

Analysis of Material Wastage & Time Overruns in Construction Project Using Descriptive & Inferential Statistics

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ABSTRACT: The history of the construction industry worldwide is full of project that were complete significant time and cost overruns in an attempt to reverse this trend, this study aims at established relation between time overrun and labour productivity on construction site in India both descriptive inferential statistics were used in analysing the data result indicate that inadequate fund for the project. Inadequate planning before project takeoff, inadequate tools and equipment and delay in delivery material. The list of the major causes of time overrun while the use of wrong construction method, inadequate construction material and inaccurate drawing specification are the key factor causing low labor productivity construction site. Significant negative relationship found between time overrun and labour productivity at construction site. The study concluded by recommending that early appointment of the project manager could ensure proper management of both human and material resources that could guarantee improved productivity and ultimately save project from time overcome.

Environmental problem have been considered as a serious situation at the construction waste management is pressing harder with the alarming signal warning the industry. Reused recycle and reproduce waste considered as the only method to recover those waste generated how where the implementation steel have much room for improvement. This paper review the technology on construction waste recycling and there viability. Ten material recycling practices are study including .i)Asphalt ii) Brick ,iii)Concrete ,iv)ferrous metal ,v)glass ,vi)masonry ,vii)non-ferrous metal, viii)paper and card board ,ix)plastic and x)timber. The viable technology of the construction material recycling should be providing an easy reference for future application.

KEYWORDS: Construction & Demolition Waste Material, Case Study on Construction & Demolition Waste Recycling in pune.

I. INTRODUCTION

Since 1993, the year when Oslo Peace Accords have been signed in Norway, Palestinian occupied territories have undergone a rapid pace of reconstruction of infrastructure which had been demolished through thirty years of occupation. In spite of lack of resources and technologies, hundreds of infrastructure, residential, and governmental projects were implemented (MAP Overview 2002). The successful execution of construction projects and keeping them within estimated cost and prescribed schedules depend on a methodology that requires sound engineering judgment. To the dislike of owners, contractors and consultants, however, many projects experience extensive delays and thereby exceed initial time and cost estimates. This problem is more evident in the traditional or adversarial type of contracts in which the contract is awarded to the lowest bidder- the awarding strategy of the majority of public projects in developing countries including Western Maharashtra Strip. Although the construction industry in the Middle East has suffered ever since the Gulf war, recent events in the region coupled with the restructuring of economies, joining

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regional and global free trade organizations, and attracting foreign investments are expected to yield an unprecedented growth in the construction activities [1].

The construction industry is the total through which physical development is achieved, and that is truly the locomotive of the national economy. The more resources, engineering, labour, materials, equipment, capital, and market exchange are provided from within the national economy, the higher the factor of the extent of self reliance. The increasing complexity of infrastructure projects and the environment within which they are constructed place greater demand on construction managers to deliver projects on time, within the planned budget and with high quality (Enshassi et al 2003). Therefore, improving construction efficiency by means of timeliness would certainly contribute to cost savings for the country as a whole. Efforts directed to time effectiveness were associated with managing time and materials, which in this study were approached via investigating time and material wastages of construction projects in Gaza. Unlike the developed countries, India does not have a mature construction industry consisting of well-established contracting and consulting companies. Much of the building and construction is done by the informal sector. This consists of individuals building family shelters, water wells and the like. The formal sector consists of public and private domestic contractors [2].

II. OBJECTIVES

- To identify and evaluate the responsible causes of influencing the occurrence of Wastes.
- To find various causes of material wastage of building construction site.
- To suggest recommendations based on the site study to control wastes and to improve construction performance.
- To identify and evaluate the responsible causes of influencing time overruns.
- To suggest recommendations based on the site conditions to minimize time overruns.
- Above points will be studied by taking case study from Construction Sites.

