EUROPEAN UNION

EU-REI
Creating a Resource Efficient India

Mainstreaming Material Flow Assessment to Enhance Resource Efficiency of Construction Sector in India

POLICY BRIEF

Development Alternatives

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Member of iPoint Group

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CONTEXT

This policy brief has been prepared on the basis of a study on Analysing Resource Flows in Indian Cities (with a focus on Construction Sector), undertaken as part of European Union's Resource Efficiency Initiative (EU-REI) in India. EU-REI aims to support India in the United Nation's Global Sustainable Consumption and Production (SCP) agenda. The objective of the study is to understand the flow and consumption of material resources for construction in cities in order to assess the potential of replacing their ever-increasing use with secondary (waste-derived) resources. The brief focuses on resource flows in construction sector in two Indian cities – Ahmedabad and Bhubaneswar and points to possible actions that may be taken at the city level keeping in mind the overall objective of reducing virgin resources consumed by the sector through utilisation of secondary resources. It encapsulates the findings of Material Flow Analysis (in terms of quantum) of the housing sector in the two cities and its environmental footprint (CO_2 emissions - equivalent). Material efficiencies can contribute to de-carbonsing the construction sector while addressing municipal and industrial waste management issues. Priority areas for policy-action at the city level and have been identified for resource efficiency of the construction sector.

KEY MESSAGES

1 **Life Cycle Assessment (LCA) and Material Flow Assessment (MFA) are necessary tools to steer the housing and infrastructure development towards resource efficiency in the coming decades.**

Housing as a sector will add nearly 70 and 40 million sq.m of built space, between 2020 - 2030 in Ahmedabad and Bhubaneswar respectively. Assessing material flows across urban centers is necessary for a comprehensive understanding of resource requirements as well achieving resource efficiency through substitution across the value chain of buildings. MFA will aid LCA based procurement and will be instrumental in reducing environmental burden of this massive demand. Combining LCA and MFA is an innovative but urgently required tool for sustainable decision making.

2 **Reliable data for assessing environmental cost of material flow and to establish realistic potential of secondary materials in construction is an urgent requirement.**

Urban Local Bodies must take the initiative in setting up the required data infrastructure and analysis tools. Without reliable and consistent data, results might lead to inadequate decisions.

3 **Currently, there is negligible appreciation at the city level of the environmental impact of the scale of virgin resource consumption by the construction sector in the long term.**

The intent at the national level policy for achieving resource efficiency in the construction sector needs to be converted to a roadmap for action at the state and city level.

4 **Secondary resources have a significant role in fostering resource efficiency in construction sector through partial replacement of virgin resources.**

Recycled aggregates from concrete and brick waste have immense potential to replace river sand and natural aggregates. From our analysis, close to 30 million tonnes of recycled aggregate from concrete and brick debris can be made available in Ahmedabad over the next 10 years.

5 **Sustainability of concrete is the single most effective strategy for resource efficiency of the construction sector.**

If business-as-usual continues, the demand for three key abiotic materials – limestone (for cement), sand and stone (for aggregates) will create severe environmental and social stress on the state's resources.

6 **Supply of secondary resource-based construction materials needs to be strengthened consistently through technical support and financial incentives to building material entrepreneurs and private developers.**

Currently, the commercial supply of such materials is largely limited to Fly ash bricks. There is good potential to augment this supply end, for instance through recycling C&D waste and industrial waste into aggregates and/or masonry blocks. This will need simultaneous action on transferring technologies from research institutions to building material enterprises and financial incentives, particularly for accessing the secondary resources available as C&D and industrial wastes.

1 INTRODUCTION

Resource Efficiency (RE) is recognized today as the inevitable way towards sustainable development. Given its objective of creating greater value with less input and minimised environmental impact, RE is necessary for continued resource availability for sustained growth of industry. It also holds tremendous potential for social benefits through resource affordability, conservation of abiotic[1] resources and job creation, for instance in recycling sectors. The emergence of Tier-2 and 3 cities of India as future engines of growth constitutes a significant shift in demand and consumption of material resources in the country. Nearly 2/3rd of the estimated 590 million population in 2030 will live in Tier 2 and 3 cities[2]. Manufacturing and service sector industries are increasingly being located in these cities, thus increasing disposable incomes and, consequently, generating urbanisation and real estate momentum.

The NITI Aayog[3] in its Strategy for Resource Efficiency for India has identified Construction as one of the priority sectors in India. The sector accounted for 20% of the material demand in 2007[4] which grew by more than 1 billion tonnes from 1997-2007. It is estimated to grow annually at an average 6.6% from 2019-2028.[5] In 2012, it was estimated that 70% of the buildings that will exist in 2030 are yet to be built (NRDC-ASCI-Shakti, 2012). Initiatives like Smart Cities Mission and Housing for All, both of which primarily target Tier 2 and 3 cities[6], are among major drivers for the sector. The sustained availability of key materials consumed by the sector – cement, iron/steel, sand, soil and stones (aggregates) – is already estimated to be under varying degrees of stress, given the current rate of expansion of built space in urban agglomerates. Due to environmental restrictions to curb rampant illegal mining, the supply and price of sand has already been disrupted in many parts of the country. As per estimate by FICCI Mines and Metals Division (2013), limestone availability for cement industry is not assured beyond 50 years. It is imperative that alternative secondary resources start getting deployed in a targeted manner to replace limited biotic resources consumed in construction.

