Case Study - Deviations between standard allowances considered against actual generation of materials wastage on construction projects.

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Abstract: Waste on construction site includes non-required materials produced during conducting various construction activities on site. Construction waste contains tor steel, structural steel, cement, sand, metal, woods, painting, and sheeting, tiling, precast blocks etc. Generally percentages allowances for materials wastages considered by estimation engineer are about 2% to 5%. But at actual executing on construction sites it is found, it increases very high up to 10% to 15% on site. Before the starting of construction projects estimated wastage standards are considered for calculations. During actual execution there are deviations observed in material wastage against standard allowance considered, it may high or low depending of various factors. If wastage occurs more than standard considered then contractor will face more cost to project than estimated, results in loss. If wastage occurs less than standards considered during estimate then construction will complete with cost saving, resulting increasing profit and saving in terms of money and environment. More material wastage occurs than standards considered is mainly due to bad handling of construction materials and its storages on site., un clear design and documents, poor quality control, Adcock procurement, negligence, untrained workers and staff, environmental condition, excess use of material, theft etc., resulting increase in construction cost and loss.

Actual material wastage controlling of site is possible with using some techniques like – Strict supervision and control of material, creating an awareness of consequence of waste and educating staff and workers, correct material planning and ordering, intensifying security, effective site management, introducing incentive schemes, improving material storage and handling facility etc. resulting reduction in construction cost and increasing profit as well as maintaining environment.

Index Terms **- Introduction, objective and methodology, profile of projects studied, data analysis, results, conclusion, etc.**

I. INTRODUCTION

Before the starting of construction projects estimated wastage standards are considered for calculations. On this basis of allowances for materials wastages work cost is estimated. During actual on site execution there deviations are observed in material wastage against standard considered, it may high or low depending on various factors. If wastage occurs more than standard considered then contractor will face more cost to project than estimated, results in loss. If wastage occurs less than standards considered during estimate then construction will complete with cost saving, resulting increasing profit and saving in terms of money and environment. There needs to work hard by site peoples during execution on site to keep materials wastages considerable low than allowances considered to maintain positive performance of organization.

For study of deviations between actual material wastage generations against standard considered, I have carried out construction site visits in Kagal MIDC Kolhapur and Chakan MIDC Pune. Both MIDC are regarded as industrial building construction hub of west Maharashtra. Presently witnessing rapid development in industrial building infrastructure. In both of MIDC there are lot of construction projects are running, out of 20 industrial projects were selected for case study due to availability of contacts and permissions. All constructions sites managements are given permission to carry out questionnaires survey for this project study topic. But out of twenty construction site managements only six construction site managements are allowed me for case study.

Only these six constructions projects are selected for case study due to the willingness of the site construction management to grant the access in their premises and records. Ten materials were selected for the survey namely: concrete, aggregate, sand, cement, bricks, tor steel, structural steel, timber, sheeting material, paint and tiles etc. Because these are the common materials are used on all studied projects.

The aim of this case study is to calculate the percentage quantities of selected building materials wasted on construction projects/sites in MIDC Kagal Kolhapur and MIDC Chakan Pune. Comparing these percentages of wastages obtained with percentages of allowances considered by estimation engineer. And providing more realistic waste allowance for estimating.

II. OBJECTIVES AND METHODOLOGY USED FOR CASE STYDY

To perform case study on related topic we have set following objectives.

. (i) To calculate the amount of some selected construction materials wasted, used and supplied on project.

(ii) To calculate the relations (in percentage) between the quantities of selected construction materials purchased and used into the activities, with actually wasted.

(iii) To know the causing factors for wastages of these material on the surveyed projects.

(iv) To compare the waste allowance percentages by estimator with quantities obtained

To achieve objectives of case study we have used following methodology.

The study also employed sample mean, percentage frequency, mode and tables to analyze and present data respectively.

Sample mean is expressed as follows:

$X = \Sigma X / n,$

Where: ΣX is sum of all data values;
N is total of data number, items in sample,

Simple percentage is expressed as: -

Simple percentage (%) = (X/n) X 100

Where: x is number of individual items;
n is total of items numbers or data

The constructors, store manager , estimating engineer , purchasing manager etc. on studied construction sites were interviewed to conclude the main causes for the wastes of construction material, waste crating sources, reducing material waste and barriers in reducing materials waste on site. These construction peoples are selected due their directly involvement in estimation, procurement, handling and storage of the construction materials

III. PROFILE OF CONSTRUCTION PROJECTS SURVEYED FOR CASE STUDY

The study relied on field observation and direct measurement to generate data required. Six on-going projects were surveyed for period of six months in Kagal MIDC Kolhapur and Chakan MIDC Pune, As follows,

Table.1- Profile of construction project surveyed for case study.