III. OUTCOMES

- This study will help the project manager
- To avoid Unavailability of materials
- Excessive amendments of design and drawing
- To Removes Poor coordination among participants
- To Remove Ineffective monitoring and feedback
- To avoid Lack of project leadership skills

IV. SOURCES OF WASTE GENERATION IN THE CONSTRUCTION INDUSTRY

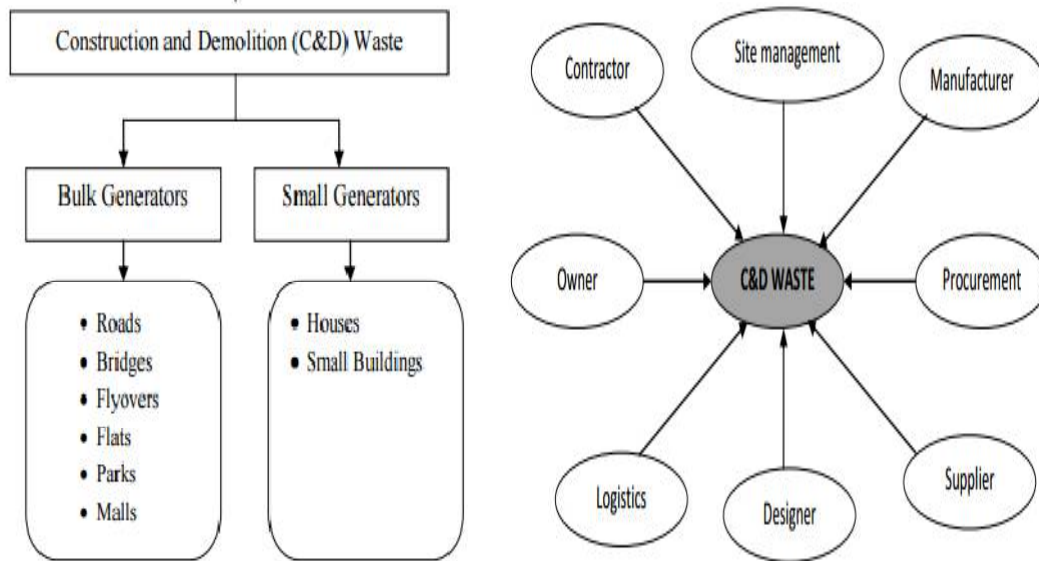
All over the world, the growth of construction industry is enormous in the past decade. The pace of generation of C&D waste is also significant. In general, there are two sources for generation of waste materials, namely, bulk generators and retail or small generators. The classification of sources is given in Fig 1. The infrastructure development sector and real estate sector are the bulk generators of waste. Construction and repair of roads, bridges, flyovers etc. are classified under infrastructure development sector. Real estate sector consists of housing, industrial, and commercial building construction, demolition of unauthorized structures etc. Small commercial enterprises and individual house building teams are considered as retail or small generators. The contributors of C&D waste in a project are given in Fig 2. The project activities are to be planned at every stage by every personnel, who are involved, to minimize the overall waste generation. Construction industry is largest economic expenditure in India. According to eleventh five year plan, it is the second largest economic activity after agriculture. The impact caused to the environment by Indian construction industry is also large. Construction industry consumes high volume of raw materials and products. It generates high employment opportunity. Based on an analysis of the forward and backward linkages of construction, the effect in the construction on economy is estimated to be significant. (Minaxi Rani, Alisha Gupta, 2016).

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Thus, cost saving potential for India is expected to be millions of dollars by adopting suitable measures for waste management. This is particularly essential for a development that responds to the challenges of environmental sustainability, low carbon emission and minimal resource depletion [3]. The total quantum of C&D waste generated in India is estimated to 11.4 to 14.69 million tonnes per annum (TIFAC, 2000). The distribution of various components of C&D waste in India is given in Fig 3. The concrete, brick and masonry together constitutes more than 50 percent of the total C&D waste. This shows the importance of developing C&D waste management plan for these components

V. RESEARCH METHODOLOGY

A. Data Require

- **Research strategy:** - Two types of research strategies are used at studies, quantitative and qualitative research. Quantitative approach is used to gather factual data and to study relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously, but the qualitative approach seek to gain insights and to understand people's perception of "the world" whether as individuals or groups.
- **Research design:** - This refers to the plan or organization of scientific investigation, designing of a research study involves the development of a plan or strategy that will guide the collection and analyses of data.
- **Population:** - The population of this research included contracting companies, consultants and public owners sectors, the contractors companies had valid registration according to the Palestinian Contractors Union (P.C.U) records.
- **Methodology of this thesis:** - After surveying the previous approaches of methodologies, the suitable one is to use questionnaire and case studies methods.
- **Questionnaire approach:** - A questionnaire was developed to assess the perceptions of owners, consultants, and contractors due to the importance index of causes and effects of delay
- **Case Studies:** - Some case studies were carefully selected and investigated. These cases discussed in-depth information regarding the causes of time and material wastages at construction projects in Western Maharashtra Strip, also to check the procedures and actions taken by contractors, owners and consultants. Each case will be

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analysed separating of others; the case will illustrate the link between the data collected by questionnaire and data in case, recommendations will be documented for each case.