1 Abiotic resources are non-living (physical and chemical) resources present in the eco-system, such as water, soil, minerals and fossil fuels. Their depletion through ever-increasing extraction for human use- such as sand and gravel for construction – is a critical environmental concern.

2 India's urban awakening; building inclusive cities, sustaining economic growth – Mckinsey Global Institute, 2010

3 NITI (National Institution for Transformation of India) Aayog is a policy think tank of the Government of India. It is responsible for strategy and policy formulation for Resource Efficiency and Circularity in Indian industries.

4 Strategy Paper on Resource Efficiency, June 2017 – NITI Aayog https://niti.gov.in/writereaddata/files/document_publication/Strategy%20Paper%20on%20Resource%20Efficiency.pdf

5 https://www.makeinindia.com/sector/construction

6 The 'tier' classification system of cities in India is based on the city's population. As per 2001 Census- Tier 1, 2 and 3 cities have population more than 100,000, 50,000 to 99,999 and 20,000 to 49,999.

Policy at the national level in India has started to acknowledge the urgency for resource efficiency and circularity across primary industries, including construction. Draft guidelines and policy roadmaps for resource efficiency, for instance pertaining to sand management and recycling of Construction and Demolition (C&D) waste have been developed in the last few years. However, implementation of these guidelines and action to translate policy to practice remains a big challenge, with little evidence on ground indicative of a directional shift towards reducing the virgin material intensity of the construction sector by utilisation of secondary resources. The utilisation of fly ash in construction sector in India is the only example of this shift towards tapping the potential of secondary resources. Life Cycle Assessment (LCA) and its constituent Material Flow Analysis (MFA) are increasingly being validated globally as effective tools for enhancing resource efficiency of buildings and construction. Urban Local Bodies (ULB) and private developers – both of which have a critical role in re-aligning material demands and consumption trends are yet to adopt any such methodologies in their decision making and businesses.

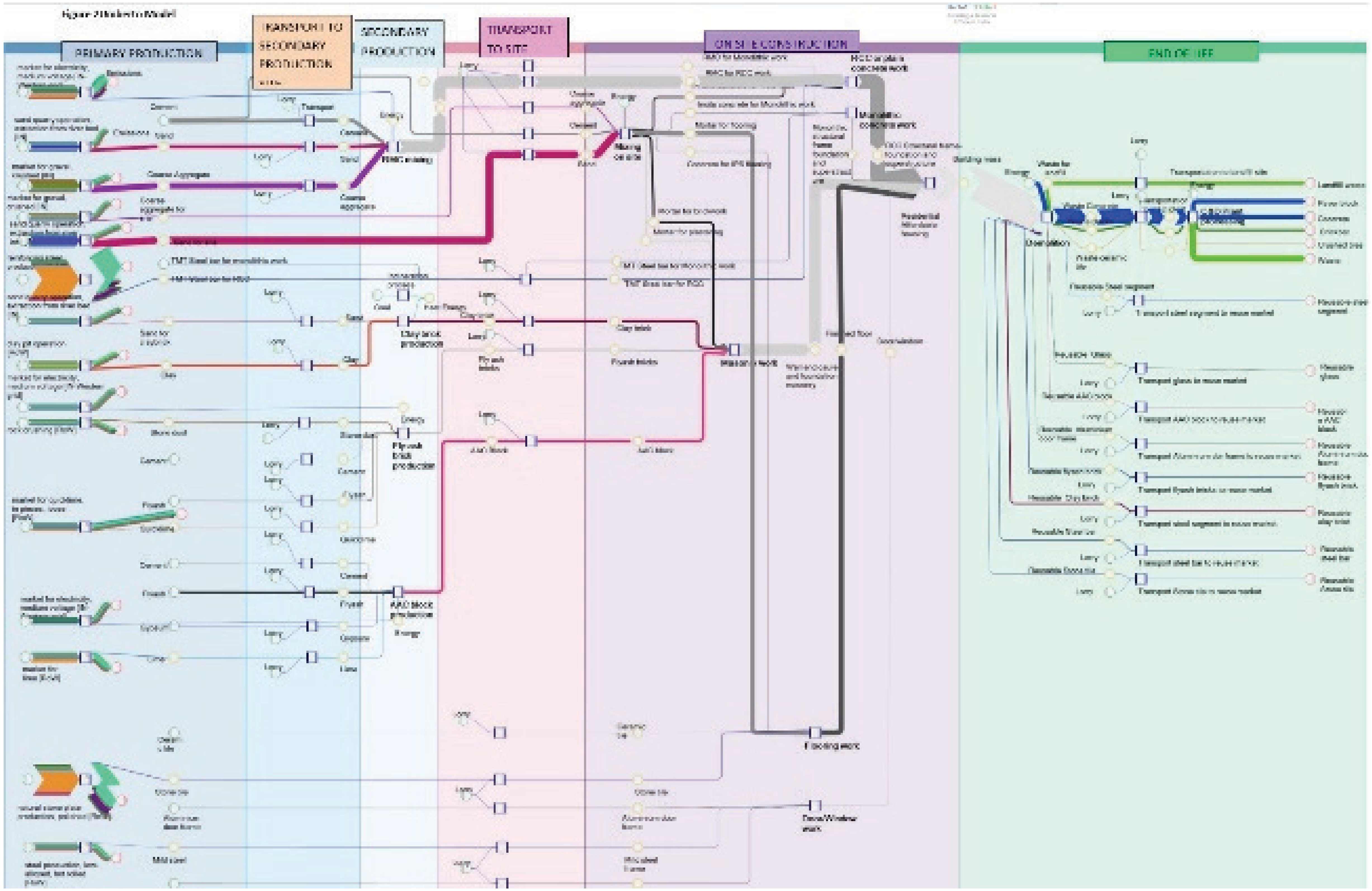
MATERIAL FLOW ANALYSIS AND LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA) has become an important tool today to address the challenges of Resource Efficiency and Circularity. LCA is essentially an assessment of environmental repercussions associated with various stages of a product's life. Buildings, with their life cycle from extraction of virgin resource for building materials to the ultimate demolition and disposal in landfills, are the 'product' in the LCA of construction sector. Material Flow Analysis (MFA) is a tool to quantify the flow and stock of materials within complex systems in order to identify de-materialisation strategies aimed at resource efficiency. In terms of practice, MFA is a stage of LCA.

