

# Critical Analysis of Material Wastage Standards for Construction Projects - Site Observations on Basic Construction Materials Wastage and Remedies

Prakash Mallappa Naik<sup>1</sup>, Prof. B.V. Birajdar<sup>2</sup>

<sup>1</sup>PG Student, Department of civil engineering, Tatyasaheb kore institute of engineering and technology, Warananagar, Pin-416113, Tal-Panhala, Dist-Kolhapur, Maharashtra, India.

<sup>2</sup> Professor, Department of civil engineering, Tatyasaheb kore institute of engineering and technology, Warananagar, Pin-416113, Tal-Panhala, Dist-Kolhapur, Maharashtra, India.

\*\*\*

**Abstract** - Depending on the type of a construction project, Building materials account for 60 to 70% of the project cost. Observational research has shown that this can be as high as 10 to 15% of the materials that go into a building, a much higher percentage than the 2.5-5% usually assumed by quantity surveyors and the construction industry. Minimizing the waste and optimizing the profitability is possible by reducing cost of material with proper planning, scheduling, purchasing, procurement, receiving, inspecting, handling, storing and warehousing. The purpose of this project is to study the sources of material wastage and to suggest the possible way to optimize it. Only materials wastages on constructions sites due to storage and handling are considered for this study because these materials are derived from natural resources and recharge of such resources is not possible.

**Key Words:** Introduction, objectives, method for study, site visit observations, solution on wastage, proposed frame work, conclusion.

**1.Introduction** - For study of basic constructions materials wastage on site., I have carried out construction site visits in Kagal MIDC Kolhapur and Chakan MIDC Pune in last six months. 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.. We observed lot of materials is utilized on site from start of construction site to its end. But some are basic materials required for all types of building constructions projects are 1) Reinforcement steel, 2) Structural steel, 3) Concrete, 4) Precast concrete member, 5) Form work, 6) Blocks and bricks, 7) Cement, 8) Sand, 9) Aggregate, 10) Premixed mortar, 11) Admixture, 11) Tiles, 12) Tiles, 13) Sheeting material, 14) Painting material, 15) Plumbing and sanitary material, 16) Miscellaneous other materials such as Aluminum materials, Floor coating material like epoxy, Architectural treatment material like ACP, railing, glass etc. We carried observations regarding materials wastages on sites due to its storage and handling & related recommendations are suggested.

**2. OBJECTIVE FOR THIS** - Objective is to study material wastages occurring on construction sites due to storage handling and to suggest possible practical solutions

**3. METHODOLOGY FOR THIS STUDY** - We have carried out ongoing construction site visits in MIDC Kolhapur and MIDC Chakan Pune. We observed material flow during storage and handling, on basis of observations we concluded causes and remedies on construction material wastages on site.

## 4. SITE OBSERVATIONS ON MATERIAL WASTAGES

**1) Reinforcement steel** - We observed tor steel used for all RCC structure like, footing, columns, beams, slabs, girders etc.

**Factors contributed for creating tor steel wastages observed on sites are**

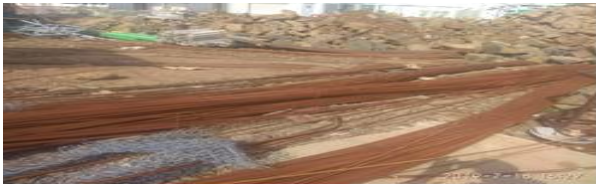
- 1) Short non usable pieces are developed during bar cutting by unskilled worker.
- 2) Steel gets buried in soil due to careless natures of unloading and stacking.
- 3) Prepared steel are remained un used due to design change.
- 4) Replacement of some bars by other diameter bars to maintain work flow due to late purchase and design change.
- 5) Tor steel is rejected by client due to rusting and test failure.
- 6) Steels ate cut in pieces to easy handling, results wastage in extra laps.
- 7) Steel gets theft during night due to poor security control.
- 8) Steel remains as residue, due to excess order by purchase and quantity surveyor.
- 9) Difference in actual material weight and theoretical calculation also observed.
- 10) Wastage also happens due to un standardized cutting steel by worker, like making L more than required for stirrups, columns and end anchorages etc.

11) Wastage also occurs due to excess steel bar bending, it will remain unused, like stirrups, chairs, pins, separators etc.

12) Wastage of steel also happens due to collapse of structure, like - wall collapse,

13) Wastage of steel happens due to its use in temporary works, like earthling,

Supporting, making hooks, using as holdfast etc.



Steel remains un-used due excess order  
Wastage due to cutting non economical



Wastage due to excess production and wrong handling



Wastage of steel due to poor storage  
Wastage due to replacement

Fig.1-Showing reinforcement steel wasting on construction sites.

**Suggested measures to minimize reinforcement steel wastage on sites are,**

1) There should not change design and drawings, instructions after making material ready to fix.

2) Schedule of bar bending should be provided by site engineer to foreman for accurate and economical steel cutting.

3) Timely estimation of material requirement should be calculated and order placed to receive material in time.

4) Care should be necessary to take while material unloading and storing, material to be stored in racks or making elevated platform to avoid contact to soil or water to avoid rusting.

5) Use cut pieces for making chairs, separators, and pins, hold fast etc instead of cutting standard bar.

6) Purchase steel from reputed manufacturers to avoid failure in testing.

7) Avoid using steel for temporary structure like making tent, earthling, etc.

8) Provide proper educations to peoples about standardized method for steel cutting, bending and handling etc.



Steel must be stored on raised platform and tarpaulin covering with segregation

Fig.2 -Suggested ways to store reinforcement steel on site.

**2) Structural steel** – We observed structural steel is used for making m.s columns, beams, trusses, foundation base, fencing, edge angle, trench covers, insert plates etc.

**Factors contributed for creating structural steel wastages observed on sites are**

1) Short no usable pieces are developed during bar cutting by unskilled worker.

2) Steel gets buried in soil due to careless natures of unloading and stacking.

3) Prepared steel are remained un used due to design, drawing change.

4) Replacement of steel by other higher side steel to maintain work flow due to late purchase and design change.

5) Wastage of steel due to rejection by client due to rusting and test failure.

6) Steels are cut in pieces to easy handling, results wastage in extra

7) Steel get theft during night due to poor security control.

8) Steel remains as residue, due to excess order by purchase and quantity surveyor.

9) Difference in actual material weight and theoretical calculation also observed. It is found extra by weight but less as per steel table calculation during billing.

10) Wastage also happens due to un standardized cutting steel by worker, like making L more than required for stirrups, columns and end anchorages etc.

