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Study of Job Layout for Construction Project

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Abstract— **Due to the complication of the site layout planning problem, construction managers often perform this task of site layout planning by using thumb rule, ad- hoc rules, and first-come-first-serve approach which leads to confusion and even to inefficiency. In residential project around us there is exact relation between construction resources and the project area. Because of improper planning and management of those resources, it leads to high risk of construction safety, labor safety and increase in cost of the project, the residential construction site whether it is small or large scale needs to be proper planned and shall be execute very seriously. A Job layout planning and optimization on site can reduce the transportation flows, moving, reloading, and enhancing the services of the construction work to improve the work productivity and thus the costs of a project. In this paper, we are going to take a case study of "Atharv Recidency" residential construction project. For that residential construction project, we suggest them an optimized site layout. The final optimized site layout is prepared in such way that it will try to minimize repeated handling of materials, will minimize travelling distance that workers must transport stored material to the point of use and will increase the productivity and create safe work environment. The project study contribute to the encroachment of present perform in construction site layout planning and can lead to a aggressive advantage for contractors using the developed system due to the increasing the efficiency of construction process and improving the level of construction speed.**

Keywords— Job Layout, Static Model, Dynamic Model, Relationship chart, Activity Relationship Diagram.

1. GENERAL INTRODUCTION

A job layout is prepared to promise that work proceeds smoothly without any obstruction. The various construction resources such as material, men, machinery etc. should be arranged in such way to achieve optimal utilization of space. The larger and more complex the project, greater will be the need for planned job layout and detailing at site. And job layout can be defined as a site drawing of the proposed construction showing the location of entry, exit, temporary services, material stores and stocks, plant or equipment and site offices.

Temporary Facilities (TFs) are defined as those facilities and areas depicted to specific tasks that support the construction process. Temporary facilities are typically not part of the permanent structure and have relatively short life spans. Construction site layout involves identifying, sizing, and placing temporary facilities (TFs) within the boundaries of construction site. These temporary facilities range from simple lay down areas to warehouses, batch plant, fabrication shops, residence facilities and maintenance shops.

Good site layout planning leads to

1) Provide a uniform flow of material about the site, free from bottlenecks.
2) Provide adequate control on equipment theft.
3) Facilitate movement of equipment on the jobsite.
4) Promote a safe working environment.
5) Provide safe, nondestructive access to the jobsite for visitors.

1.1 History of Job Layout

Static models can not consider the changes in facility location that occur on construction sites onto the progress of time. These models assume that all facilities exist on the site for the entire duration of the project. Static models can be conformable for projects where space is plenteous, having large construction sites with short durations and for project where there are not many changes in the layout of the construction site over the course of time. However, where number of facilities to come and leave the project site over the course of construction in more complicated projects, static model are not practical with longer durations. Static models do not allow reusing the space occupied by facility which is no longer required on the site. [1]

Dynamic models consider the changes that occur on construction sites over the course of progress in project. The space usage on the site changes over the course of construction. The time and duration for which the facilities are required on the site depends on the activities they are attached with. The role of facilities on the construction site is to provide base for construction activities. A model shares locations to facilities where they can have better assistance for the activities. The dynamic model described that, both the required facilities and the space required to help them on the site, are subject to change. [1]

Dynamic models can consider the changes in facility location that occur on construction sites onto the progress of time. These models assume that there is no need to exist all facilities on the site for the entire duration of the project. Dynamic models can be conformable for projects where space is sparse or rare, having small construction sites with long durations and for project where there are requirement of many changes in the layout of the construction site over the course of time. However, where number of facilities to come and leave the project site over the course of construction in more complicated projects, dynamic model are practical with longer durations. These models do allow reusing the space occupied by facility which is no longer required on the site

The upshot of changes in space requirements on site layout can be illustrated through the following example. Consider a construction project with number of facilities like cement

storage, brick storage etc. that are required on the site for different times and durations. Project owner wish to construct the R.C.C frame first and after completion of R.C.C work, he wants to go for finishing work like brickwork etc. In that case, the facility like sand, aggregate, cement storage are required on the site at the initial stage and need to give or allocate a space for them till the R.C.C work to be completed. After that the same space can be utilized by bricks, tiles etc. in the final stage of construction. The above example clears up the concept of dynamic model that is developing the layout that is optimized over the duration of project.

