Cement Bag Handling and Storage System for Small Scale Projects

Abstract: In construction industry we have different scale of site ranging from big dams to small house and for construction of any modern building we required cement. This cement is stored on site in make shift storage arrangement which is temporary in condition. Though we have the specifications & codes for cement storage, still on site the storage conditions make quality of the cement vulnerable for construction which leads to defective construction quality. Hence in this paper main thrust is given on design of a system which will make cement storage easy & will maintain quality of cement by protecting it from weathering conditions & on site damage with easy handling. This is achieved by using simple technique of shrink wrapping on cement bags and wheel based effortless handling system with provision of 3 bags of cement at a time.

Key Words: Cement Handling, Storage, ease of handling, protection from weather.

I. INTRODUCTION

In this modern era construction is not possible without cement. Generally on construction site the workers carry cement bags from one place to another & wages are paid as per number of bag handled i.e. nearly Rs. 15 to Rs 20 per bag. At the same time worker has to carry the cement bag on his back which is not a very human way of handling the cement bag, this sometimes also results into health hazards. Arrangement for cement bag storage is also required to be done which is generally carried out with GI sheets & balls. Such type of temporary arrangement does not ensure full proof protection from rain.

The research paper focuses on develop a system which assist in handling of cement bags from transportation medium to onsite storage unit to make cement bag handling completely easy and effortless. Being a system, additional packaging of bags is also studied & proposed to ensure protection of cement bags from weathering conditions. For doing this detail study of cement bag storage units and cement bag carrying unit, process of cement bag handling, etc. is carried out.

What is Cement?

A cement is a binder, a substance that sets and hardens and can bind other materials together. The word "cement" traces to the Romans, who used the term opus caementicum to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder.

Cement Bags

These are the bags made out of plastic or paper & generally transported by trucks on site. These bags are used for small to medium scale size (i.e. sites with project cost 1 lakh to 1 cr) There is no specific container type of storage available for the cement bag. For storage of cement bags on site we have some standard procedures but generally these bags are not transported, handled & stored following the standards. Hence it is necessary to design a system for transportation, handling & storage of the cement.

II. CASE STUDY

These case studies are important to understand the presently practice onsite cement storage unit or space. The objective of doing case study is basically to understand the space allocated to store the cement & conditions in which the cement bags are store on site. Also handling of the cement bags from transportation to the cement storage needs to be observed. While doing case study from the point of view of the users i.e. contractor, site engineer, supervisor & labor should be understood while proposing any new system. Interaction with these people is also carried out as a part of this case study. As proposed cement storage is for small sites like houses, small flat schemes etc, case studies of small scaled projects are done.

Case Study 1 – Atharva Aishwarya, Wardha Road

This is the upcoming flat scheme located near Wardha Road. The bulk concreting is done with the help of transit mixer but cement bags are required for the construction of masonry wall, plaster, tile fixing etc.. Cement is stored on site in a storage made up of GI sheets & balli. It’s been observe that there are 25 bags of cement stacked in two piles 12 in each. Though as per IS 456 - 2000 there should be maximum 10 bags in a pile, it is been observed that more than 10 bags are stored in one pile. There was sufficient space available for cement bag storage but still the specifications are conveniently ignored. The space for cement bag storage was also shared with the other material storage which is again not advisable.
Both Fig. – 1 and 2 shows the condition of cement storage on site which is vulnerable to weather and not as per IS code 456-2000

Case Study 2 – Mr. Selokar’s residence, loksewa nagar

This is the Residence for Mr. Selokar situated at Loksewa Nagar. Previously the cement is stored on site in a storage made up of GI sheets & ballis. But after completion of Ground floor slab cement is stored in a veranda of under construction structure. Total 40 bags were stored in the veranda & covered with the plastic cloth. There are no walls which enclose the cement storage but as it store in veranda it has slab above and covered with plastic cloth.