The analysis in the study is based on data about quantum of construction projects in the cities, typical material consumption rates of construction items and potential sources of secondary materials available for utilisation in the cities. In order to understand the environmental implications of construction sector, a software – Umberto LCA+, was used to analyse the data through MFA and LCA. While MFA delineates the quantum (tonnage) of material flow across the life cycle of a building, LCA assesses the carbon footprint (CO_2 equivalent) of buildings, along with other environmental indicators.

Model of Life cycle of buildings constructed for MFA and LCA in Umberto LCA+

The model estimates the material flow and carbon footprint of a building across different stages of a building's life cycle- from production of primary materials (cement, sand, steel, etc.), transport to material production facility, production of secondary materials (RMC, masonry units), transport of material to construction site and post-occupancy stage (demolition, reclaim, re-use and landfill)



2 CASE STUDIES: AHMEDABAD, BHUBANESWAR

The cities of Ahmedabad and Bhubaneswar represent two levels of urban development in Tier 1 and Tier 2 cities respectively, in India. Even at different rates of urbanization and geographical growth, both cities, being the largest urban agglomerations in the States of Gujarat and Odisha, have witnessed nearly 30% and 23% increase in their population from 2000-2010[7] and will increase by at least 25% more from 2019-2030[8]. Data is missing from 2010-2019, shows a gap in estimation. This is concomitant with growth of development plan areas and the built-up footprint in the cities, with affordable housing being the highest growth segment.

AHMEDABAD

The Tier 1 city of Ahmedabad has experienced significant growth of real estate and infrastructure sectors. It is a progressive city in terms of architectural design, management and construction technologies. Among changes in the construction sector, the use of clay bricks is beginning to decline steadily specially in large scale projects. The use of Ready Mix Concrete (RMC) has almost mainstreamed in the city, which is more conducive to efficient use of cement and aggregates and also to the possibility of integrating secondary resources under tight quality control. AAC blocks are a much preferred walling material today, on account of the overall weight reduction of structures which they enable and their speed of use, being larger in size.

7 As per Census data of the two cities
8 As per population projections made in AUDA and BDA Development Plans

BHUBANESWAR

Bhubaneswar is one of the fastest growing cities in the eastern part of India and recognised historically and culturally as a City of Temples and an aspiring UNESCO Heritage City. The Tier 2 city acts as a nucleus of development in Odisha and attracts large number of migrants from the surrounding districts and states. Over the last few years, its 'Smart City' status has generated opportunities for a more sustainable urban development in the form of compact and efficient urban form, livability and clean environment. Seen within the context of resource efficiency in construction, Bhubaneswar and neighbouring Cuttack, which are also the two most populous cities in the state, make a contiguous coastal region for planning and development – as visualised in a 2030 vision for an integrated Bhubaneswar-Cuttack Urban Complex (BCUC). The big gap in availability of affordable housing for the urban poor is one of the biggest challenges in the region today – more than one-third of the 4.3 Lakh housing units needed by 2030 are in the EWS/LIG category.[9]

9 Comprehensive Development Plan for Bhubaneswar Development Plan Area (BDPA)

3 SUMMARY OF FINDINGS

While the scale of construction sector and subsequently the material flow vary in Ahmedabad and Bhubaneswar on account of their size and urban development trajectory but there are similarities in material consumption trends. The key findings below are based on data of construction permits issued and typical construction typologies of residential sector in the two cities.