- *Questionnaire design:* - It has been assembled around of (136) factors which affect the time and material wastages in engineering projects in various countries around the world and at intervals of time, but not all of these factors are consistent with the conditions and circumstances surrounding the Western Maharashtra Strip from economic level, the type of projects, geographical region and occupation factors which experienced the Western Maharashtra Strip, so it has been selected factors commensurate with the nature of construction projects and problems in the Western Maharashtra Strip. Modifications and new questions then added as a result of interview of experienced construction managers to suit the local construction industry in Western Maharashtra Strip.
- *Questionnaire content:* - The questionnaire included three parts that related to the factors of time and material wastages at construction projects in Western Maharashtra Strip, these parts are organization profile, factors influencing time overruns and factors influencing material wastages.
- *Pilot study:* -These structured questionnaires should be based on a carefully prepared set of questions piloted and refined until the researcher is convinced of their validity. Therefore the pre-testing is an important stage in the questionnaire design process, prior to finalizing the questionnaire. It involves administrating the questionnaire to a limited number of potential respondents and other knowledgeable individuals in order to identify and correct design flaws. The Arabic version of questionnaire was tested in order to make sure that the questions were easily understood .The test was made by distributing ten drafts of the questionnaire (four to contractors, three to consultant and three to owners). In general, they agreed that the questionnaire is suitable to achieve the goals of the study. The following comments and some modifications have been done
- *Data Measurement:* - In order to be able to select the appropriate method of analysis, the level of measurement must be understood. For each type of measurement, there is/are an appropriate method/s that can be applied and not others. In this research, ordinal scales were used. Ordinal scale is a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned to the agreement or degree of influence (0, 1, 2, 3, 4) do not indicate that the interval between scales are equal, nor do they indicate absolute quantities. They are merely numerical labels. Based on Likert scale researcher has the following:

Item	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Scale	4	3	2	1	0

- *Statistical Validity of the Questionnaire:* - Validity refers to the degree to which an instrument measures what it is supposed to be measuring. Validity has a number of different aspects and assessment approaches. To insure the validity of the questionnaire, two statistical tests should be applied. The first test is Criterion-related validity test (Spearman test) which measures the correlation coefficient between each paragraph in one field and the whole field. The second test is structure validity test (Spearman test) that used to test the validity of the questionnaire structure by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one filed and all the fields of the questionnaire that have the same level of similar scale.

VI. CASE STUDY OF PUNE

a) CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

Environmental issues such as increase in flood levels due to illegal dumping of C & D waste into rivers, resource depletion, shortage of landfill and illegal dumping on hill slopes are evident in the city. The scope of this study is limited to the construction industries in residential and non-residential buildings in city of Pune. Bridges, roads and

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other urban infrastructures are excluded in this study. Compiled data and information of this paper come from secondary sources such as various research papers related to the C & D waste, various reports of surveys done by various agencies and institutions, information through case studies from international journals, reports and proceedings of various waste management organizations and national authority websites on C&D waste management in India. Field surveys and interviews with various stakeholders were undertaken by the authors to ascertain the status of C&D waste management in the city of Pune. The list of builders and Pune Municipal Corporation (PMC) officials is given in references attached with this research paper. Diagnostic analysis of current status of C&D waste management in terms of policies, laws and regulations, current management practices, technologies and key stakeholder participation were conducted and analyzed.

b) Present condition and issues related to c & d waste in Pune:

There are 44Sezs in and around Pune. With the development of Sezs since last decade Pune is experiencing boom in construction sector. With the change in culture, change in lifestyles and technology, many redevelopment projects are coming up in Pune. The C& D waste in Pune constitutes 40% of MSW in Pune. The environment status report of the PMC recently admitted that illegal dumping of construction rubble in the riverbeds and hills continued in the city. In many instances debris is dumped in the green belt of the river, affecting its natural flow.