11) Wastage also occurs due to excess steel fabricating, it will remains un used, like base plate, cleats, sag rods, insert plates etc.

12) Wastage of steel also happens due to collapse of structure, like -shed collapse,

13) Wastage of steel happens due to its use in temporary works, like earthling, supporting, workers hutments, using as holdfast etc.



Steel wastage due to bad storage

Steel gets buried in excavated stuff

Fig.3- Showing structural steel wasting on sites.

**Suggested measures to minimize structural steel wastage on sites are,**

1) Design and instructions should remain firm, there should not frequently change.

2) Proper shop drawing should be provided to fitter for accurate cutting of materials.

3) Accurate estimation of material requirement should be calculated in advance and order placed to receive material in time.

4) Necessary care should be necessary to take while material unloading and storing, material to be stored in racks or making elevated platform to avoid contact to soil or water to avoid rusting.

5) Use cut pieces for making inset plate, cleats, and stands, hold fast etc instead of cutting standard length steel.

6) Purchase steel from reputed manufacturers to avoid failure in testing.

7) Avoid using steel for temporary structure like making tent, earthling, stool, platform etc.

8) Provide proper educations to peoples about standardized method for steel cutting, bending and handling etc.

9) Keep structural steel material covered to avoid touch with rain and moisture.

10) Depute strong security persons for material safety.

11) Use suitable erecting machineries for structural erecting to prevent wastage due to structural collapse.



Materials to be stored on raised platform with separate category

Fig.4 - Suggested ways to store structural steel on.

**3) Concrete** - It observed on construction site is concrete is basically used for cast in situ concreting like footings, columns, beams, walls, slab, girders, road, foundation etc. Types of concreting materials used on site are of two types namely site mixed concrete and ready mix concrete brought from outside.

**Factors contributed for creating concrete wastages observed on sites are**

1) Wastage of RMC concrete due to extra order than required.

2) Quantity receiving on site sometimes found less in volume due to error in plant.

3) Wastages occur due to un controlled mixing of ingredients.

4) Wastages happen during of concrete transportation like- falling through pump.

5) Wastage occurs during concrete placing like, falling of concrete from shuttering, shuttering failure, extra pouring concrete in slab etc.

6) Wastage occurs due to rework, workers mistake, honeycombing concrete etc.

8) Wastage occurs due to rejection of concrete due failure of tests like, slump, compressive strength, less curing etc.

9) Wastage of concrete occurs due failure of placing, transporting and mixing equipment, like – concrete remains un-poured in transit mixer beyond setting time.



Wastage due to rework, mistake  
Wastage due to extra thickness of pcc



Wastage due to design change,  
Wastage during transporting and placing

Fig .5 - Showing concrete wasting on construction sites.

**Suggested measures to minimize concrete wastage on sites are,**

- 1) Place order by estimating accurate quantity to RMC and always make extra arrangement to accommodate extra concrete.
- 2) Make good quality shuttering to eliminate wastage of concrete due to failure.
- 3) Improve workman ship by providing training, to eliminate honeycombed concrete to avoid rework.
- 4) Avoid extra loading of concrete to avoid wastage of concrete during transportation.
- 5) Use proper method for ingredient mixing, batching to reduce wastage due to faulty production, rejection.

6) Keep good maintenance of concrete mixing, transportation and placing machinery to avoid wastage of concrete.

7) Improve workmanship to avoid extra consumption of concrete than required, like in slab, road, footing, flooring etc.

8) Used standardized work practice for batching, mixing, and transportation and posting in position to avoid failure in before and after concrete test, avoid rework.



Proper method of, transportation batching, mixing, and placing of should be used





Proper thickness, quality standards and method of concreting should be followed.

Fig.6 - Suggests ways to minimize concrete wastage on construction sites.

**4) Precast concrete members** - Some precast members used on sites observed are kerb stone, paving blocks, local lintels, RCC Hume pipes, chamber covers, compound retaining structures etc.

**Factors contributing for creating precast member wastages observed on sites are**

- 1) Damaging precast members during transportation.
- 2) Damaging precast members due to wrong method of unloading.
- 3) Breaking precast members due to wrong handling, placing on site.
- 4) Due to rejection, quality issues.
- 5) Cutting to achieve architectural shapes.
- 6) Theft of materials, poor security issue.
- 8) Design and instruction change after receiving material.
- 9) Rework due to bad workmanship.
- 10) Precast member's breaks due to poor method of storing and double handling.
- 11) Rework due to wrong instructions.
- 13) Wastage occurs due to collapse of transporting and erecting equipment.



Damages to paver block due to handling Damages to kerbs due to bad storage



Poor storage of RCC Hume pipes

Damages to half gutter due to bad storage

Fig.7- Showing precast concrete member wasting on construction sites.

**Suggested measures to minimize precast concrete members wastage on sites are,**

- 1) Use suitable transportation system to avoid damage to precast member.
- 2) Do careful unloading and storing on site, on leveled platform, to avoid damage.
- 3) Unload material on leveled surface, near work place to avoid double handling.
- 4) Avoid design change after material ordering and receiving material on site.
- 5) Improve workman ship to avoid quality issues due to workmanship, avoid rework.
- 6) Use cut pieces, damaged pieces for sides' corners instead cutting of good member.
- 8) Purchase material from reputed supplier to avoid rejection due to quality issue.
- 9) Depute trained mason and supervisor for execution of work to avoid rework.
- 10) Avoid over ordering of material by exact estimating quantity.
- 11) Receive material from supplier by conducting necessary tests.
- 12) Uses good security systems to avoid theft of materials.
- 14) Use suitable transporting and erecting equipment to avoid failure.



Kerb stones and paving blocks to be stored on leveled ground to avoid sliding



RCC pipes and grass paver to be stored on leveled ground with category wise

Fig .8 - Suggests ways to store precast concrete member on construction sites.

**5) Form work** – It observed on construction sites that form works are mainly used for holding and supporting cast in situ concrete in its required shape. MS material and wooden materials are basically used as form work. Out of wooden formwork contributes more wastage; wastage to MS from work is negligible.

**Factors causing for creating wooden form work wastages observed on sites are**

- 1) Damages to wooden material during failure of transport system.
- 2) Damages to wooden materials due to bad method of loading and unloading.
- 3) Wooden materials get wrapped, shrinkage, bends due to storing in open climate.
- 4) Cutting of materials to required shape, drawing and decisions change etc.
- 5) Instead of using more repetition, using new material for each time.
- 6) More cutting of materials requires for architectural treatment.
- 7) Nonstandard sizes of concrete members promote more cutting, less repetitions.