RESIDENTIAL BUILT FORM

While bulk of the residential stock which is 40-50 years old comprises mainly of low-rise (G+2 to G+3) buildings in both cities, there is a higher percentage of mid-rise (G+4 to G+8) buildings since year 2000 and an emerging scenario of high rise buildings (G+9 to G+14) since 2010. The prevalence of high-rise buildings (upto 70m height) is greater in Ahmedabad because of a bigger high-income segment. Multi-storeyed buildings are increasingly being adopted for the Affordable Housing (dwelling unit built-up area 300-700 sq.ft) – in Bhubaneswar, this will constitute the largest segment in the next 20-25 years, owing also to its significant slum settlements which will be rehabilitated.

A significant implication of the built form is the quantity of concrete and steel which is consumed primarily in the RCC frames. When increasing building height from G+4 to G+13, the quantity of concrete, cement and steel per m^2 of built space increase by about 30%, 20% and 40% respectively.

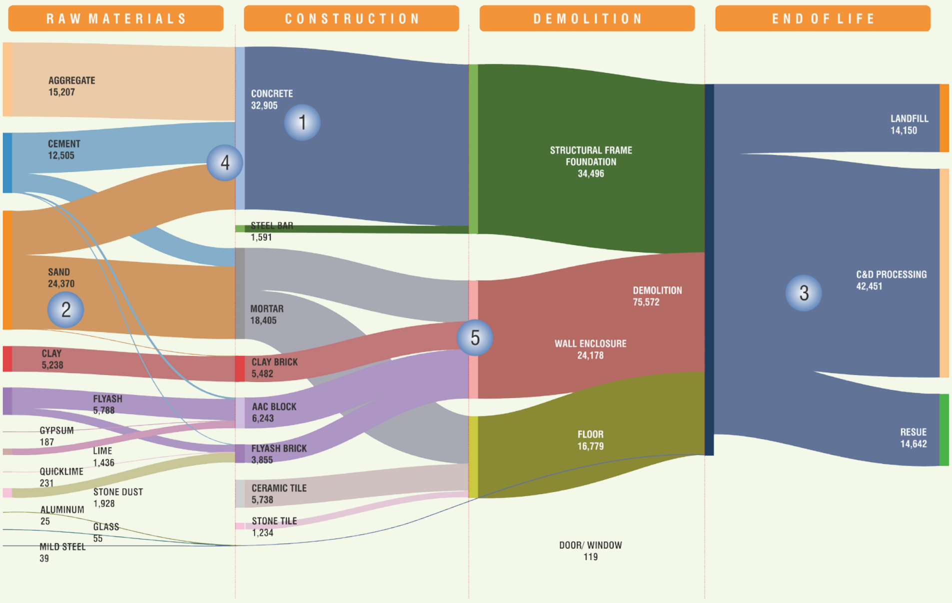
MATERIAL FLOW

The gross weight of material which flows to every m^2 of residential built space is 2-2.5 tonnes.

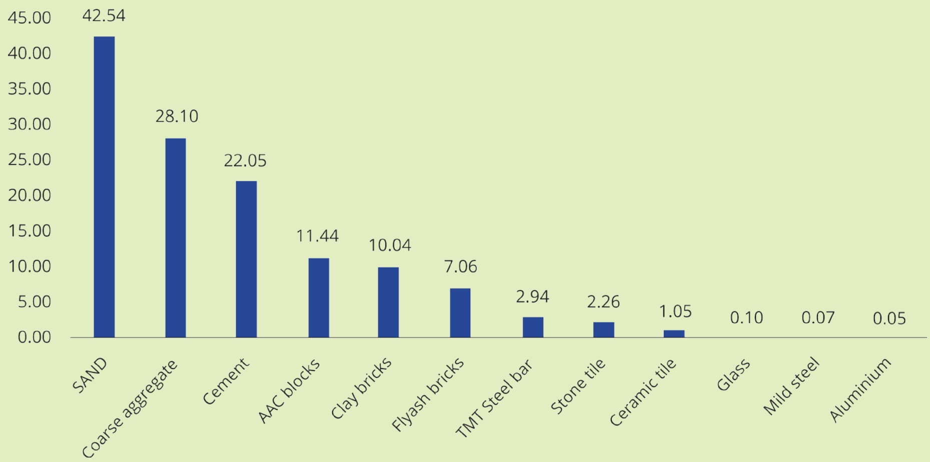
Concrete has the highest intensity of use in the construction sector – RMC alone accounts for nearly 40% of the total material flow at 800-900 kg/m^2 of built space. This is followed by masonry – consisting of clay bricks, autoclaved aerated concrete (AAC) and fly ash bricks – together accounting for about 25% of the total material flow.