Comparative analysis of Case studies

<table>
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<tr>
<th>Criteria</th>
<th>Case Study – 1 Ashalva Aishwarya</th>
<th>Case Study – 2 Mr. Selokar Residence</th>
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<tbody>
<tr>
<td>Transportation of Cement</td>
<td>Through distribution trucks</td>
<td>Through distribution truck</td>
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<tr>
<td>Handling of Cement</td>
<td>Manual</td>
<td>Manual</td>
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<tr>
<td>Storage of Cement</td>
<td>Temporary shade made out of GI sheets &amp; ballis</td>
<td>Temporary arrangement in under constructed veranda</td>
</tr>
<tr>
<td>Floor for storage</td>
<td>Ply sheets laid on ground &amp; covered with used cement bags</td>
<td>Ply placed on bricks to give height from the ground</td>
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<tr>
<td>Walling &amp; roofing for storage</td>
<td>As it’s a temporary shade walling &amp; roofing are made with GI sheets &amp; Ballis</td>
<td>No walls , bags are covered with plastic &amp; as cement bags stored in veranda slab is acted like roof.</td>
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Observation: cement storage is not in good conditions as it contains lots of holes & sheets are rusted & damaged for worker as it contains lot of cement dust also bags are damaged during handling

No proper enclosure is provided for cement storage hence weather or site conditions may damage the quality of cement

Table –1

Options of System For Different Conditions

Different options are work out as per the number of bags which need to handle during the cement transportation & storage.

Options proposed for more than 200 bags

1. **Silos**

   ![Silos](image)

   Silos are generally used for the mass storage of cement. Loading is done with the help of suction machine. The size available is from 6 ton to 20 ton

2. **Proposed Flip flop arrangement**

   ![Flip flop arrangement](image)

   Another system which is thought of is the flip flop mechanism where the complete box or container get flip flopped & during this the one side can be used as slope to slide & stack the cement bags & the container get flop over the stacked cement bags to complete the system. This system may have wheels through which this container can be moved from one place to another.
3. **Proposed Crane Loaded Truck System**

Fig - 7

Now a days there are trucks which are having inbuilt crane with them, because of which the container containing the cement bags can be handled & then moved with the help of wheels.

4. **Proposed Container with roller base**

Fig - 8

In this option of cement transportation & handling, slight modification in existing transportation system is required in form of rolling tube base & a pulley to control the movement of the cement storage container.

5. **Proposed Cylinder for cement storage**

Fig - 9

Options available for 10 to 20 bags

**Proposed pulling box**

Fig – 12   Fig - 13

In this option the in fig 12 & 13, 10 bags of cement in 2 piles are stored in a rectangular box of size of 0.6 m x 0.1 m. this box can be pulled with the help of rope & assembly of wheels are attached to this box which will be removable. At time of lifting the box at height for storage proper handles need to be provided to minimize the sway & maintain the center of gravity. Hence the triangular handles are provided for maximum coverage & support to the box.

**Options available for 01 to 05 bags**

1. **wheel drum**

Rather than cement bags the cement can be stored in cylinder, which can be easily get handled, but will create difficulty while transportation & storing because of the circular shape.

**Options available for 50 to 150 bags**

1. **Proposed small box type unit**

Fig - 10

In another option for cement bag storage & handling unit the unit of 2m x 2m x 1.2m can be used to store 130 bags of cement. This handling & storage unit then can be transported from one place to another with the help of removable wheels which can be attached or detached as per the requirement.

2. **Proposed cement drums**

Fig - 11

In this other option shown in fig 11, the drums are proposed to use as cement storage & handling unit, in which the cement bags are packed & stored in the drums of size appx. 0.50 mts diameter & 0.90 mts in height. These drums can be transported in existing transportation system used for the cement transportation but extra care needs to be taken as these are drums hence extra tying arrangement need to be provided.
In this other option in fig -14 the circular storage unit is used with the top & bottom lead which is slightly bigger than the diameter of the drum, so that the drum can be rolled on these leads like wheels.