8) Wastage due to theft of materials.

9) Wastages due to non-proper method of storing, cleaning, protecting and handling.

10) Using materials without rust coating, without shuttering oil.

11) Wastage due to collapse of structure due to bad supporting.



Wastage due to improper store



Wastage due to keeping expose in rain

Fig..9 - Showing timber shuttering members wasting on construction sites.

**Suggested measures to minimize wooden form material wastage on sites are,**

- 1) Needs proper care during loading and transportation, to avoid damages.
- 2) Needs proper care during unloading and storing onsite, store near work place.
- 3) Keep all wooden protected and covered with tarpaulin to avoid contact with moisture and extra sun light.
- 4) Store wooden material on raised platform to avoid contact with soil, provide termite protection, avoid contact with water etc.
- 5) Avoid drawing and design change to reduce re cutting of formwork materials.

6) Use shuttering oil or moisture barrier to protect material during concrete casting.

7) Keep standard sizes of members to be shuttered to avoid cutting wastage.

8) Focus on more repetitions should occur, careful handling, storing, and cleaning, before and after use to avoid rusting.

9) For sealing gaps, sides and minor works use cut pieces avoid cutting of new one.

10) Workers should be trained to economical use of wooden materials.

11) Proper designing of shuttering materials should be done before use to avoid extra material utilization and to avoid wastage due to shuttering failure.

12) Use more MS type shuttering materials whenever possible, use less wood material



Proper stocking of timber material

Timber materials should be protected on elevated platform with tarpaulin covering to avoid touching with rain, sun light, and soil.

Fig.10 - Suggests ways to store wooden shuttering on construction sites.

**6) Blocks and bricks** – We concluded from site visits that , bricks and blocks are basically consumed as walling materials for offices, shed, chambers, and foundation site protections etc. Material such as red bricks, fly ash bricks and less weight aerated concrete bricks are used as walling materials.

**Factors causing for creating bricks and blocks wastages observed on sites are**

1) Damages of bricks during transportation, failure of transporting system.

2) Damages to bricks during unloading and loading on site, during double handling.

3) Wastage occurs due to using it for temporary works like, hutments, line out pillars.

4) Wastages of bricks occur, rework due to bad workman ship and design change.

6) Wastage of bricks occurs due to bad method of handling, striking of various construction machineries and equipment on site.

7) Cutting full length bricks for closer use, instead of beaked pieces.

8) Wastages occur due to no proper handling by mason, balance materials remains scattered in place after completion of works.

9) Material gets theft due to poor security system.

10) Material gets rejected by user due to bad quality of material receiving on site.

11) Wastage also occurs due to collapse of structure, residue left, over ordering etc.



Wastage due to bad storage and cutting



Wastage due to bad handling & storing Wastage due to bad transport-handling

Fig.11- Showing bricks and blocks wasting on construction sites.

**Suggested measures to minimize bricks and blocks wastage on sites are,**

1) Use proper transporting equipment to transport brick from making unit to site.

2) Necessary attention should be give during loading and un loading of bricks on site.

3) Bricks should be stacked on level ground or on pallet, height should be accessible.

4) It should be placed in container, covered place, not on walkway to avoid damages.

5) Avoid double handling, by storing it near work place.

6) Use broken brick pieces for closer, avoid breaking full brick.

8) Proper quality measures should be followed during order to avoid rejection.

9) Improve security quality to eliminate wastage due to theft.

10) Training should be provided to mason about careful handling and stacking.

11) Avoid damages to bricks by dashing with equipment and machineries on site.

12) Avoid use of bricks for temporary works like, labor hutments, lineout pillars etc.



Bricks should be placed on leveled firm ground with reachable height for easy handle

Fig.12. - Suggests ways to store bricks and blocks on construction sites.

**7) Cement** - This material is utilized as a component of mortar and casting place concrete in several different processes, such as brick- work, plastering, and floor screed etc. on observed sites.

**Factors causing for creating cement wastages observed on sites are**

1) Wastages during transporting, loading and unloading occur, as hooks are used to load and unload, wastages also occurs due to double handling, due to theft etc.

2) Waste of cement is observed in the manufacturing of mortar on site. Cement materials are usually loaded manually in the mixer using inadequate equipment.

3) Waste of cement is also happens due to poor method of handling, like keeping cement as it on site after completion of works without proper protection.

4) Brickwork joints are also responsible generation waste of cement, due to the excessive utilization of mortar in joints.

5) Excessive thickness of plaster is also one of major cause of cement wastage on site.

6) Providing concrete in excessive thick instead of required, like in slab promotes wastage of cement.

8) Wastage of cement due to rain, moisture due to bad storage.

9) Wastage of cement also happens due to rework, design changes, rejection, failure of structures etc.



Wastage due to poor storage

Wastage due to poor handling

Fig.13 - Showing cements wasting on construction sites.

**Suggested measures to minimize cement wastage on sites are,**

1) Proper care should be taken during transporting of cement to site, avoid failure of truck.

2) Do not use hooks for unloading and loading of cement on site.

3) Keep cement on raised platform, with covered in shed to avoid moisture contact.

4) Improve security system to avoid theft of cement.

5) All necessary tests should be performed before receiving cement on site 6) Provide strict supervisions and training to construction peoples to avoid extra thickness in concrete, plaster, brickwork joints, tile mortars etc.

7) Avoid double handling of cement materials, to reduce wastage due to bags broken.

8) Prefer to purchase fresh cement, by providing requirement in required time.

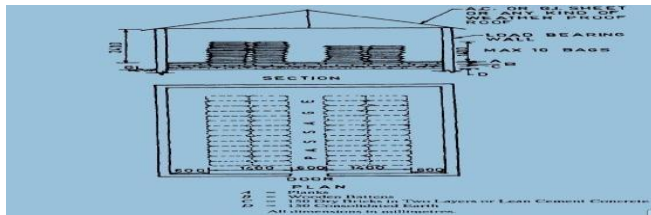
9) Use cement before expire date, to avoid rejection.

10) Avoid rework, design changes, failure of structures to avoid wastage.

11) Use loose cement for RMC plant instead of in bags.

12) Provide training to construction peoples about proper handling and storage on site.





Cement should be kept in shed with elevated platform, covering with tarpaulin to avoid touching with soil and moisture.

Fig.14. - Suggests ways to store cement on construction sites.

**8) Sand** - It is observed that sand is mainly utilized for making all types concrete, brickwork, plaster, fixing of precast member and waterproofing on site. Types of sand namely natural and artificial sands are used for various works on site.