At the primary material, sand dominates the quantum of material flow i.e. 30-35% because of the high volume of concrete used across the construction sector, combined with cement/fly ash based masonry units, cement-based mortars and plasters. This is followed by aggregates 18-22% and cement 15-18%. The mineral based material flow – comprising of cement, steel and aluminium accounts 16-18% of the total flow.

Sankey diagram - Material flow for housing in Ahmedabad for projects from 2014-2019 BUA 32.75 Million sq.m



Estimated Demand of Construction Materials for Housing in Ahmedabad in 2030 (million tonne)



CARBON FOOTPRINT

The CO_2 equivalent emissions of the residential built space is 0.6-0.8 tonne per m^2.

Concrete is the biggest contributor to emissions i.e. 300-350 kg CO_2 – accounting for 40-45% of the total emissions. At the primary material level, cement and steel are biggest individual contributors to emissions – responsible for nearly 50% and 12% of the CO_2 emissions. Due to a lower proportion of high-rise buildings in Bhubaneswar, masonry materials account for a higher proportion of emissions nearly 30% as compared to 20% in Ahmedabad.

Aggregates especially sand, which accounts for the highest proportion of material flow, are responsible for less than 2% of the total emissions.

TRANSPORTATION

Transportation accounts for 3-4% of the total emissions from residential construction – this includes transport of primary materials into the city and transport to construction sites within the city. Overall, every m^2 of built space accounts for 70-80 km of material transport, out of which masonry materials and cement account for 60-65% and 15-20% respectively.

SECONDARY RESOURCE UTILIZATION

Resource: Construction & Demolition waste

Ahmedabad is one of the first cities in India to take the initiative to set up a C&D processing facility (300 tonnes/day) in 2014. This is a welcome step, considering redevelopment of old buildings into multi-storeyed apartments, which is poised to become a major trend in the city and consequently, an important source of secondary materials in the form of demolition waste. The study estimates that at least five lakh houses making up more than 80 Million m^2 of built-

C&D waste potential in Ahmedabad
***based on redevelopment potential** May 2020*

Material	Quantity
Concrete	26 million m^3
Steel	1963 million kg
Brick	65.6 million m^3
Plaster	8.4 million m^3
Flooring tiles	42.2 million m^2
Glass	108 million kg

up space are already available for demolition. AMC and AUDA maintain digital database of construction and demolition permits issued. However, apart from a rudimentary estimate of 700 tonnes per day of C&D waste (source: AMC YEAR), there is no accurate estimate available for the same. In addition, Ahmedabad is also in the vicinity of the ceramic hub in Morbi where large quantity of ceramic waste powder and broken ceramic waste (more than two million tonnes as per a rough estimate by the study) is generated every year to be dumped but which has proven potential in concrete production.

Based on estimated availability of concrete waste from redevelopment potential today in Ahmedabad, recycled aggregates can be used in production of 38 million m^3 of M20 concrete which at a 50% replacement of natural aggregate with Recycled Aggregates (RA). This volume of concrete can be used in construction to the tune of 102 million m^2 of built-up space which is the equivalent of 7.5 Lakh housing units (2 BHK, @120m^2 built-up area).

Resource: Industrial waste

Industrial waste in Odisha	
Industry	**Waste generated per year**
Thermal power plants	Fly ash - 32 Million Tonnes
Iron and Steel	Iron tailings - 50 Million tones Blast furnace slag 9.7 Million Tonnes
Aluminum	Red mud - 4.5 Million Tonnes
Fertilliser	Gypsum - 2.8 Million Tonnes

A distinguishing feature of Odisha's economy is its high degree of industrialisation and large volumes of generation of industrial waste. As per the Forest and Environment Department, Government of Odisha, out of 43 million tonnes waste generated in 2014-15, 20 MT has been re-used or disposed off. Among the industrial units located across the state, a large quantity of industrial waste is located within radius of 200 km radius of the Bhubaneswar-Cuttack region covering Angul, Cuttack, Dhenkanal, Jagatsinghpur, Jajpur and Paradip. Industrial wastes such as Gypsum, Dolochar (solid waste generated by the sponge iron industry), red mud and blast furnace slag each have their proven utility in construction sector but are hardly utilised. One positive trend in Odisha has been utilisation of fly ash from its thermal power plants. More than 80% of the 32 million tonnes fly ash is utilised in Odisha, out of which almost 50% is used in the construction sector, which is the reason for the widespread use of fly ash bricks in Bhubaneswar and other cities where fly ash is readily available. This is a successful example of policy implementation directed at replacement of virgin resources with secondary wastes like fly ash and resource efficiency in the construction sector. The policy also played a role in shaping the market economics of fly ash bricks by promoting the use of a complementary waste material available in abundance.