Wong's Experience tells the industry that there is no fix rule or extremely powerful software in the planning of site layout, construction operations and the related issues. There are only basic principles. There are numerous options, alternative schemes, action agenda, management strategy or contingency plans to meet the actual requirements before or during the course of a construction project. How to make the correct observation, identify the problems and arrive at the right decision is the main key to achieve the best solution. A well-experienced and practical construction executive or work team supported by a reasonable resources and management back up should be the best solution to all problems. [2]. In this paper, we are going to apply static model for our case study.

2. CASE STUDY

2.1 Data collection

To achieve the objectives of the current study, the data is collected from Atharv Residency construction project at Sinnar, District- Nashik. The details of the plot are shown in Fig 1. This construction project is of seven residential apartments. Each apartment is of same structural planning of G+ 3 storeys, with a ground floor as a parking floor. Discussion with project manager and the peoples involved in this project at site is helping me to know the information about the activity of construction of buildings. Constructions of all these seven buildings are starting at the same time. Also, company wants to construct the R.C.C frame of whole buildings first and then going to do a finishing work. This informatory data we got from discussion with project manager.

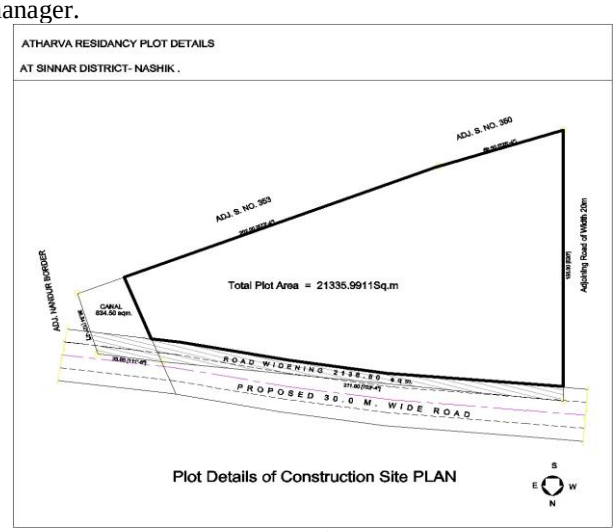

Fig -1: Plot Details of Construction Site

2.2. Details of case study

Nirmitee construction has successfully completed a various types of small construction like row house and small residential apartment up to G+ 3 storeys. Now, would like to start a new project in a large scale, which construction project is of seven residential apartments as shown in Fig.2. The company gave the name to that new project as "Atharv Residency." Atharv Residency construction project is the project based on the development basis. This is the first project of Nirmitee construction on development basis. Nirmitee construction has not made any site layout for their previous project. Because of that, they realize some of loss in labor productivity and indirectly increase in cost of project. The Nirmitee construction wants to reduce a construction cost.

The company is going to appoint a subcontractor and done the payment on completed work. Many times subcontractor is complaining about the payment of completed work that he could not affordable on the rate confirm with company. So that, subcontractor wants to increase the rate from company, for the completed work or he wants to leave the project. That is not the problem of one subcontractor but it is the same problem of the entire subcontractor, who has worked with the company in past and in present also.

If company thinks to increase the rate to the subcontractor for completed work then company will get loss in profit. Also, company has to give the same market rate to the subcontractor then why to increase the rate of subcontractor for the completed work? Also, if company thinks to appoint new subcontractor then new subcontractor will also complain for same. Therefore, why to appoint new subcontractor as old subcontractor gives a good workmanship? Company gets into puzzle and need to get a permanent solution of the problem so that subcontractor gets ready to work with the same rate as per market rate.