**Factors causing for creating wastages of sand observed on sites are**

- 1) Wastage of sand occurs due failure of transport system.
- 2) Wrong method adopted for taking measurement of sand receiving on site.
- 3) Rejection of material due to excess silt contains failure of sieve analysis.
- 4) Excess use of sand in extra thickness of concrete, extra thick plaster and extra thick brick joints, extra thick of tile mortar etc.
- 5) Consumption of material for repairing faulty work, rework etc.
- 6) Wastages occur due to poor method of storing and handling, like storing in muddy area, and sliding of sand through wheel barrow during handling.
- 7) Washing away of sand due to rain, get buried in soil, and gets contaminated with other materials like mud, soil etc.
- 8) Design changes, rejection of work, failure of structures, theft of materials etc.



Wastage due to bad type handling

Wastage due to rework of wall - plaster



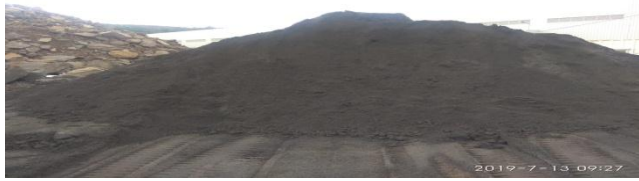
Wastage due to extra thick plasters

Wastage due to improper storage

Fig.15 - Showing sand wasting on construction sites.

**Suggested measures to minimize sand wastage on sites are,**

- 1) Maintain stick quality control on material to maintain silt contain, sieve analysis.
- 2) Measurement should be taken accurately of trucks receiving material on site.
- 3) Store sand on silt free, leveled platform and cover it.
- 4) Avoid sand wastage due to washing away by rains.
- 5) Improve security systems to neutralize wastage due to theft.
- 6) Proper training must be given to construction peoples about handling and use.
- 7) Maintain good supervision to avoid excess consumption in concrete, plaster, brick works, precast mortar, and it tile mortar.
- 8) Avoid rework due to design change, mistakes, failure of structure etc.
- 9) Keep material reconciliation to find out ways extra consumptions and solutions.
- 10) Use proper methods for batching, mixing, placing and transportation methods on sites to avoid wastages due to excess consumptions, get buried in soil etc.



Natural sand and artificial sand should be marinated on leveled and compacted firm platform with proper gradient, separate from other concrete making materials, like aggregate, cement etc.

Fig.16 - Suggests way to store sand on construction sites.

**9) Aggregates** – It is observed during site visit that, aggregates are mainly used for various types of concreting works on site. It is also used for lying in transformer yard, Generator yard and alongside of precast compound wall.

**Factors causing for creating wastages of aggregate observed on sites are**

- 1) Material gets refused due to inferior quality, failure of sieve, flakiness etc.
- 2) Material gets wasted due to storing in muds and soil area.
- 3) Extra material gets consumed in extra thickness of concrete and laying in transformer yard and DG yard, than required.
- 4) Faulty method of taking measurement of truck through materials receiving on site.
- 5) Material gets wasted due to transport system failure.
- 6) Material gets rusted due to keeping expose to climate long time.
- 7) Material remains un used due to excess order, needs to remove from site.
- 8) Material double handling also contributes generation of wastage.
- 10) Material wastages occurs in rework happens due to design change, failure of structure, workers mistake and providing replacement etc.
- 11) Material gets wasted than required during its batching, mixing, placing and transporting in required place in various forms.



Wastage due to mixing with soil

**Aggregate mixed in debris**



Wastage of aggregate due to improper handling and storage on batching plant

Fig.17- Showing aggregate wasting on construction sites.

**Suggested measures to minimize aggregate wastage on sites are,**

- 1) Proper control is necessary on supplier to get material in right quantity and quality.
- 2) Store the material in dry and leveled platform; avoid storing in soil and mud.
- 3) Avid double handling of materials, use suitable transport system to avoid wastages due to over loading, falling etc.
- 4) Avoid reworks due to design changes, mistakes, failure of structure, test failure etc.
- 5) Proper care needs to take during batching, mixing, placing and transporting in place for various works, to avoid wastages due to excess loading and spilling.
- 6) Proper training must be given to construction peoples about material storage, care and handling during working on site.
- 7) Material reconciliation should be done time to time to maintain control on wastage.
- 8) Avoid weathering of material by proper storing and avoiding movement of equipment on it.



Aggregates should be kept on leveled and compacted firm platform with proper stockpile, separate from other concrete making materials, like sand, cement etc.

Fig.18- Suggests way to store aggregate on construction sites.

**10) Premixed mortar** - Making availability sand and maintaining mortar properties are felt difficult on site. So some construction companies are using premixed mortar for plaster and brickwork.

**Factors causing for creating wastages of premixed mortar observed on sites are**

- 1) Damages to bags during transportation, unloading and loading as hooks are used.
- 2) Bags are gets set due to storing on moisture ground.
- 3) Bags are gets sets due storing it on open climate without covering.
- 4) Excess use due to extra brick work joint and extra thickness of plaster.
- 5) Material remains un used after mixing due to workers mistake.
- 6) Material gets returned due to inferior quality and expiry date.
- 7) Materials remain excess due to unnecessary extra ordering and purchasing.
- 8) Materials wastages occur due to non-proper batching, mixing and placing in place.
- 9) Wastages occur due to rework, design change and failure of structures etc.



Wastage due to poor handling  
Wastage at time of mixing and placing



Bags get sets due to bad storage in store

Fig.19 - Showing premixed mortar wasting on construction sites.

**Suggested measures to minimize wastage of premixed mortar on sites are,**

- 1) Necessary care needs to be taken during unloading and loading, avoids hooks

- 2) Bags should be stores in closed shed and on leveled elevated platform to avoid touching with moisture and water.
- 3) Maintain accurate thickness of plaster and brick joints to avoid extra consumptions of materials.
- 4) Mix sufficient materials required for work, and consume it before setting time to avoid wastage.
- 5) Use material before expire date, to avoid rejection.
- 6) Select reputed manufacture to purchase premixed mortar bags to avoid quality issues, rejections etc.
- 7) Use proper method for batching, mixing, placing and transporting methods to reduce wastage due to over mixing, over placing and spilling during moving on site.
- 8) Provide proper training to construction peoples on careful handling of materials.
- 9) Regular material reconciliation will helps on monitoring material consumptions.
- 10) Avoid rework like - mistakes, failure structures, design changes et



Premixed mortar should be stored in closed shed with elevated platform, covering with tarpaulin to avoid touching with soil and moisture.

Fig.20 - Suggests way to store premixed mortar on construction sites.