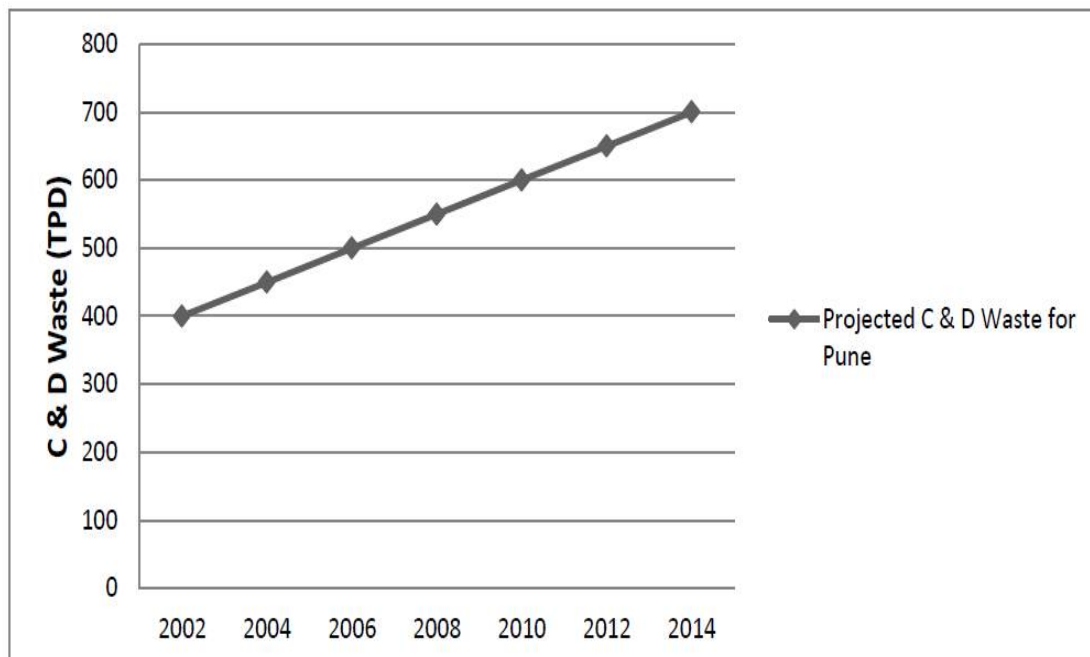


Fig. 1- Projected C & D waste in Pune, Source- Action plan for ISWM developed by UNEP-IETC, EMC

c) Necessity of c & d waste management

With the global concern of conservation of energy and natural resources, there is urgent need of implementing C & D waste management strategies through technological and design solutions of adoptability, deconstruction, recycling and reusing and effective formation of legislative, administrative and monitoring framework for implementation of the same. Development of human resources for implementation of C & D waste management through awareness and training is another important concern. R&D work towards exploring newer applications and maximizing use of existing technologies for a sustainable C & D waste management is need of a time.

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d) Potential of various waste materials for reuse and recycle:

Special townships with a minimum area of 100 acres have been launched in Pune and Nagpur since 2008 as a sequel to Maharashtra's new housing policy of 2007. According to the provisions in the act, 60% of the area to be purely residential and out of the total floor area proposed to be utilized for residential development, 20% of the residential area to be used for residential tenements of 40 sq m for economically weaker section. This gives estimate of 48,562.2 sq.m area to be built for economically weaker section for a 100 Acre Township. In this case, role of reusable and recyclable material become crucial in the view of keeping the cost of new construction low. When considering a reusable and recyclable material, three major areas need to be taken into account are: economy, compatibility with other materials and material properties.

Following are some of the C & D waste materials:

