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STUDY OF ANALYSIS & DESIGN OF DOUBLE STOREY 400/220KV GIS CUM GANTRY (TOWER) BUILDING

Nilesh Chandra Lal[1], Pankaj Singh[2]
[1]*M. Tech Structural Engineering, R.K.D.F.Institute of Science & Technology, lal.nilesh08@gmail.com*
[2]*HOD, Structural Engineering,R.K.D.F.Institute of Science & Technology, rkdfist.95@rediffmail.com*

Abstract- Construction of High Voltage substations in the heart of cities is becoming more and more difficult. The small size of available land, the difficulties associated with the entrance and exit of high voltage overhead lines, the increasing protest of neighbors, high priority of projects and short schedule to energize these substations are some of the common problems for those who work in the design and execution department at any electric utility company.

The dimensions of specified/available land for the projects of 400/220 KV substation in urban cities is very small and irregular. The complete project cycle of the GIS project from planning stage till commissioning is very time consuming and complicated. Thus, the planned time to provide the GIS (Gas Insulated Substations) equipment is too long and could not satisfy the projects schedule. Under such conditions, to save space, time & cost it is a thought to have Double Storey GIS building with 400 KV Gantry on the top of the building in 400/220 KV GIS substation. This may be the new way to solve problems of space in urban areas although there may be already proven solutions. With this type of arrangement, we may able to solve the land associated problem for the GIS substations.

Index Terms— GIS substation, Transmission Line, Pre-Engineered-Buildings; Staad Pro; Utilization Ratio; Tapered Sections.

1. INTRODUCTION

With the widespread establishment of electrical grids, power transmission is associated most with electric power transmission. Alternating current is normally preferred as its voltage may be easily stepped up by a transformer in order to minimize resistive loss in the conductors which are used to transmit power over great distances; another set of transformers are required to step down to safer or more usable voltage levels at destination.

Power transmission is usually performed with system of sub-stations and overhead lines along with all associated systems.

So, powertransmission is the process by which electricity is transported over long distances from generating sub-stations to distribution side sub-station which then spreads it to consumers atrequired voltages. New power transmission lines are required for establishing connection with new solar energy power plants.

Power transmission industry is growing rapidly in most of the parts of the world. Considering the increasing use of electricity in a developing country like India, voltage drop of the domestic and commercial electricity users and inability to support the local substations with the existing system of transmission network, construction of high voltage transmission system alongwith associated substations in the country is felt highly important. The first step is to find a land with suitable conditions to construct a 400/220 KV GIS substation is the initial activity of any project. During the process of land acquisition and finalization, various pieces of lands is considered; the one with the low cost and no legal issue is preferred. But in urban areas in cities like Delhi, Mumbai etc the land prices are very high and many associated legal issues are there.

In general practice of power transmission, the GIS substations buildings are built of RCC frame or steel frame having single storey. In a substation having two voltage level there is requirement to construct two different buildings accommodating equipment of different voltages. Considering the land availability in urban area, the conventional normal layout of 400/220KV GIS can be converted to double storey GIS building with 400KV Gantry on the top. So, this type of arrangement is needed for saving the land foot print. This building is of steel structure due to various technical and economic factors.

The use of steel structures is not only economical but also eco-friendly at the time when there is a threat of global warming. Here, "economical" word is stated considering time and cost. Time being the most important aspect, steel structures (Pre-fabricated) is built in very short period and one such example is Pre-Engineered Buildings (PEB). Pre-engineered buildings are simply, steel buildings in which excess steel is avoided by tapering the sections as per the requirement of bending moment. However, one may think about its prospects, but it's a fact about which many people are not aware of. Consider if we go for regular steel structures then time frame will be more, cost will be more, and both together will make it costlier project. Thus, in pre-engineered buildings, the total design is done in the factory, and as per the design, members are pre-fabricated and then transported to the site where they are erected in a time less than 6 to 8 week.

The structural performance of these buildings is well understood and, for the most part, adequate code provisions are currently in place to ensure satisfactory behaviour in high winds. Steel structures also have much better strength-to-weight ratios than RCC and they also can be easily dismantled. Another advantage of using Pre-Engineered Buildings is that, they have bolted connections and hence can also be reused after dismantling. Thus, pre-engineered buildings can be shifted and/or expanded as per the future requirements. In this paper we shall discuss the various advantages of using pre-engineered buildings in GIS substation and, with the help of example, a comparative study shall be made between pre-engineered Double Storey GIS building and conventional two single-storey GIS building with steel structure.

2. OBSERVATIONS:

Below is mentioned some observations points of analysis and design of double storeyGIS building cum gantry building over conventional GIS building.