**11) Admixtures and construction chemicals -** There are various admixtures like accelerators, retards, water reducing, concrete bonding, plasticizers etc. admixtures are used in concreting, plaster mortar and for waterproofing on observed sites.

**Factors causing for creating wastages of admixtures observed on sites are**

- 1) Wastage occurs due to extra using of materials than required.
- 2) Wastage occurs due to using after expiry date.
- 3) Wastage occurs due to selection of wrong admixtures for related works.
- 4) Materials remain unused due to extra purchase.
- 5) Materials gets returned due to failure in test, inferior quality receiving.
- 6) Wastages due to damaging drums during transporting.

7) Material gets wasted due to bad method of storing and handling, losing its property storing in extreme climate.

8) Replacing by high cost material due to urgency and late decisions, unavailability of required material.

9) Structure gets wasted due to quality issue, failure etc.

10) Workers mistake, system failure in proper batching, mixing, placing and transporting in required position.

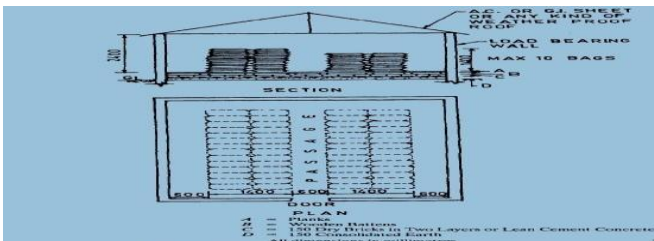
11) Bonding material gets wasted due to sudden rain after application.

10) Avoid rework due to mistakes, design changes, failure of structures etc.



Admixtures and constructions chemicals should be stacked in closed ventilated shed, with firm base to avoid spill off and avoid contact with sun light. Proper inventory should be maintained to avoid wastage and over order.

Fig.22- Suggests way to store admixture & constructions chemicals on sites.



Admixtures drums are stored with scrap, resulting damages to drums and expose to sun light leads properties change. This may cause rejection of materials.

Fig.21 - Showing admixture and construction chemicals wasting on sites.

**Suggested measures to minimize wastage of premixed mortar on sites are,**

- 1) Use materials before expiry date.
- 2) Take materials from reputed suppliers to avoid quality issues and test failures.
- 3) Use right quantity of material in right place, avoid extra consumption than required.
- 4) Use proper transporting system to avoid damages to admixture drums.
- 5) Material should be unloaded properly in clean and elevated place.
- 6) Keep all types admixtures separately, to easy identify, avoid wrong mixing.
- 7) Provide training to construction peoples regarding careful handling and storing.
- 8) Adopt suitable method for batching, mixing, placing and transporting in position, to avoid wastages due to extra mixing or splitting of materials.
- 9) Quantity of material should be work out properly to avoid excess material order.

**12) Tiles** – It is observed that tiling materials are mainly used for office flooring, toilet bathroom flooring, wall cladding, sills, treads and risers for staircase, decorative.

**Cause of tiling materials wastages on observed construction sites are.**

- 1) Wastages occur due to transport system failure.
- 2) Wastages occur due to poor method of loading and unloading on site.
- 3) Wastages due to manufacturing defects bend tiles.
- 4) Wastages occur due poor method of handling.
- 5) Wastage occurs due to cutting of tiles to accommodate nonstandard sizes of rooms.
- 6) Rework due to drawing change, mistakes, failure of structure.
- 7) Rejection due to inferior quality material, bad workmanship, colour variations etc.
- 8) Extra materials receiving on site due to excess ordering.
- 9) Wrong specification materials receiving on site due to wrong order.
- 11) Wastages happen during careless method of handling and fixing on site.
- 12) Wastages also occur due to equipment failure, striking of machineries etc.
- 13) Material texture and colour variations due to changing supplier and company.





Poor methods of storing of tiles

Granite and kota gets buried in filling

Fig.23 - Showing tiling materials wasting on construction sites.

**Suggested measures to minimize wastage of tiling materials on sites are,**

- 1) Provide material order to branded suppliers to avoid manufacturing defects like, color variations, tile bends and edge breaks etc.
- 2) Use proper transport system to avoid damages due to truck failure.
- 3) Materials must be loaded and un loaded properly to avoid damages.
- 4) Materials should be stacked on well leveled and firm surface and in covered shed,
- 5) Store material on space where less movement of equipment to avoid striking.
- 6) Avoid un standard sizes of rooms to reduce wastages due to cutting.
- 7) Purchase all required materials in one lot from one supplier to avoid color variations and manufacturing defects.
- 8) Use cut pieces for skirting and corners instead using cutting full tiles,
- 9) Proper training must be given to worker mason about material handling.
- 10) Avoid double handling, creating urgency in work etc.



Tiling materials should be stacked on levelled ground with proper segregations



Tiles should be handled with due care during transportations to avoid damages

Fig.24 - Suggests way to store tiling materials on construction sites.

**13) Sheeting Materials** - It is observed that pre-coated GI sheeting are used as sheeting for roof, canopy and cladding for various industrial sheds on studied projects.

**Factors causing for creating wastages of sheeting materials observed on sites are**

- 1) Providing extra laps than estimated and designed.
- 2) Wastages due to cutting sheets for sky lights, windows, ducts etc.
- 3) Wastages due damaging sheets during transporting, loading and un loading.
- 4) Sheets get damaged due to purchasing in loose form, instead of packing.
- 5) Sheets gets damaged due bends by wing and cyclone during installation.
- 6) Rusting of sheets due to water logging.
- 7) Rejection of materials due to bad workmanship, mistakes, and production defects.
- 8) Manufacturing and supplying sheets with wrong specifications.
- 9) Extra material receiving due to faulty estimation and order remains unsure.
- 10) Sheets damages due to poor handling and stacking on site, coating gets removed due to dragging during storing and fixing in position.
- 11) Theft of materials, damages to sheets by equipment and machinery collision on it.
- 12) Damages during, stacking, segregating, placing and transferring in position etc.





Wastage due to cutting

Wastage due to poor storage



Wastage due to bad handling and storage

Fig 25 - Showing sheeting material wasting on construction sites.

**Suggested measures to minimize wastage of sheeting materials on sites are,**

- 1) Materials should be purchased from reputed manufactures only to avoid manufacturing defects.
- 2) Materials should be properly packed during transportation not in loose form.
- 3) Use proper equipment and method for unloading and loading on site.
- 4) Un loads the materials near required location to avoid double handling.
- 5) Avoid extra laps, provide standard designed laps only.
- 6) Minimize cutting wastage by fixing sky light sheets along percolated sheets.
- 7) Un load materials on leveled firm raised platform and cover it to avoid touching with dust and water to avoid water logging.
- 8) Use proper care to handle during segregation and installation to avoid scratches.
- 9) Unload material with segregated category wise for easy handling.
- 10) Avoid fixing of sheets during wind and extreme sun light to avoid damages.
- 11) Avoid rejections due to design change, failure of structure, workers mistake etc.
- 12) Quantity should be estimated properly and place order accordingly to avoid excess material order.