In the first meeting with the company, I am going to point out the above problem of the company. The problems are obstacles to the growth of company. As, company has not done and had not prepare any job layout in previous project also, I am suggesting them to prepare a job layout so that, the travelling time between two facility gets minimized, resulting in to increase in labor productivity. It means, work flow between two facilities gets fast than the previous. As work flow between two facilities gets fast, the time required for construction get reduce. And it result that, maximum work can be done by labor in very short time. Due to this systematic approach of working, subcontractor will ready to do a work on a same or at a less rate than market rate. Because subcontractor will do a maximum work from labor in a short time so that he will get a good profit.

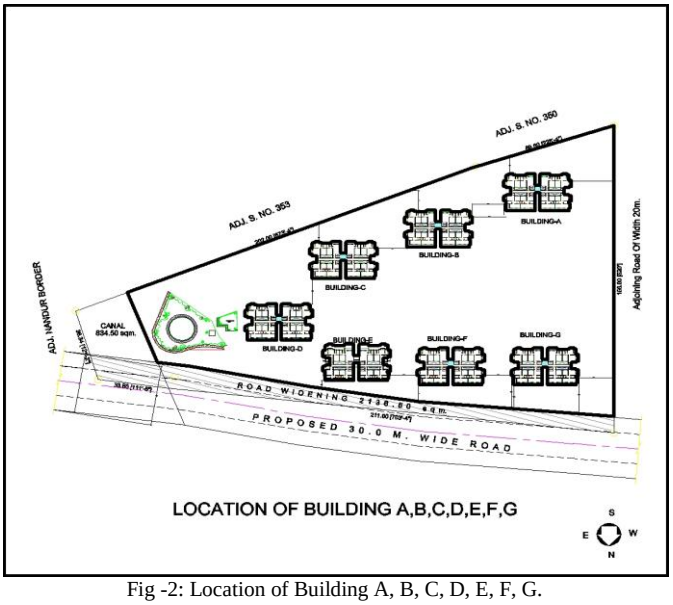

Fig -2: Location of Building A, B, C, D, E, F, G.

Finally the company gets ready to prepare a job layout as it wants to solve the problem of subcontractor. And in this case study we are going to suggest a job layout for the Atharv Residency construction Project.

2.3 Identification of facility

The Following are the temporary facilities are identified to be constructed on site

1) Site Office 2) Booking office 3) Subcontractor's office 4) First Aid and Medical Room 5) Guard Room 6) Toilet on Site 7) Engineer and Staff quarters 8) Labor quarters 9) Equipment Maintenance room 10) Parking for machines 11) Bar bending shop 12) Fabricated rebar storage yard 13) Carpentry shop 14) Cement warehouse 15) Batching plant and aggregates storage 16) Testing Lab 17) Material storage lab 18) Water tank 19) Scaffolding storage 20) Canteen.

2.4 Relationship chart

In the previous step, we have identified the facility required on construction site. In this step, we are going to decide that which facility should be close for which facility or which facility needs to be kept far from which facility. The left hand side of the relationship diagram shows the list of identified facility and right hand of the chart shows the description of relation between the one facility to the others facility. Description of the relation between facilities can be denoted by alphabets as A, B, C, D, E. The alphabet is also called as 'proximity weight' or 'proximity value' because we have fixed some relation of facility in respect to the remaining facilities depending on proximity relation. The chart shows the description about the proximity relation between facility locations therefore we called it as a 'relationship chart.' [Figure 3 and 4]

Any effective layout needs to start with an in-depth discussion of work relationships. In this case, the primary focus of the discussions surrounded the issue proximity. Each of the major facility is listed on the left side of the relationship chart. Each facility is related to every other facility at the site. In the relationship chart, these closeness values were placed in the corresponding diamond based on the following scale:

A = Absolutely Necessary that the two facility should be close (to be close).
B = Especially Important that the two facility must be close.
C = Important that the two facility may be close.
D = Unimportant or no need to be close the two facility.
E = Undesirable or need to be far the two facility.