Site no	Name of Project and	Name of Construction Management	Year of Constructions
1	Construction of foundry shed for Ghatge patil industries, MIDC Kagal, Kolhapur.,	Synthesis Design work plac and Associated constructions, Kolhapur	2016-17
2	Constructions of ETP and RO plant for Raymond luxury cotton limited, MIDC, Kagal, Kolhapur	Vivek shete & associates, and Associated constructions, Kolhapur	2016-17
3	Constructions of Utilities and roads for Unichem laboratory MIDC kagal, Kolhapur	Knexir associates Mumbai and Vishvakarma buldres, Goa	2016-17
4	Construction of Industrial shed for Raymond luxury cottons ltd, MIDC Kagal, Kolhapur	Vivek shete & associates, and Associated constructions, Kolhapur	2017-18
5	Construction of ware house and paint shop, machine shop with utilities for Plastic omnium auto exterior unit, MIDC Chakan, Pune	Mott- MacDonald associates Mumbai and Assocons Projects LLP Pune	2017-18
6	Construction of industrial building and allied works for GEDIA India Ltd, MIDC Khed-Chakan, Pune.	S.N Pingle consultancy Pune and Assocons projects LLP Pune.	2018-19

IV. DATA PRESENTATION AND ANALYSIS FOR CASE STUDY - data gathered from the survey are.

Project 1 - Construction of foundry shed for Ghatge patil industries, MIDC Kagal.
Table 2- Material received, consumed, wasted, and causal factor on project-1.

Item	Metal	Sand	Cement	Bricks	Tr-steel	Str-steel	Timber	Sheets	Paint	Tiles
Unit	cum	cum	bags	nos	mt	mt	Cum	sqm	lit	sqm
Qty-supplied (A)	11800	15000	80000	150000	400	600	3000	15000	4500	1500
Qty-used (B)	11200	14100	75500	139700	382	560	2700	14500	4360	1350
Qty-wasted (C)	600	900	4500	10300	18	30	300	500	140	150
% C to A	5.08	6.00	5.63	6.87	4.50	5.00	10.00	3.33	3.11	10.00
Casual factor	Storage and handling	Storage and handling	Storage and handling	Storage and handling	Operational	Operational	Design and document	Operational	Design, and document	Design and document

Project 2 - Constructions of ETP and RO plant for Raymond luxury cotton limited, Kagal.
Table 3 - Material received, consumed, wasted, and causal factor on project-2.

Item	Metal	Sand	Cement	Bricks	Tr-steel	Str-steel	Timber	Sheets	Paint	Tiles
Unit	cum	Cum	bags	nos	mt	mt	Cum	sqm	lit	sqm
Qty-supplied (A)	9800	10094	70000	130000	200	250	3000	1000	5000	1000
Qty-used (B)	9310	9690.2	67550	123500	194	240	2790	970	4775	920
Qty wasted (C)	490	403.76	2450	6500	6	10	210	30	225	80
% C to A	5.00	4.00	3.50	5.00	3.00	4.00	7.00	3.00	4.50	8.00
Casual factor	Storage & handling	Storage & handling	Storage & handling	Storage & handling	Operation	Operation	Design & documen	Design & documen	Purchase	Design & documen

Project 3 - Constructions of Utilities and roads for Unichem laboratory MIDC Kagal.
Table 4 - Material received, consumed, wasted and causal factor on project-3.

Item	Metal	Sand	Cement	Bricks	Tr-steel	Str-steel	Timber	Sheets	Paint	Tiles
Unit	cum	Cum	bags	nos	mt	mt	Cum	sqm	lit	sqm
Qty supplied (A)	9100	9373	65000	120000	100	80	2000	950	1000	2000
Qty used (B)	8554	8904.3	62400	112800	96	77.2	1880	917.7	960	1800
Qty wasted (C)	546	468.65	2600	7200	4	2.8	120	32.3	40	200
% C to A	6.00	5.00	4.00	6.00	4.00	3.50	6.00	3.40	4.00	10.00
Casual factor	& Storage handling	& Storage handling	& Storage handling	& Storage handling	Operational	Design & document	Procurement	Operational	Procurement	Design and document

Project 4 – Construction of Industrial shed for Raymond luxury cottons ltd, MIDC Kagal.

Table 5 - Material received, consumed, wasted causal factor on project-4.