Sheeting materials to be stored near to site and on raised platform and with proper tarpaulin cover to prevent contact with soil and moisture and for less handling.

Fig. 26 - Suggests way to store sheeting materials on construction sites.

**14) Painting materials** – It is observed that painting materials like oil bound distemper, enamel paint, apex paint; luster paints are used for painting of walls and structural steel.

**Factors causing for creating wastages of painting materials observed on sites are**

- 1) Rejection of painting material due to shade miss match.
- 2) Extra consumption of painting material due to bad workmanship.
- 3) Painting material wasting due to extra mixing and non-using it.
- 4) Damages to painting buckets during transporting, loading and unloading.
- 5) Theft of paint materials.
- 6) Rework due to bad workmanship, design change, shade variations etc.
- 7) Material remains un used due to extra order.
- 8) Wastage happens due to poor method of batching, mixing, and application on site.
- 9) Material gets contaminated with dust, 10) Wastages occur due to scaffolding and application system failure.
- 11) Receiving expired date materials, rejection.
- 13) Extra thinner required for cleaning due to bad workmanship.



Wastage due to bad storage & Wastage due to rework



Wastage due to bad workmanship Damages to painted

Fig.27 - Showing painting material wasting on construction sites.



Painting materials should be kept on raised platform, in rack with proper segregation and identifications for easy handle and inventory.

Fig.28 - Suggests way to store painting materials on construction sites.

**Suggested measures to minimize wastage of painting materials on sites are,**

- 1) Necessary attention to be taken during transportation of buckets to avoid damages.
- 2) Proper method should be followed to unload and stacking of painting materials.
- 3) Painting materials should be stack in segregated form, in rack, elevated level platform, in lock and key.
- 4) Proper batching and mixing should be done to avoid color variations.
- 5) Proper trained personnel to be employed for works to avoid wastages and mistakes.
- 6) Use good scaffolding system and application system to eliminate wastage due to equipment failure.
- 7) Maintain cleanness to avoid extra consumption of thinner for cleaning.
- 8) Purchase material in one time and reputed supplier to avoid shade mismatch and quality issues. Avoid over ordering.
- 9) Improve supervision quality to avoid extra consumption of materials on site.
- 10) Maintain good security to avoid material losses due to theft.
- 11) Use material before expire dates.
- 12) Kept materials in covered area to avoid wastages due to contaminated with dust.



**15) Plumbing materials** – These materials are consumed on building construction projects for water supply, disposal of sewage and raw water, providing sanitary facility to building users.

**Factors contributing creating plumbing material wastages on observed site are.**

- 1) Wastage of these materials occurs due to damages during transportation.
- 2) Damages occur to materials during, loading, unloading and storing on site.
- 3) Selection of materials apart from specifications.
- 4) Design and user requirement change.
- 5) Un necessary cutting leads to creation of wastages.
- 6) Materials gets wasted due theft.
- 7) Replacement due to poor workmanship, inferior quality materials, manufacturing defect etc.
- 8) Wrong estimation of material quantity contributes excess order, leads wastage.



Plumbing materials are thrown in steel yard, poor handling a



M.S materials are thrown on PVC plumbing materials due to pipes are damaged

Fig.29 - Showing plumbing materials wasting on construction sites.

**Suggested measures to minimize wastage of plumbing materials on sites are,**

- 1) Material order should be placed with proper estimation and series.
- 2) Selection of standard supplier should be done to avoid quality issues.
- 3) Necessary attention to be provide during materials transportation to prevent damages.
- 4) Suitable methods to be adopted to store materials, it should be covered, kept separated, not one above others.
- 5) Proper security should be employed to avoid theft.
- 6) Proper skilled workers should be employed to carry out works to reduce damages and reworks etc.
- 7) Careful selection of plumbing materials to avoid manufacturing defects.
- 8) Avoid rejection by maintaining good workman ship, using specified materials, etc.
- 10) Keep covered all installed sanitary fittings to avoid damages during acid wash and cleaning to avoid rusting.
- 11) Use proper method and good tools, equipment for fixing of fittings.
- 12) Avoid wastages of materials due to cutting, use cut pieces for corners etc. instead of cutting standard length pipes.



Plumbing materials and its fittings should be stacked on racks with proper segregations as per specifications for easy access and inventory control.

Fig.30 - Suggests way to store plumbing materials on construction sites.

**16) Miscellaneous materials** - It is observed that some miscellaneous materials are also used on studied constructions sites are as follows.

**Aluminum materials** - These materials consumed on building construction projects for making doors, windows and partitions etc.

**Flooring coating materials** - These materials are basically used in industrial building to protect parent flooring and to make it more serviceable. Epoxy and liquid hard treatment is mainly used in industrial building to avoid dust accumulation, and easy cleaning. Architectural treatment materials - There are lot of materials used for architectural treatments in building constructions sites like- aluminum composite materials, glass materials, railing materials, false ceiling materials, gypsum materials etc.

**Factor contributing creation of wastages of above materials on observes sites are,**

- 1) Wastage of aluminum and architectural materials occurs mainly due cutting of materials for nonstandard opening sizes.
- 2) Workers mistake, design changes, damages to materials during transportation, poor handling during working also contributes creation of material wastages.
- 3) Rework due to faulty work man ship, purchasing nonstandard materials, non-utilization before expiry dates, using floor before curing period, excessive use of materials, wastage due to improper and extra mixing of materials, etc



Wastage of aluminum material



Wastage of ACP material, poor

Fig.31 - Showing miscellaneous material wasting on construction sites.

**Suggested measures to minimize wastage of miscellaneous materials on sites are,**

- 1) Use standard opening sizes to avoid aluminum and ACP material wastages in cutting to required shape.
- 2) Attention to be provided during transportation, loading, unloading and handling of miscellaneous materials to avoid damages.



3) Store materials on elevated and levelled platform in lock and key to avoid mixing each other and also to protect from theft, use proper equipment and machinery.

4) Use materials before expiry dates, like epoxy paint, ACP sealant etc.

5) Avoid rework due to design change, workman ship, using wrong material etc.

6) Depute proper skilled workers to maintain workman ship and for optimum use of materials.