Fig.3 shows that how to fill the relationship chart. In that figure, relationship between booking office and scaffolding storage yard is shown by 'E' alphabet because there is need, to keep far, both booking office and scaffolding storage yard. The purpose of keeping both facilities apart is to avoid bad impression on customer. Also, relation between bar bending shop and fabricated rebar storage shop is shown by 'A' alphabet because the making material of bar should store at near location to achieve higher productivity by decreasing traveling distance. In this way, we are going to get the final relationship chart which is based on the proximity of facilities. Fig. 4 shows the completion of relationship chart.

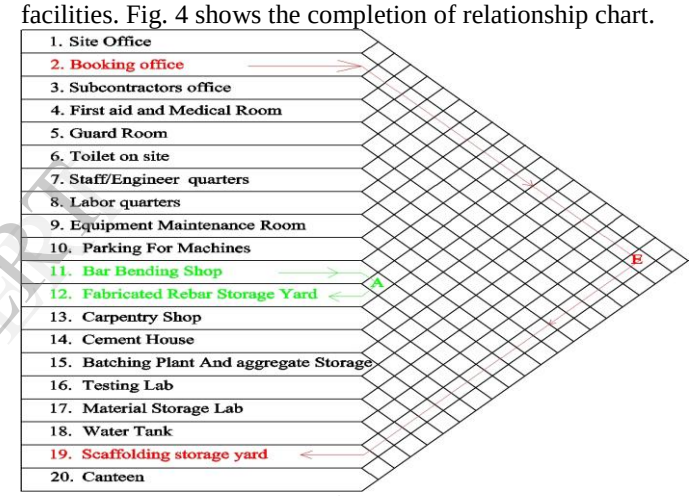

Fig -3: Filling of Relationship Chart

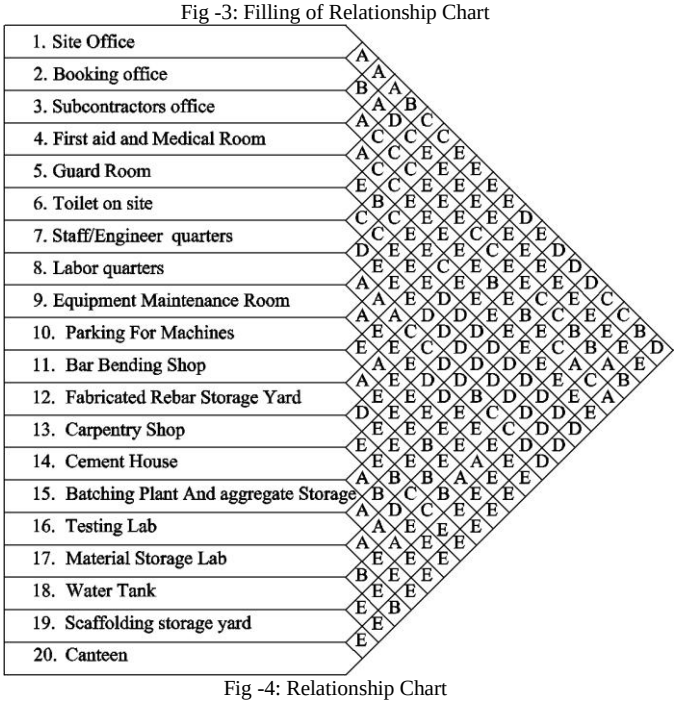

Fig -4: Relationship Chart

2.5 Facility movement

The decision of fixing the facility location is depend on the entry location, exit and how will be the flow of facility occurs on site. In this construction project, we have fixed the entry location and exit. The entry should be fixed at the west side of plot where there is approaching a road of width 20m. The purpose behind the fixation of entry on west side is to attract the customer by showing them the extent of construction project. The extension of construction project cannot be visualized from any other side. The exit is kept on north side of the plot, where there is approaching road of width 30m. After fixing the entry location, we are going to think on facility movement on site. To identify facility movement or the flow of facility, we take use of Fig 2 and randomly locate the facility to identify an optimized flow of facility. This process can be made in number of times till the optimized flow cannot be observed. But if, we do facility movement simultaneously with relationship chart then we get some clear picture about optimized flow. Then we get facility location with proposed building location. Now, grouping or bundle of the same or nearly same function of facility can be done to get the initial relationship diagram. The grouping of facility is done in oval shape as shown in Fig 5. The grouping of facility is shown below.