4 PRIORITY AREAS FOR POLICY ACTION IN CONSTRUCTION SECTOR

REDUCE CONSUMPTION OF MATERIALS PRODUCED FROM NON-METALLIC MINERALS

Sustainable Concrete – concrete being the biggest contributor to material consumption and environmental impact, enhancing sustainability of concrete will be most effective strategy for resource efficiency of the construction sector. The emergence of Ready Mix Concrete (RMC) with stringent quality control allows newer mixes of constituent materials of concrete.

Cement – part replacement of cement with greener alternatives is highly effective for resource efficiency. LC3 cement (Limestone Calcined Clay Cement)[10] has great potential to reduce the limestone demand by cement industry and in reducing its environmental footprint. Fly ash concrete can be produced in the quality controlled environment of RMC plants used in RMC plants.

Sand – river sand continues to be preferred for use in concrete. There is no perception of the environmental cost of sand mining. It is highly unsustainable to mine ever increasing quantities of river sand to meet construction needs. Part replacement of sand with M-sand or manufactured sand, essentially re-cycled sand made from secondary resources such as C&D waste is critical to avoid large scale ecological damage. M-sand is already being utilised in some states in India, due to ban on sand mining and availability of granite rocks and C&D wastes.

Coarse aggregate – accounts for the largest quantum of material flow. Recycled aggregates from C&D waste will reduce both the requirement of virgin stone for aggregates and pollution from stone crushing plants.

IMPROVE DATA INFRASTRUCTURE

Monitoring resource use and efficiency

There is no information infrastructure within the city administration whereby reliable data on quantum of construction materials consumed in the city can be used to identify emerging barriers in continued availability of material resources.

10 LC3 cement is made using limestone and low-grade clays which are abundantly available in many parts of the world. It has the potential to reduce the CO_2 emissions of cement production by upto 30%.

Estimating the potential of secondary resource utilization – especially C&D waste

There is a wide divergence in estimations of C&D wastes across India.[11] There have been reliable C&D waste estimates in developed countries based on various standardized methodologies such as Waste Generation Rate method, Lifetime Analysis Method, Classification System Accumulation method. However, it is not possible in India currently to apply these methods due to limitations in data availability and divergent waste management practices. A peer reviewed based methodology for estimation based on trends in urban growth in different scales of cities and of industrial and agro by-product material streams available is required. Studies for forecasting and foresight are also needed to support decision making.

Life cycle analysis – While LCA methodologies to calculate environmental cost of construction projects exist globally and have been indigenised to suit Indian urban development conditions, in the absence of credible data and accepted methodology, these have not been mainstreamed into policy and practice through standards, regulations, incentives and business models. An Indian framework of methodology, indicator sets and metrics for integrating environmental costs into construction projects is needed in a comprehensive study and analytical compilation of the existing knowledge on the same.

UPGRADE BUILDING TECHNOLOGY – PREFABRICATED CONCRETE AND ASSEMBLY BASED SYSTEMS

Prefabricated construction is at an early stage in India, where it has been demonstrated in a few mass housing projects, with the single of saving time through rapid construction of repetitive housing units. This has mostly been through large prefabricated concrete elements. For instance, monolithic concrete[12] has been used in EWS housing in Rajkot (Gujarat). Prefabricated construction which involves assembly of components at site, is more amenable to future recyclability and also reduces on-site waste. Since components are produced in a more quality-controlled environment, it is more conducive to utilisation of recycled aggregates in production of concrete. However, a more balanced and innovative approach is needed in pre-fabrication to rationalise the quantity of concrete and steel used on a per-unit area basis. There are proven technologies in small scale pre-casting of concrete at the construction site itself, primarily for roof construction which reduce steel consumption by 15-20%.

11 A study conducted by Development Alternatives on resource efficiency in the Indian construction sector estimates on the basis of expected urban population growth that India will generate approximately 2.7 billion tonnes of C&D waste annually by 2041. Characterisation studies on C&D waste in India are minimal since it is usually collected and mixed with MSW. TIFAC's waste characterisation study highlighted soil, sand and gravel (fines); brick and masonry, and concrete as the three largest fractions accounting for 90% of the waste (TIFAC, 2001). Similar studies were carried out in Delhi (IL&FS Ecosmart, 2005) and Coimbatore (CCMC, 2015), with the bulky materials jointly found to occupy 90% and 91% respectively (Figure 8). The remaining 10% comprises of wood, metal, bitumen, plastics, etc.

12 Monolithic concrete is a construction technique where building components are cast-in-place monolithically using appropriate grade of concrete in one operation with use of precision engineered modular Aluminium formwork. It is estimated that this system requires more steel per sq.m of floor area in comparison to conventional RCC frame, the use of Aluminium formwork increases the embodied energy and carbon intensity of the building, even if the formwork is used for a 100 repetitions

SECONDARY RESOURCE UTILISATION

C&D waste is poised to be a big reality in the construction sector. Ahmedabad already has lead in C&D processing – but the overall resource conversion remains limited due to centralised nature of processing and uncertain demand for waste-based materials. Institutions like CSIR - Institute of Minerals & Materials (CSIR-IMMT) have developed technology packages for utilising industrial waste in construction. But these solutions are largely limited to waste management at the industry itself and adoption of these materials at scale is non-existent in nearby urban areas. The major challenge in this regard is the absence of regulatory frameworks which synergise industry and construction sectors. Unfavourable taxation – while virgin aggregates are taxed at 5%, manufactured products are taxed at 18% also compromises the economic viability of recycled products.