2. Proposed Bag package with wheel

In this another option in fig -15 the 4 shrink pack cement bags are directly placed in to wheel assembly which has recess to accommodate the cement bags. These two wheels are tie together with the help of steel bars so that the assembly should not get disturbed due to uneven ground surface.

Selection and Finalization Of The System

After comparing all options for cement handling it is been observe that all the options are possible but require some or the other kind of modifications in term of transportation system or incorporation of mechanical means as required. Hence the final design which needs to be selected should fulfill all design criteria which are decided previously & should be easily work out & implemented for current situation of site storage system.

In all these options the cement handling unit with shrink wrap cement bags & wheels to handle these bags from one place to another, can be finalize with slight modifications.

Design Criteria

While finalizing the design some criteria are needed to be work out before making product.

Weight

Weight consider for the product is the weight of cement bags which is 50 kg each. As the product design is in the form of wheels, the weight they will be able to carry need to be consider.

Hence I consider 3 to 4 bags of cement i.e 150kg or 200 kg.

Size

The size of one cement bag is 350 mm x 700mm x 150 mm.

Hence if we keep 3 bags of cement one above the other the size of package will be 350 mm x 700 mm x 450mm. When wheel for the said size of package is considered, the appx. Size of wheel required to design is of 900mm diameter. So when we keep both the wheels on sides of package the complete size of product is 700 mm wide & 900 mm high.

Packaging Arrangement

Shrink packaging of the cement bags is proposed so that the bags will be protected from weathering effect & there will be no cement dust while handling the cement bag. Shrink wrap, also shrink film, is a material made up of polymer plastic film. When heat is applied, it shrinks tightly over whatever it is covering Shrink packaging required a conveyer arrangement for packaging, where the cement bags are packed on conveyer arrangement hence the set of shrink packaging can be easily accommodated in existing system.

Transportation

With proposed system of handling, we can continue with the existing transportation system as no modification is required.

Storage

As these cement bags are shrink packed we can continue with the existing method of storing cement bags. Because of the shrink packing cement bags don’t required any extra care for protection from weathering conditions.

Manufacturing consideration

Material:

For the manufacturing of cement handling unit there are following material can be considered-

1. Metal or M S Pipe – it is very sturdy material being a metal & also have greater scrape value. But as a metal it also attracts the possibility of theft & very heavy to handle. Since the system is proposed for 4 bags unit itself weighs 200 kg, hence metal handling unit will increase the weight of complete assembly.

2. Wood or Ply wood – Though this unit is easy to manufacture in wood or plywood, but it is not good for the mass manufacturing & wastage is also very high in this material as shape of the unit is circular one.

3. FRP – This is most prevailing material as we have freedom of making any kind of shape in this material. But it has zero scrape value hence it will again adds to the cost of unit. Also we cannot manufacture the units in double layer or detailing cannot be done in FRP

4. Plastic – Being modern material its very advisable to use it for manufacturing of the unit. As per the design of the unit it is possible to mass manufacture the unit with required detail & also we can have a...
monolithic double wall unit to accommodate the cement package.

**Process**

As the plastic is the most preferable material for the manufacturing of the cement handling unit, there are number of methods for manufacturing plastic products.

Rotational molding is the method which is most preferable for this kind of product.

The rotational molding process is a high-temperature, low-pressure plastic-forming process that uses heat and biaxial rotation (i.e., angular rotation on two axes) to produce hollow, one-piece parts.

**Design Ideation**

The different options for carrying cement storage with the help of wheel mechanism are worked out with the help of models in 1:5 scale. To get the idea of weight, sand bags are used with the cardboard wheels. Also, the concept of shrink wrapping the bags is explained in the form of models in following way.

![Fig - 16](image)

All 4 bags are shrink wrap individually 1st & 2nd Bag shrink wrap together & form 1st pack. Then 1st pack & 3rd bag wrap together & form 2nd pack. This 2nd pack & 4th bag wrap together & form the final pack of 4 bags. With this shrink packed bags different options based on finalized concept are made.