Group 1
1) Site office
2) Booking office
3) Subcontractor office
4) First aid and medical room
5) Toilet on site
6) Labor quarter
7) Guard room

Group 2
1) Toilet on site
2) Carpentry shop
3) Water tank
4) Scaffolding storage.

Group 3
1) Cement warehouse
2) Batching plant and aggregate storage

Group 4
1) Toilet on site
2) Staff and engineer quarter

Group 5
1) Bar bending shop
2) Fabricated rebar storage yard

Group 6
1) Testing lab
2) Material storage lab

Group 7
1) Equipment maintenance room
2) Parking for machines

Group 8
1) Canteen
2) Toilet on site.

Others
1) Internal Road
2) Electric Poles.

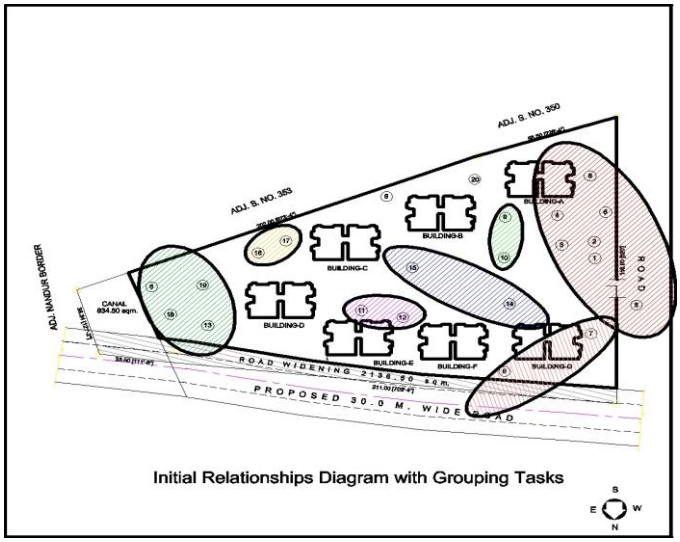

Fig -5: Initial Relationships Diagram with Bundled or Grouping Task

With the help of relationship chart, the initial relationships diagram with grouping tasks is done and discussed with project manager and all staff members, for practical appraisal of space and location.

2.6 Space requirements

Once work relationships were worked out to the optimized level, the group involved in the construction project including project manager, senior Engineer, site Engineer etc wants to establish the space relationships for each facility. Once again, this process was accomplished over a series of weekly, one-hour meetings. Each person listed their personal space needs and these were presented orally and discussed by all. The process of working through this activities area discussion added much understanding to how the business operates now and should operate in the future. Table 1 shows the final output for this process in square meter of space desired for maximum productivity for each section calculated by deep discussion and practical consideration on site.

Table 1 Space Requirement Of facility

	size AxB		
Facility	**A**	**B**	**Area**
Site Office – Sq. m.	5.8	6.12	35.496
Booking Office	5.8	8.77	50.866
Subcontractors office	8.7	13.16	114.492
First Aid and Medical Room	5.8	6.12	35.496
Guard Room	5.75	3.8	21.85
Toilet on Site	30	4	120
Staff quarters	12	24	288
Labor quarters	12.65	54.4	688.16
Equipment Maintenance room	13.85	14.2	196.67
Parking for machines	19	19.22	365.18
Bar bending shop	6.66	26	173.16
Fabricated rebar storage yard	4.326	12	51.912
Carpentry shop	14.65	25.4	372.11
Cement warehouse	10.19	30.6	311.814
Batching plant and aggregates storage	16.19	21.79	352.7801
Testing Lab	6.6	16.52	109.032
Material storage lab	6.6	16.52	109.032
Water tank	20	1	20
Scaffolding storage	20.53	29.31	601.7343
Canteen	9.59	21.85	209.5415

2.7 Activity relationship diagram

After completion of grouping of facility task, each group is now moving according to others group or move according to the relation that group with other group. The relation among the group can be shown in figure by single, two, three and four line between the groups. The meanings of those four lines between groups indicate that it is absolutely necessary that these groups should be close together. Three lines show an especially important closeness relationship. Two lines illustrate that it is important that they may or may not be close. One line illustrate that there is no need to be close that groups. Figure obtain is called as activity relationship diagram as shown in Fig.6.