REGULATIONS FOR AFFORDABLE HOUSING

EWS/LIG housing will be one of the fastest growing segments to meet targets of 'Housing for All'. High rise construction (upto S+10) is being seen as the way forward for affordable housing. This will consume at least 1.25 times more concrete and steel per m^2 of built space as compared to low-rise construction (upto S+4). A study conducted for resource efficient affordable housing in Rajkot district of Gujarat[13] emphasises the co-relation between affordability, qualitative needs of housing environments and carbon-intensity of construction and operation of buildings. The study points out 15% higher carbon emissions for 7-storeyed housing as compared to 4 storeyed housing and recommends an FSI of not more than 1.5 for affordable housing (the General Development Control Regulations (GDCR) stipulates FSI upto 2.7 for affordable housing). This has significant implications on development regulations which inadvertently penalise low-rise construction – such as in the case of Ahmedabad where the vernacular model of housing is increasingly being discontinued in favour of high-rise construction. Tier-2 cities like Bhubaneswar, which are still predominantly low-rise in character are in a good position to consider the potential benefits of this form of development in meeting its massive demand for low-income formal housing.

STAKEHOLDER PERCEPTION

The two key stakeholder groups at the city level - urban local bodies and private developers, both need to inform their perception strongly with environmental implications of the business-as-usual approach. In the case of Ahmedabad, the city administration is reasonably aware of the imperative to utilise C&D waste in construction, even if for non-structural applications, in which there is an institutional agreement to utilise C&D waste-based paver blocks and kerbstones from the recycling plant in the city. Private developers have a strong instinct to take initiatives at construction sites to minimise wastage and

13 Position Paper on Low Carbon Resource Efficient Affordable Housing – Ashok B Lall Architects, Greentech Knowledge Solutions Pvt.Ltd - 2017

its re-use at site. Also, there is evidence of innovation around waste utilisation such as ceramic waste, brick sector waste, at the level of small enterprise and academic research. In the case of Bhubaneswar, the city administration is yet to take any step towards secondary resource utilisation in construction even if there is a plan to set up a C&D plant in the near future. On the positive side, there is a good connect between industry and R&D institutions such as Institute of Minerals and Materials Technology - (IMMT) to develop industrial waste-based building materials. Even if concerns regarding sustainable supply of abiotic resources such as limestone and sand are being recognised at the national policy level, there is almost no acknowledgement of the issue of scarcity at the city administration level. Stakeholder perception about adoption of RE measures is also limited by the negligible presence of validated technical solutions for utilising secondary resources which can be adopted to broaden the scope of RE across the construction sector.

5 POLICY RECOMMENDATIONS

MAINSTREAM MATERIAL FLOW ANALYSIS (MFA) AND LIFE CYCLE ASSESSMENT (LCA) AT THE CITY LEVEL

In order to start addressing the issue of resource efficiency of construction in a focused manner, there needs to be a formal mechanism to understand the intensity of resource use (quantum per unit built space) and its environmental costs. To begin with, MFA using real-time data generated at the city level will provide a strong foundation to resource efficiency initiatives. This will need to be supplemented with LCA, which conceptually integrates MFA in its methodology.

Ahmedabad and Bhubaneswar (where the study was conducted) are two prime examples of urban agglomerations in India where MFA and LCA can be initiated in the construction sector. Umberto LCA+ (which was used for MFA in the study) is a tool and methodology which should be anchored at the city level for urban local bodies to be able to undertake these processes through sector-specific indicators.

In order to develop the requisite capacity to use LCA, a dedicated and compact LCA Cell can be established at the ULBs which has access to its data-sets and also interfaces with other technical/environmental entities to integrate LCA into decision making. The EU-India cooperation in the Resource Efficiency sector is well placed to bring in the requisite technical capacity to city administrations.

SMART CITIES – OPPORTUNITY FOR DATA DRIVEN ASSESSMENT

The SMART cities mission creates a favourable environment for introduction of IT-enabled infrastructure for more informed decision making based on environmental cost of resources. The mission can be leveraged for enriching the data environment for C&D waste generation and management in the city which is a pre-requisite for its eventual utilisation in construction. Ahmedabad and Bhubaneswar can leverage their SMART City status for this purpose.

ACCELERATE THE IDENTIFICATION AND ADOPTION OF SECONDARY RESOURCES IN THE CONSTRUCTION SECTOR

C&D waste and industrial waste are both inevitable outcomes of urbanisation and industrial growth and key sources of secondary materials with complementary characteristics for use in construction- especially concrete based construction.