- **Bricks-** If deconstructed properly, bricks can be reused after removal of mortar. Broken bricks can be used for refilling or for manufacturing debris paver blocks or debris blocks.
- **Stone-** Stone can be reused for plinth formation, masonry construction, landscape purpose, ledges, platforms, window sills, coping etc. depending upon the form of available stones.
- **Concrete-** The utilization of recycled aggregate is particularly very promising as 75 per cent of concrete is made of aggregates. In that case, the aggregates considered are slag, power plant wastes, recycled concrete, mining and quarrying wastes, waste glass, incinerator residue, red mud, burnt clay, sawdust, combustor ash and foundry sand. The enormous quantities of demolished concrete can easily be recycled as aggregate and used in concrete. Research & Development activities have been taken up all over the world for proving its feasibility, economic viability and cost effectiveness. Work on recycled concrete has been carried out at few places in India by CBRI and CRRI, but waste and quality of raw material produced being site specific, tremendous inputs are necessary if recycled material has to be used in construction for producing high grade concrete.
- **Timber-** Whole timber arising from construction and demolition works can be utilized easily and directly for reused in other construction projects after cleaning, de-nailing and sizing. In some cases, timber elements from deconstructed building may have aesthetic and antique value.
- **Plywood and other timber based boards-** Plywood and other timber based boards can be either reused for interior works in new construction or it can be recycled for manufacturing of timber based boards.
- **Gypsum-** in India, about 6 MT of waste gypsum such as phosphor-gypsum, fluoro-gypsum etc., are being generated annually. Plaster developed from this waste gypsum has showed improved engineering properties without any harmful effect. Phosphor-gypsum and lime sludge can be recycled for manufacture of Portland cement, masonry cement, sand lime bricks, partition walls, flooring tiles, blocks, gypsum plaster, fibrous gypsum boards, and super-sulphate cement.
- **Metals & metal alloys-** Ferrous Metals are the most profitable and recyclable material. In India more than 80% scrap arising is recycled. Scrap steel is almost totally recycled and allowed repeated recycling. Structural steel can be reused as well as 100% steel can be recycled to avoid wastage at construction site. The main non ferrous metal collected from construction and demolition sites are aluminium, copper, lead and zinc. In India aluminium usage is up to 95000 tonnes with about 70% recycled in 2004. Copper is recycled up to 119000 tonnes out of a national market of 262000 tonnes.
- **Debris-** Construction debris can be recycled to manufacture paver blocks which can be used in light traffic areas and masonry blocks. Other uses of processed debris include use in lean concrete for levelling purpose, as mortar for masonry, as bedding mortar for pavement tiles and used for land filling.

e) Need of equipment's and facilities:

According to the report published by Asian institute of technology, school of environment, resources and development, Thailand, reusing facilities and recycling facilities in India have moderate existence, whereas the status of sorting/segregation, storage and monitoring facilities is unknown. There are three types of recycling plants Viz. Mobile, Semi-Mobile and Stationary plant. In the Mobile plant, the material is crushed and screened and ferrous impurities are separated through magnetic separation. The plant is transported to the demolition site itself and is suited to process only non-contaminated concrete or masonry waste. In the semi-mobile plant, removal of contaminants is carried out by hand

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and the end product is also screened. Magnetic separation for removal of ferrous material is carried out. End product quality is better than that of a Mobile unit. These plants are not capable to process a source of mixed demolition waste containing foreign matter like metal, wood, plastic, hardbound etc. Stationary plants are equipped for carrying out crushing, screening as well as purification to separate the contaminants. Issues necessary to be considered for erection of a Stationary plant are: plant location, road infrastructure, availability of land space, provision of weigh-bridge, provision for storage area etc. Different types of sorting devices and screens are used for separating contaminants from end-product and grading the recycled product in various grain sizes. Vibrating screens, star screens or disc-separators are used for removal of impurities.

f) Loopholes in legislative and regulatory framework in Pune:

Interviews conducted with urban local bodies and other relevant stakeholders have raised some issues. The reasons of ineffective implementation of MSWM Rules being inadequate finances, multiplicity of agencies for operation and maintenance, inadequate training of personnel, lack of performance monitoring, inadequate emphasis on preventive maintenance, lack of management and lack of equipment's and facilities, unawareness about the legislation related with C & D waste and its provisions and most importantly indifferent attitude of municipal officials from all the concerned departments against the issue. Neither of these legislations in India has any provisions regarding reduction of the C & D waste through planned deconstruction nor the Bureau of Indian standards (BIS) and National Building Code (NBC) has any provisions regarding quality standards of reuse, salvage, and recycled material

g) Key stakeholders involved in C & D waste management:

The key players in the sector of C&D waste management policies are local authorities, developers/builders, contractors, owners, NGOs, research institutes, academic institutes, professionals like architects and engineers etc. According to the report published by Asian institute of technology on reduce, reuse and recycle (3r) practices in construction and demolition waste management in Asia, participation of national and local authority is moderate, participation of contractors and NGOs is relatively low whereas participation of clients, consultants and associations is unknown. This study reveals that participation of academe is high. CRRRI and CBRI have done R & D in the field of recycling of building materials.