Item	Metal	Sand	Cement	Bricks	Tr-steel	Str-steel	Timber	Sheets	Paint	Tiles
Unit	cum	Cum	bags	nos	mt	mt	cum	sqm	lit	sqm
Qty supplied (A)	12600	12978	90000	200000	150	120	4000	2000	5000	1800
Qty-used (B)	12096	12491	86850	190000	144	115.2	3800	1940	4850	1674
Qty-wasted (C)	504	486.675	3150	10000	6	4.8	200	60	150	126
% C to A	4.00	3.75	3.50	5.00	4.00	4.00	5.00	3.00	3.00	7.00
Casual factor	Storage & handling	Storage & handling	Storage & handling	Storage & handling	Design & documentation	Operational	Procurement	Operational	Procurement	Design & documentation

Project 5- Construction of ware house and paint shop, machine shop utilities for Plastic omnium auto exterior unit, MIDC Chakan, Pune.

Table 6 - Material received, consumed, wasted and causal factor on project-5.

Item	Metal	Sand	Cement	Bricks	Tr-steel	Str-steel	Timber	Sheets	Paint	Tiles
Unit	cum	Cum	bags	nos	mt	mt	cum	sqm	lit	sqm
Qty supplied (A)	17500	18025	125000	200000	150	120	4000	2000	5000	1800
Qty-used (B)	16712.	17258.	121250	188000	143.7	114.84	3720	1920	4855	1656
Qty-wasted (C)	787.5	766.06	3750	12000	6.3	5.16	280	80	145	144
% C to A	4.50	4.25	3.00	6.00	4.20	4.30	7.00	4.00	2.90	8.00
Casual factor	Storage & handling	Storage & handling	Storage & handling	Storage & handling	Operational	Operational	Operational	Operational	Design & document	Design & document

Project 6-Construction of industrial building and allied works- GEDIA India Ltd, Chakan.

Table 7 - Material received, consumed, wasted and causal factor on project-6.

Item	Metal	Sand	Cement	Bricks	Tr-steel	Str-steel	Timber	Sheets	Paint	Tiles
Unit	cum	Cum	bags	nos	mt	mt	cum	sqm	lit	sqm
Qty-supplied (A)	8400	8652	60000	130000	145	50	2500	1000	2500	1400
Qty used (B)	8064	8305.9	58200	123500	139.2	48.25	2375	970	2412.5	1274
Qty-wasted (C)	336	346.08	1800	6500	5.8	1.75	125	30	87.5	126
% C to A	4.00	4.00	3.00	5.00	4.00	3.50	5.00	3.00	3.50	9.00
Casual factor	Storage & handling	Storage & handling	Storage & handling	Storage & handling	Operational	Operational	Operational	Procurement	Procurement	Design & documentation

Table 8 - Frequency of causal factors of material wastage on the surveyed projects

Material	Storage-Handling	Operational	Design-Document	Procurement
Aggregate	6	0	0	0
Sand	6	0	0	0
Cement	6	0	0	0
Bricks	6	0	0	0
Tor steel	0	5	1	0
Structural steel	0	5	1	0
Timber	0	2	2	2
Sheeting Material	0	4	1	1
Painting Material	0	0	2	4
Tiles	0	0	6	0
Total	24	16	13	7

Table 9 - Average wastage of material on surveyed projects in percentage.

Mean	Aggregate (%)	Sand (%)	Cement (%)	Bricks (%)	Tor steel (%)	Structural steel (%)	Timber (%)	Sheeting material (%)	Painting material (%)	Tiles (%)
Mean of C to A	4.76	4.50	3.77	5.64	3.95	4.05	6.67	3.29	3.50	8.67

Table 10 - Frequency of causal factors of material wastage on the surveyed projects.

Casual factor	Frequency
Material storage and handling factor	24
Operational factor	16
Design and documentation factor	13
Procurement factor	7

V. DISCUSSION OF RESULTS FOR CASE STUDY

Table 2 to table 7 show the quantities of studied construction materials used, supplied for the works and wasted on the six sites surveyed, as well as the causes of each wasted, obtained from interviews with the respondents.
The computed percentage of quantities wasted, to the quantities supplied and quantities used are also captured.

A careful observations of these tables revels that on project 1 to 6, the quantities obtained were for materials quantities comprise aggregate, sand, cement, bricks, tor steel, structural steel, timber, sheeting materials, painting materials, tiles.

From the analysis of data collected, the frequency table shows that handling of the construction material is the factor that contributes mostly to materials wastage, with frequency of 24 (Table 10) The study also shows that operational factor and design documentation factor are strong factor for wastage of material on site with frequency 16 and 13 respectively. Other factor identified as causing waste of material is procurement factors with frequency of 7, even though the frequency shows they contribute minimally.