Inventorisation, characterisation and valuation of major waste streams is the first step towards realising the potential of secondary resources in construction. This needs to be supported by strengthening the research and knowledge base around utilisation of waste materials in construction, performance testing and standardisation of waste-based materials, with focus on structural applications (such as approved grades of concrete with recycled aggregates). Environmentally sensitive branding of waste based building materials and market-responsive packaging (specifying recycled content inside) will facilitate adoption of these materials. Cross-sectoral linkages between industry and construction sector are important to formalise sourcing of secondary materials.

National Policies and implications for construction sector

National Resource Efficiency Policy (Draft) 2019 - MoEFCC

Invokes two SDGs in particular - **Goal 11 (sustainable cities)** – reduce adverse per capita environmental impact, with special attention to waste management; **Goal 12 (SCP)**- focus on waste reduction through recycling and re-use.

Emphasises Life Cycle Approach; Sustainable Public Procurement; judicious exploitation of non-metallic minerals for construction; RE indicators for Construction sector; institutional set-up for implementing RE measures and Data compilation on RE

Sustainable Sand Mining Management Guidelines 2016 - MoEFCC

Environmentally sustainable and socially responsible mining for sand and gravel; conservation of river equilibrium and its natural environment; monitoring of mined material, tapping alternative sources of sand and gravel.

Construction and Demolition Waste Rules 2016 – MoEFCC

The rules lay down in detail the duties of all kinds of waste generators for Segregation, Storage, transport and disposal of C&D waste, with large generators (more than 20 T/day) needing to prepare Environmental Management Plans. The Rules also specify responsibilities of Central Ministries, State governments, Local authorities, Pollution Control Boards and waste processing facilities. State governments and local authorities are mandated to utilize 10-20% materials from C&D waste in municipal and government contracts.

Strategy on Resource Efficiency in Construction and Demolition Sector - MoHUA & NITI Aayog 2019

The strategy is intended to help facilitate the implementation of the C&D Waste Rules 2016 to ensure that ULBs across the country are able to adopt proper C&D waste management and recycled products find appropriate and adequate utilisation.

SUSTAINABLE PUBLIC PROCUREMENT

Currently, except for AAC blocks, the material options for construction projects have not diversified and do not reflect environmental concerns. Municipal authorities need to initiate the demand for resource efficient/secondary resource-based materials with lower environmental costs. LCA forms the basis for responsible decision making through sustainable public procurement (SPP). AMC already introduced 8-12% purchase of C&D paver blocks to support SPP tool as an enabler towards RE transition. Additional environmental criteria of waste utilisation/lower emissions need to be embedded into the tendering process. The success of fly ash based products needs to be replicated in this context.

FINANCIAL INSTRUMENTS AND INCENTIVES

In order to foster adoption of environmentally responsible products into the market, it is critical to get the pricing right by internalising environmental costs and integrating precautionary principles. Policy instruments can often play a decisive role in augmenting the production and consumption of 'green' products. Such instruments can be deployed across the life cycle of product in the form of taxes, subsidies, incentives, marketable permits and performance bonds. For instance, tax on natural gravel in Sweden and stringent landfill tax in the UK have respectively resulted in substitution of natural gravel with alternatives and reduction in number of land fill sites in favour of more efficient waste disposal. Both cities which were part of the study – Ahmedabad and Bhubaneswar are heavily dependent on river sand for construction and urgently need such policy interventions to steer away from this path.

STRENGTHENING THE SUPPLY END

Strong emphasis is needed on expanding the entrepreneurial base of recycled products through transfer of validated technology packages from lab to land and financial incentives to building material manufacturers. Grants or financial support towards viability gap funding for cleaner and resource efficient technologies and innovative start-ups, is crucial for strengthening the supply eco-system of environmentally responsible products. Industry associations have a role to support the development of and conformance to production and product quality standards by their members engaged in manufacturing building products using secondary resources. They could further support their members through advocacy for access to resources, fiscal incentives and public procurement of secondary resource-based materials being produced.

The CII Green Pro-Green Product Certification, launched in 2015, focuses on certifying products, materials and technologies related to construction and manufacturing sectors. The Godrej (Construction division) C&D plant in Mumbai has been set up to produce certified building products from recycled concrete produced using C&D waste.

DISSEMINATION OF EXPERIENCES

It is important that experiences from practice and policy strategies across the country and from relevant global cases be documented with respect to a framework of analysis and communication that highlights the benefits of mainstreaming secondary resources into the built environment and the success of policy strategies in different contexts. The knowledge and experiences in the sector are nascent but growing and a dynamic platform where such experiences are anchored at a national level would be useful. The role of public institutions such as the Building Materials and Technology Promotion Council, National Institute of Urban Affairs, Human Settlements Management Institute, industry associations such as CII and FICCI, professional associations such as the Council of Architects, Engineers Institute of India, technical and policy think tanks such as Society for Development Alternatives, The Energy and Resources Institute (TERI) and multilateral support agency programs such as the UNEP – One Planet network (SBC) and the EU-SWITCH Asia among others may be explored.

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