➤ The responsibilities of these key stakeholders are as follows

• Responsibility of municipal authorities -

1. Providing and developing infrastructure for collection, storage, segregation, transportation, recycling, processing and disposal of C & D waste.
2. Complying with the MSW rules as per the implementation schedule laid down in legislation.
3. Proper co-ordination among various departments of authority.
4. Conducting Training programmes regarding C & D waste for the officials of concerned departments.
5. Generating awareness among all the stakeholders with the collaboration of print and electronic media.
6. Monitoring the performance of waste processing and disposal facilities
7. Improvement of existing land filling sites, if any.
8. Identification of landfill sites for future use

• Responsibility of the generator of waste:

1. Avoidance of littering and ensuring delivery of wastes as stipulated by the municipal authority.
2. Complying with the MSW rules/ C & D waste rules.
3. Insisting on designs and technologies which will reduce the waste and reduce the use of materials in construction.

• Responsibility the state pollution control board (SPCB):

1. Monitoring the compliance of the standards regarding ground water, ambient air, leachate quality and the compost quality including incineration standards as specified under Schedules II, III and IV4. The details of application

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procedure, grant of authorization for setting up waste processing and disposal facility including landfills are also given in the Rules.

2. Co-coordinating with CPCB and the Committees with particular reference to implementation and review of standards and guidelines and compilation of monitoring data.

Most of compliance monitoring and enforcement is done by SPCBs. The few direct enforcement actions taken by the CPCB are generally done by the zonal offices. All the waste management rules and regulations address specific wastes separately and their enforcement is with the SPCB.

• **Responsibility of an architects, engineers and specification writers:**

1. Designing for adaptability(less function specific), deconstruction and dismantling
2. Use of modular co-ordination with pre-fabricated components, use standard accepted technologies
3. Designing building for parallel disassembly rather than sequential disassembly (time saving, material saving, labor cost saving)
4. Specify materials and assemblies that can be easily disassembled at the end of their useful life.
5. Choosing durable non-toxic interior finishes or materials.
6. Surveying the site before demolition or deconstruction.
7. Identifying salvage and reuse items, recyclable materials and hazardous materials for special handling.
8. Developing a Construction Waste Management Plan.
9. Monitoring the waste reduction program. The architect and designer play an important role in assuring the contractor's compliance with the waste reduction program by requiring and reviewing waste management progress reports and invoices from recycling and garbage haulers and recycling facilities. Monitoring the success of the program and potential barriers by including a discussion about the waste reduction program during the project meetings.

• **Facility managers, property owners and managers and developers:**

1. Establishing requirements for waste reduction. Beginning with making waste reduction a priority from the start of the project and planning for it throughout all phases of design, construction, installation, and occupancy.
2. Setting goals for waste reduction for each project and preparing a team of qualified professionals experienced in environmentally sound design and construction practices.
3. Identifying materials that can be salvaged and reused.
4. Monitoring and supporting the program. Monitoring the progress of waste reduction efforts by requiring contractors to submit the waste management plan and waste management progress reports.

VII. CONCLUSION

In urban India, there has been a little executed in the field of C & D waste management though policy framework exists. As discussed in the paper, all the stakeholders have their role to play in this regard for sustainable development. With the increase demand of infrastructure and housing and subsequent growth in construction sector, future challenges are enormous on the background of current construction practices. High rise buildings are coming up with in situ concrete construction for framing and envelop which will come under redevelopment project after 30-40 years. With given a situation of scale of these projects and material inputs that it requires, there is huge challenge to manage C & D waste in near future. Infrastructure shall be developed by local authorities such as recycling plants, location of land filling sites and recycling plants shall be allocated in Development Plan. Exhausted stone quarries in Pune can be reclaimed by designating them for land filling of C & D waste. Charges shall be levied on the disposal of C & D waste to the designated landfill sites based on amount of waste generation. BIS and NBC shall include provisions for quality standards of reusable, recyclable and recycled content building materials and construction technologies. MSW department shall be made accountable for all the activities related to C & D waste management to reduce the confusion among various departments regarding accountability. Awareness campaigns and training shall be conducted regarding C & D waste management for all the stakeholders. Academic and Research institutes, NGOs, Government departments, print and electronic media, Construction sector can contribute towards this aspect.

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