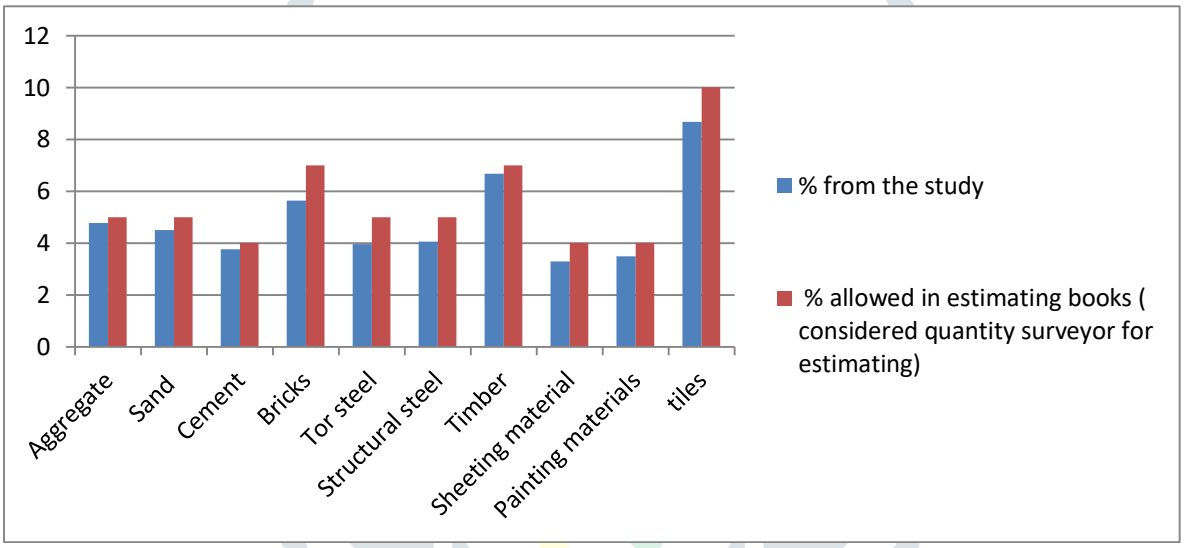
The table- 9 shows the average percentage of wastage for construction material on surveyed projects indicates that, (by comparing materials received to wasted)

For every 1 cum of aggregate on brought site, 4.76% of it is wasted,
For every 1cum of sand brought on site, 4.5% of it is wasted,
For 1 bags of cement brought on site, 3.77 % of it is wasted,
For 1kg of tor steel brought onsite, 3.95% of it is wasted,
For 1kg structural steel brought on site, 4.05% of it is wasted,
For 1cum of timber brought on site, 6.67% of it is wasted,
For 1 sq. sheeting material brought on site, 3.29% of it is wasted,
For 1 lit painting material brought on site, 3.5% of it is get wasted,
For 1 sq. tiles brought on site, 8.67% of it is get wasted.
For 10 bricks brought on site, 5.64% of it is getting wasted.

VI. COMPARISON OF PERCENTAGE MATERIAL WASTAGE FROM THE STUDY WITH WASTAGE ALLOWANCE PERCENTAGES CONSIDERED BY QUANTITY SURVEYOR.

Table 11. Percentage of material wasted obtained from the study and percentage of waste allowed.

Item	% from the study	% allowed in estimating books (considered quantity surveyor for estimating)
Aggregate	4.76	5
Sand	4.50	5
Cement	3.77	4
Bricks	5.64	7
Tor steel	3.95	5
Structural steel	4.05	5
Timber	6.67	7
Sheeting material	3.29	5
Painting materials	3.50	5
Tiles	8.67	10



Graph 1- Percentage of material wasted obtained and percentage of waste allowed

VII. SUMMARY OF CONCLUSION, FINDINGS AND RECOMMENDATIONS ON CASE STUDY.

The following surmises the findings obtained in this study:

1. The percentage relationship between the quantity of materials supplied to site and that wasted varies from one material to the other as well as from site to site.
2. The percentage relationship between the quantity of materials incorporated into work and that wasted varies from one material to the other.
3. On some sites wastage of materials found due to improper way of handling of materials.
4. Factors identified generating waste on sites is bad methods of material handling and storage, poor operational methods, changing in designs, and poor procurement.
5. It is found tiles generates highest wastage on site with 8.67%, followed by timber with 6.67%, bricks with 5.64%; aggregate with 4.76%, sand with 4.50%, structural steel with 4.05%, tor steel with 3.95%, cement with 3.77%, painting material with 3.5%, sheeting material with 3.29%.
6. The percentage waste allowance for the surveyed building materials in estimating literature is approximately same with the actual percentage waste from site measurement.