Careful transportation of glass material



Storage of aluminum materials



Storage of epoxy & floor coating material Storage of ACP supporting material

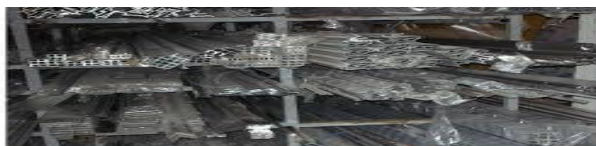


Fig.32 - Suggested ways to store miscellaneous material on construction sites

## 5. SOLUTIONS FOR CONSTRUCTION MATERIAL WASTAGES ON SITE

During construction site visits and case study, various factors observed responsible for generation of materials wastages on all studied construction sites are grouped in main six categories are as follows.

1. Failure in proper control and planning of materials on construction site.
2. Less interest in doing work as team work.
3. Un controlled project management.
4. Absences of technical soundness in peoples involves on construction sites.

5. Lack of professional motivation.

6. Less communication between parties etc.

### The measures proposed to overcoming above issues

1. Perfect control and planning of construction materials on sites.
2. Maintaining teamwork among all peoples working on construction projects.
3. Adopting good project management systems.
4. Improvement of technical capabilities in peoples working on construction sites.
5. Keeping professional motivation.
6. Improving communication between parties.

#### 1) Perfect control and planning of materials on construction sites.

It is observed that, traditional material planning and control systems are followed by construction site management visited. This fails to collect material requirement from various departments working on site in advance and to supply required materials in required quantity at required time to respective department. Also it is observed there was no control on received materials on site in unloading, transporting and storing and handling, peoples were using and handling materials in rough manners resulting in wastages. To avoid material wastages on site some measures suggested are,

1. To use computerized inventory control systems instead of manual systems.
2. Take requirement of materials from all departments on site in advance, which will provide better time allowance to negotiate and searching better materials and providing delivery in required time.
3. Proper care should needs to take while material un loading, transporting and storing and handling.
4. Needs to avoid double handling. Un loading materials at required locations only.
5. Do time to time material reconciliation which will help to know amount of material wastage and way to control it.
6. To provide training to peoples working on site for proper materials care, storage and handling to achieve waste minimization aim.
7. Involve peoples working on site in material management, like estimating requirement, studying specifications, identifying space for unloading, finalizing transporting systems etc.

#### 2) Maintaining proper team work among players of constructions.

Some material wastage happens on site due to poor team work between peoples working site. Peoples are working in dependently and using materials accordingly

which contributes material wastages on site, Teamwork means workers working as a group to achieve a common goal. Teamwork, if carried out effectively, results in motivated workers, improved job satisfaction, reduced overall work time, and can improve the quality of work resulting reducing material wastage.

To ensure the successful adoption of waste reduction there should be an effective teamwork between all peoples working on site. To ensure proper teamwork on construction sites,

1. Managers should be promised to change.
2. Workers need to work on site as team.
3. Companies should be more clients focused.
4. Firms should be promised to change organizational cultures that do not promote waste minimization in construction.
5. Partnering to maintain team building and team members must be involved in decision-making to make partnerships meaningful.
6. Needs to maintain communication between peoples working on site.
7. Role and responsibility of peoples working on site should be well defined.
8. Needs to develop supportive and cooperative nature in peoples working on site.
9. Needs to conduct daily site coordination meeting between peoples working on site for daily planning of works and to sort out issues between them.
10. If any person working on site disturbing team work, them he should be removed from site.



Fig.33- Main contractors on construction sites are busy in discussing as a team.

### 3) Adopting good project management systems

Project management means conducting all project activity in required sequence to achieve required goals by providing required resources with eliminating mistakes. It is observed on some sites that there was poor control of project manager on site peoples. Peoples working on site in un controlled manner, not using resources and materials properly during material loading, unloading, transportation, batching, mixing, and placing at required place. Some machineries and equipment are frequently breakdowns; workers are un aware of proper procedure of

work. These results in creation of material waste, to overcome this issue some measures suggested are,

1. Project manager should keep his strong command on peoples working on site
2. To define role of each person and his contribution on site.
3. To conduct site coordination meeting with staff on site to plan and tackle issues.
4. To make proper planning of works and material requirement schedule.
5. To use proper inventory control systems on site.
6. To use proper accounts and purchase systems on site.
7. To depute waste manager on site to highlight wastages and control it.
8. To provide training for peoples working on site regarding proper material handling, storing, transporting, batching and mixing in required place.
9. To improve coordination between construction peoples.
10. To keep all equipment and machineries in good maintenance condition.



Fig.34 - Project manager issuing instructions to peoples working on site.

### 4. Improvement of technical capabilities in peoples working on sites.

It is observed on various sites that, peoples working like, carpenters, fitters, mesons, etc. are not technically sufficiently sound. So wastage of materials happens from them due to cutting no economical shape, using extra materials than required, following faulty work procedures contributes re work, these results in generation for wastage of construction materials on construction projects.

1. The improvement of technical capabilities in construction peoples is very important in order to effectively adoption of waste reduction on construction sites. To ensure that technical capabilities are enhanced, suggests that
2. To provide proper educations to peoples working on site about specifications and method of work to be executed.

3. Suggested that stick on use of standardization process for execution of works instead using any short cuts.
4. There is also the need for managers to maintain personal discipline, direct and coach others to keep within standards and procedures and always react to off standard and off target situations with immediate investigation.
5. It is also important that managers do not allow short cuts and tackle reasons why a standard is overlooked or neglected.
6. Also, standardized construction elements should be utilized to reduce the magnitude of materials wasted on construction sites.

**5. Keeping professional motivation**

It is observed on many sites that peoples working are not satisfy regarding their salary, bonus, and involvement in planning, and facilities getting from company. So they were not contributing their full efforts towards material wastage minimization and in achieving production targets. Such depressed or un satisfied peoples working on site are contributing more material wastages as they are not following instructions, work procedures intentionally. To obtain good results on production as well as wastage minimization on site, peoples working on site should remain highly motivated. Some measures suggested to motivate peoples working on site are.

1. To provide proper salary and facilities to peoples working on site.
2. To involve peoples are working on site in planning and design making.
3. To provide incentives, bonus, rewards, for achieving better results.
4. To provide proper training about job and promotions.
5. Motivated peoples contributes more efforts towards achieving targeted goals, they cooperates management decisions, instructions and also follows standard rules defined, which helps wastages minimization on site..



Fig. -35 Manager understanding site peoples issues to motivate them.