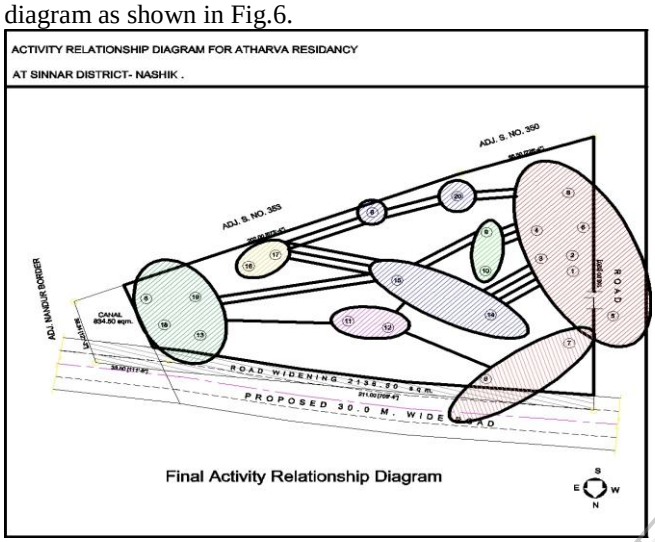

Fig -6: Final Activity Relationship Diagram

Finally using a blank diagram of the site plan, we are able to continue the process of moving toward a more efficient site layout by placing the activity relationship diagram over the existing site plan. And we get layout plan which is near to optimized site layout.Fig.7.

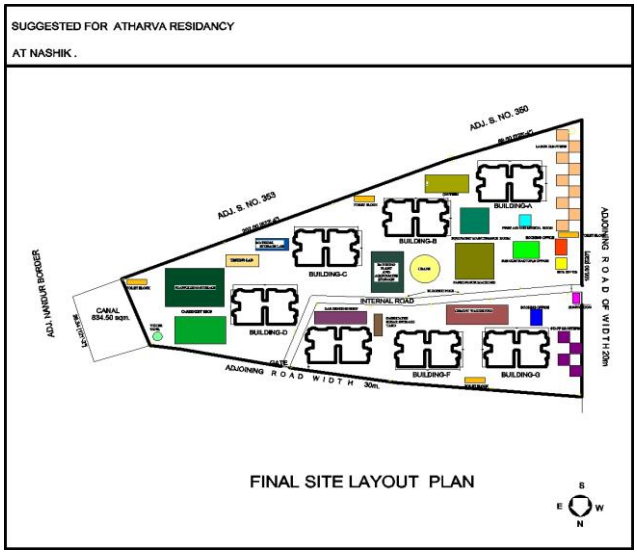

Fig -7: Final Suggested Site Layout

3.0 CONCLUSION

A fundamental aspect that is necessary to emphasize is the necessity of creating awareness about the site layout concept. People generally do not know the problem involved in site layout concept, and tend to work according to their habits, fundamentally based in the traditional conversion way. In this project, we have suggested a site layout for Atharv Residential Construction Project. Suggested site layout is based on relationship chart and activity relationship diagram. The grouping of facility is helping us to keep the proximity relationship of the temporary facility. The method contributes to only one third part of the application of site layout concept for projects. Management's approach and employees' involvement contribute to the remaining part of application of site layout concept. The suggested site layout for Atharv Residential Construction Project is prepared in such manner that work proceeds smoothly without any interruption and will decrease the duration in Atharv Residency construction project so that activity duration can be reducing simultaneously in construction process.

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