**Option 1–**

![Fig - 17](image)

The 1st option was tried out by making wheel with a puncture of cement package type i.e of size 50 cm x 46 cm & then these wheels are attached at both ends. But as thickness of wheels is very less it can’t withstand the load of cement bag

In 2nd option shown in fig 18 rods are used to hold the wheel together.

**Option 3–**

![Fig - 18](image)

In this 3rd option shown in fig 19 and 20 the clamps are used with increase wheel thickness. Also, to fix the clamps the groves are provided hence no extra locking assembly is needed.

**Option 4 –**

![Fig - 21](image) ![Fig - 22](image)

In this option shown in fig 21 and 22 the flaps are provided to hold the cement bags in position while handling the cement bags. Clamps are provided for the easy working of the wheels & as these flaps are attached with the wheels there will be no extra attachment is required.

**Design Details of Finalised option**

After working out all these options the 3rd option is finalized as it gives more stability to the complete wheel system with easy handling and minimum joints & detail drawings are prepared for fabrication.

**Detail drawings –**
With the help of these detail drawings the fabrication or model making is started in plywood.

To make the wheel with recess to fix the cement bags two different circles are cut in the plywood of size 900 mm. One plywood circle is then having cut out of size 350 mm x 600 mm to accommodate the 4 bags of cement as shown in fig 21. These two circles are then attached with each other with the help of battens of 100 mm width.

In fig 24 the cement bags are piled together & wheels are then attached. While rotating the wheel it has been observe that these wheels fall apart because of the weight & circular movement. Hence extra battens are attached to make a single assembly.

User Feedback

After completion of the basic product, feedback is taken from the contractor, supervisor & labor for the further betterment in the product.

Feedback of User 1 –

According to contractor this system is very innovative & cost effective as labor requirement for the cement handling is curtail down to 2, but the material used to make mock up model is plywood which will not be beneficial for the final product hence the wheels should be light so that they will not add on the weight while handling.

Feedback of User 2 –

According to supervisor the shrink wrapping is the good idea to minimize the dust but packing 3 or 4 bags in a one pack will lead to the handling & lifting problem while stacking the cement bags.

Feedback of User 3 –

According to the labor it’s very easy to handle the bags rather than carrying them on back, but these wheels should be sturdy to withstand the rough surface on site. Also handling 4 bags of cement at a time is quite difficult hence rather than having 4 bags 3 bags should be consider for the handling.

Final Design

As per the feedback of the users, rather than having the complete pack of shrink packing, individual bag should be shrink pack & handle in a group of 3 bags.

Because of the thickness of 100 mm these bags are already supported with this width hence no extra clamping is required to hold the bags.

The material used for the making of these wheels is plastic & method is rotational molding hence these wheels will be light in weight as compare to the plywood wheels, will be water proof & required zero maintenance. Also edges will be smooth hence cement bags will not get damaged.

Final Dimensions for the wheel – based on user feedback

900 mm Diameter, 350 mm x 500 mm cut out & 100 mm thickness cut of size is been reduce so that bags will get fit into it tightly. The complete dimension of the product when loaded with cement bags is 700 mm wide x 900 mm height.

As width of the door provided for the temporary on site cement storage is generally 750 mm minimum, the complete width of the product should be bellow 750 mm for easy entry & exit in cement storage.
III. CONCLUSION-

In construction industry, for smaller sites cement handling is done manually, which cause health hazards to a person who is handling the cement bags. Also the quantity loss is also happen due to carrying techniques which is hooking of bags. This hooking cause hole to the air tight cement bags which again leads to the cement exposure to atmosphere and quality loss. But with this cement bag handling process and slight modification in the packaging will lead to the more efficient and safe working on site. Which lead to the less quantity loss at storage, less air base hazards to the workers, fast working for de-loading of cement bags from transport medium to site and easy on site storage in prevailing site conditions.

REFERENCE:-


Fig - 25 and 26 shows mock up Model in Plywood