**6. Improving communication between peoples**

During site visit we observed that there was major communication gap between workers and staff, between staff and purchase manager, store manager. Due to proper

instructions were not get passed from construction site people to peoples resulting re works leading to material wastages. Less communication between construction site peoples and store purchase peoples leads to late material order and receiving inferior quality material due to shortage lead time. Communication gap in construction players also contributes poor materials transportation, handling, loading and unloading etc. results in material wastages. To reduce material wastages due to communication gaps needs to improve communications between construction site peoples. To improve communications between peoples following measures should be implemented.

1. To arrange daily site meetings by gathering peoples working on site to discuss about work planning, various issues and remedies on it.
2. To provide induction to workers and staff before starting new works about material management, Viz-loading, un loading, storage, handling and reporting.
3. To conduct training and awareness programme to construction peoples about material wastage minimization, which also helps to improve communication between them
4. Needs to provide better communication systems like phones, internet systems to peoples working on site to achieve better communication.
6. Motivating peoples to work as team works, improve communication.



Fig.36 – Improving communication between constructions peoples by gathering.

**6. PROPOSED FRAMEWORK TO MINIMIZE MATERIAL WASTAGE ON SITE.**

The purpose of the framework is to help managers to:

Better understand the major challenges (barriers) that could hinder the implementation waste minimization on construction project.

Identify what could be done to tackle these challenges (what to do).

Identify how to address these challenges (how to do it) and

Realize the possible outcome (results), which is minimizing materials wastage. on various construction sites in Kolhapur and Pune MIDC.

**Proposed frame work to minimize construction materials wastage on site**

**REFERENCES**

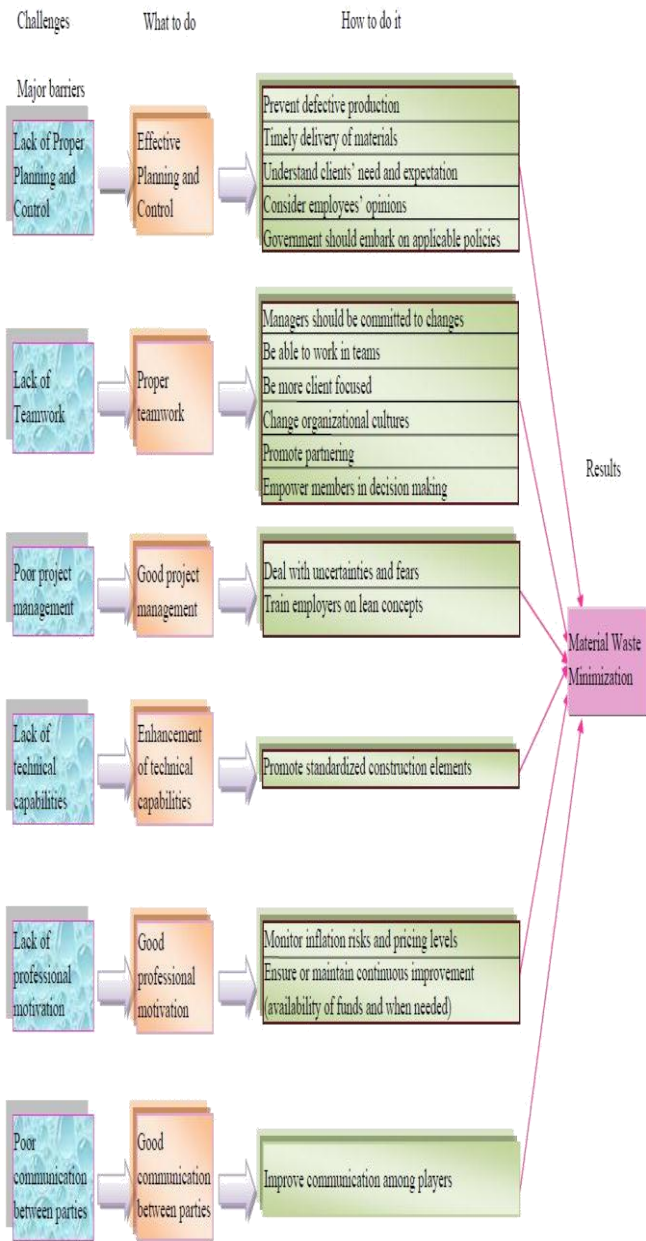


Fig.37 – A frame work for minimizing material waste.

**7. CONCLUSION –**

This chapter presented results from the quantitative analysis and the site observations. Results have been presented on the causes and sources of construction materials wastes and waste minimization measures. A compendium on wastage of basic construction materials and recommended ways of waste minimization is also provided. Results were presented on barriers to adoptions of waste minimization. A framework which has the potential of reducing wastage of materials at the construction is introduced. This chapter also presented results and findings of case studies conducted

1. Anantha R.V., Lokeshwari M.” Management of Construction And Demolition Waste”. Journal of Environmental Research and Development, Vol. 5 No. 1, July-September 2010
2. Abhijith H., Sreejith M.H., Jacob P.A., Aiswarya S”Minimizing Construction Wastes by Efficient Site Practices”. 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 Waste Reduction”. Micra Conference 2012
5. Anagal V., Nagarkar G., Atnurkar K., Patel A. “Construction and Demolition Waste Management – A Case 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 Green Technology”. 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”, Journal of Construction 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: Main Causes 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 To Minimize Environmental Damages Due To Quarrying”, Journal of Environmental Research and Development, Vol. 1 No. 1, July-September 2006
10. Hemalatha B.R., Prasad N., Subramanya B. V.V. “Construction and Demolition Waste Recycling For Sustainable Growth and Development”, Journal of Environmental Research and Development, Vol. 2 No. 4, April-June 2008
11. Ijjigah E.A., Jimoh R.A., Aruleba B.O., Ade A.B. “An Assessment of Environmental Impacts of Building Construction Project”, IISTE, ISSN 2222-1719, 2013
12. Jain M.” Economic Aspects of Construction Waste Materials In Terms of Cost Savings - A Case of 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 Research, Volume : 4 Issue : 6 Issn - 2249-555x, 2014.
18. Sawant P.H., "Construction Waste: Source Identification, Quantification and Its Management InHousing Projects", National Conference , 201319. Shen L.Y., Tam V.W.Y., Tam C.M., Drew D. "Mapping Approach For Examining Waste Managementon Construction Sites", American Society of Civil Engineering, 0733-9364, 2004
19. Shetty R. S. "Construction and Demolition Waste – An Overview of Construction Industry In India",International Journal of Chemical, Environmental & Biological Sciences (Ijcebs) Volume 1, Issue 4,Eissn 2320–4087, 2013