The average material wastage percentage obtained on construction sites in study is compared with percentage allowed by quantity surveyors. As explained in the table-10 and graph-1 the comparison reveals that there is not much more difference found in actual wastage generated on sites and standard considered by quantity surveyors for estimation. Actual wastage generated on site is at upper level to standards considered; it means if more wastage occurs beyond this, it will cause creation of losses. On a general note the position of this theory is that site management, quantity surveyor still needs to work hard on bringing down actual wastages happening on site. This will help to reduce allowance provided during estimating work in order to reduce pre tender project cost estimate and reduce financial losses for company.

VIII. IN VIEW OF THE FINDINGS OF THIS STUDY, THE FOLLOWING MEASURES ARE ADVANCED.

Proper and careful handling of materials on sites is necessary. It is found during study that handling of materials contributes heavy materials wastages on site.

1. Competent and experienced site managers/supervisors as well as trained persons should be employed in construction works.

2. Construction firms should establish strong material management policies and sanction any contributors to all types of waste.
3. Estimation engineer should consider materials wastages allowances obtained from study during processing tenders for construction projects for accurate results. Also to obtain economy in estimating full wastage of timber should be split due its reuse, about 60% – 70% of the construction waste consumed in a previous work should be utilized for in the further work.

REFERANCES

1) Anantha R.V., Lokeshwari M." Management of Construction And Demolition Waste". Journal ofEnvironmental Research and Development, Vol. 5 No. 1, July-September 2010
2) Abhijith H., Sreejith M.H., Jacob P.A., AiswaryaS"Minimizing Construction Wastes by Efficient SitePractices". International Journal of Education and Applied Research, ISSN: 2348-0033 (Online)ISSN : 2249-4944 (Print), 2014
3) Adewuyi, T.O., Otali. "Evaluation of Causes of Construction Material Waste Case of Rivers State,Nigeria" Ethiopian Journal of Environmental Studies and Management Vol. 6 Supplement 2013,
4) Ahankoob A., Khoshnava S.M., Rostami R., Preece C." Bim Perspectives on Construction WasteReduction". Micra Conference 2012
5) Anagal V., Nagarkar G., Atnurkar K., Patel A. "Construction and Demolition Waste Management – ACase Study of Pune." Natioanal Seminar Roorkee, Paper No. A-18, 2012
6) Bagdi N., Aggarwal V., Sherwal N. "Management of Construction Waste In India: A Case of GreenTechnology". Global Journal of Management and Business Studies. ISSN 2248-9878 Volume 3,Number 4, 2013.
7) Bossink B.A.G., Brouwers H.J.H "Construction Waste : Quantification and Source Evaluation",JournalofConstruction Engineering And Management, Issn:0733–9364, 1996
8) Formoso C.T., Lucio S.M., Cesare C.D., Isatto E.L. "Material Waste In Building Industry: MainCauses And Prevention", Journal of Construction Engineering and Management, July/August, 2002
9) Gamashta L., Gumashta S. "Reuse of Concrete and Masonry Waste Materials In Construction ToMinimize Environmental Damages Due To Quarrying", Journal of Environmental Research andDevelopment, Vol. 1 No. 1, July-September 2006
10) Hemalatha B.R., Prasad N., Subramanya B. V.V. "Construction and Demolition Waste Recycling ForSustainable Growth and Development", Journal of Environmental Research and Development, Vol. 2No. 4, April-June 2008
11) Ijigah E.A., Jimoh R.A., Aruleba B.O., Ade A.B. "An Assessment of Environmental Impacts ofBuilding Construction Project", IISTE, ISSN 2222-1719, 2013
12) Jain M." Economic Aspects of Construction Waste Materials In Terms of Cost Savings - A Case of
13) Indian Construction Industry", International Journal of Scientific And Research Publications, Volume2, Issue 10, ISSN 2250-3153, 2012
14) Kareem K.R., Pandey R.K. "Study of Management and Control of Waste Construction Materials InCivil Construction Project", International Journal of Engineering and Advanced Technology ISSN:2249 – 8958, Volume-2, Issue-3,
15) Meghani M. D., Vyas C.M., Bhavsar J.J., Hingu R.J. "A Study on Basic Material Waste In BuildingIndustry Main Causes and Prevention" National Conference on Recent Trends In Engineering&Technology, 13-14 May 2011
16) Nagapan S., Rahman I. A., Asmi A. "A Review of Construction Waste Cause Factors", Conference atUniversityTun Hussein Onn Malaysia, 2012
17) Rao B.P., Shivakumar B., Suresh H. S. "Waste Minimization In Construction Industry", Indian Journalof Applied