kinker slag can be used as coarse aggregate in cement mix also.

**Utilization of red mud**

Red mud has been used as a substitute for ordinary clay for producing bricks. Several attempts have been made to recycle red mud not only to avoid environmental pollution, but also to use it in developing polymer composites, wood substitute products, bricks, ceramic glazes such as porcelain, sanitary ware glazes, electro porcelain glazes, tiles and extraction of metals [3].

**Utilization of crushed sand**

Natural river sand has been banned by some of the states in India for use in construction because of ecological problems. The crushed sand from crusher industries can be used as a replacement of natural river sand in construction. But the crusher dust should be screened properly for getting a well gap graded fine aggregates.

**Utilization of rice husk**

Rice husk is available in the state which is basically used as fuel by burning it and thus releasing $CO_2$ to the atmosphere and causing green house gas emission. Rice husk can be used for manufacturing of light weight concrete.

**Use of coconut coir**

Coconut coir can be used as natural fibre in concrete for increasing the stiffness and ductility of the concrete. It also reduces plastic shrinkage and dry shrinkage of the concrete.

**Use of bamboo as reinforcement**

Bamboo has been used since a long time for reinforced clay roof. Same can be used for reinforcement of thin & light weight Reinforced Concrete Structures. Bamboo tree grows very first than any other tree and can be very effective for partial replacement of steel reinforcement and thus making it eco-friendly.

**Use of heat shield Coating**

Heat shield coating helps for terrace and outer walls reflects infrared as well as UV(Ultra Violet) radiation, decreasing the room temperature between 5 to $10^o$ C and thus helps in saving energy up to 28% and preventing global warming[8].

**Use of low VOCs paints**

Use of low toxic, solvent-free coating helps in reducing VOCs(Volatile Organic Compounds).Efforts should to develop & use more and more zero VOCs paint or coating such as polyurethane based hygiene coating for improving indoor air quality.

**Use of Rat trap Bonds in Brick walls**

Rat trap bond helps to create a cavity in between external & internal surfaces which reduces the internal temperature of the room by 5 to $10^o$ C and making the room cool thus saving energy. It also saves the bricks by 20-30% which in turns saves the loss of fertile top soil.

## CONCLUSION

Use of industrial wastes and by-products as an aggregate or raw material is of great practical significance for developing building material components as substitutes for the traditional materials and providing an alternative or supplementary materials to the housing industry in a cost effective manner at the same time converting this poison to a nectar. Use of local available agricultural wastes, other low cost materials and techniques will certainly be helpful for cost economy, eco-friendly and affordable durable housing which will bring cheers to the millions of people for getting their green dream houses.

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