- **DESIGN-** The lateral stability of the building is ensured by providing the frame action of the main frame
- **DESIGN-** The longitudinal stability of the building is provided by the truss action in the cross braced bays of the building.
- **OPTIMIZATION-** Requires 75% less land
- **MATERIAL USED-** Requires more structure Material by 10%.
- **TIME-**Complete project time including design, manufacturing, supply and erection is reduced by about 50%.
- **DESIGN-** Requires specialized computer design
- **FOUNDATION-** Easy to manage and light design work
- **STRUCTURAL WEIGHT-** Efficient use of steel at different components of section which reduces the weight from 20% to 40 %
- **ERECTION-**Pre-casted sections are designed as per the site necessity
- **ERECTION COST AND TIME-** Over all Erection time is less than 6 weeks which makes it cost effective
- **OVERHEAD SPACE-** It may vary according to convenience
- **INSIDE SPACE-** Interior columns are eliminated due to which the inside space increases
- **AESTHETIC**- Aesthetically nice
- **SEISMIC RESISTANCE**- Light structural members can perform well against seismic reactions
- **SAFETY AND RESPONSIBILTY**- Order is fulfilled by a single supplier leads to better management of materials and sections
- **PERFORMANCE**- Higher performance due to efficient bracing system
- **ECONOMY**- Economical in terms of erection time and economy
- **DEMOUNT ABILITY**- Less time required for demounting

3. RESULTS

Table 2: COST COMPARISON BETWEEN THE CONVENTIONAL GIS STEEL BUILDING AND DOUBLE STOREY GIS CUM GANTRY BUILDING

	Conventional Building	**Proposed Building**
Land Required (hectare)	12	4
Land Cost for Urban Area (INR in Cr.)	26.28	8.76
Weight of Structural Steel (ton)	300.00	610.00
Cost of Structural Steel (INR in Cr)	3.75	7.62
TOTAL COST (Cr.)	30.03	16.38
Savings in Primary Investment (Cr.)	13.65	

4. CONCLUSION

Below is mentioned the points which proves that double storey GIS building with Gantry over it is more advantageous than conventional GIS building.

- With the commissioning of such types of installations in GIS substations, the problem of land requirement & acquisition can be solved. The land requirement reduces to about 75% from the conventional GIS substations.
- The time schedule of the project also gets reduced to about 6 months from the base plan. As this type of installation is PEB type so its fabrication & erection takes 50% less time as against construction of the same building in conventional GIS substation.
- The quantity of material required in these types of installation is required less as compared to the two-separate building in conventional type GIS substations. The saving in primary investment and life time cost will also reduce as maintenance of the steel frame structure is less as compared to two separate building in GIS conventional substations.
- Quick assembly of the building as it is single building against two separate building in conventional type of substation.
- By such types of installations in the power sector we can reduce the pollution as well and thus contribute in reducing the carbon footprint.

As it is seen, wherever the required land for substation is not meeting the requirement and the available resources for establishing a GIS substation is not enough, the layout can be changed to double storey GIS building with gantry on the top. As it is can be clearly seen in the present work, the land requirement can be reduced by 66.6% for the double storey GIS cum Gantry building, providing lesser land footprint as against conventional GIS building. This type of solutions is relief for contractors of the project who are generally worried about the elongation of the time schedule due to time consumed in acquisition of large land area and thus delay in execution and commissioning of project.

The time schedule was reduced to 6 months from the base plan. The quality assurance, the workload and the functioning of the substation had increased in a feasible way. Comparison also clearly shows that even though structural steel weight required in the proposed building is two times the requirement of conventional building there is overall cost saving of about 49.9 %. The saving in the primary investment based on land and steel can be approx. 18,92,49,155.20 INR. With the right decision of Engineering this type of processes cab be introduced to other upcoming projects which will be a great success.

Hence the double storey GIS cum Gantry building is more advantageous over conventionally designed GIS buildings for two separate voltage level in terms of cost effectiveness, time saving, future scope, subtleness and economy. This paper of comparative study between conventional and double storey GIS cum Gantry building shows their experimental and analytical studies carried out in this field. The results show that the double storey GIS cum Gantry building are far more economical energy efficient and flexible in design than other type of buildings in GIS substations.

Further costs can be reduced by more detail analysis of the foresaid topic as it is also seen that the weight of PEB depends on the Bay Spacing, with the increase in Bay Spacing up to certain spacing, the weight reduces, and further increase makes the weight heavier.

For longer span structures like the one considered in this work, conventional buildings are not suitable with clear spans. Double Storey GIS cum Gantry Pre-Engineered Building are the best solution for longer span structures without any interior column in between as seen in this present work. With the advent of computerization, the design possibilities became almost limitless. Saving of material on low stress area of the primary framing members makes proposed building more economical than Conventional steel buildings.

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