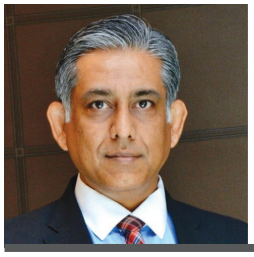
Cost Optimisation During Engineering



Cost optimisation is critical to any construction project, whether concrete or steel buildings. These buildings require considerable resources, time, and efforts to design and build, and optimising their costs can ensure that the project is both sustainable and financially feasible.

Amit Sharma, MD & CEO, Tata Consulting Engineers

Nowadays, most construction projects get delayed due to inefficient project/construction management, engineering design issues, techno-economic changes, and lack of effective coordination between various stakeholders and project schedules, which leads to cost overruns. Today's major problem faced by the engineers in the design office and construction sites is not completing the work in the targeted days and allocated budget. This can be overcome by implementing effective project management techniques, the right procurement strategy and the cost optimisation process during the engineering and construction phases.

Reducing the cost of buildings is essential for ensuring that construction projects are sustainable and financially feasible. For every project, conducting a value engineering workshop (even jointly with the client) is recommended to identify the areas for value adds to save CAPEX and OPEX cost. Here are some strategies to help structural design engineers achieve cost optimisation during the engineering stage.

Cost Optimisation Enablers

Efficient Design: Proper building design can help reduce construction costs by maximising the use of space and minimising the need for unnecessary materials. Efficient design can also reduce the time and labour required to construct the building. Some of the essential considerations of effective designs are given below:

- Architectural conceptualisation shall begin with identifying the most optimum grids depending upon the functional requirements. Generally, a 6m x 6m grid is considered the most optimum. The internal layout can then be fitted into the grid system. This helps create a structural framing without any regularities in plan and elevation and leads to optimum member sizes that result in cost savings.
- Adoption of Building Information Modelling (BIM) in the project life cycle helps in achieving project cost reduction, shortening construction schedule, and improving the overall construction quality.
- All efforts shall be made to eliminate irregularities in the building geometry by modifying architectural and structural configuration. The well-proportioned building does not twist about the vertical axis. To achieve this, vertical elements shall be balanced in the plan according to the mass distribution, and the floor slab's aspect ratio shall be less than 3.
- A building falling in high seismic zones shall have minimum irregularities or shall comply with provisions given in local

codes and standards. Architect fraternity shall also refer to such clauses during the conceptual stage to avoid any reworking at a later stage of structural analysis and design.

- In the case of steel structures, Pre-Engineered buildings have always proved to be cheaper than a conventional steel structures. Using parallel flange sections also helps reduce the overall weight and design optimisation. Using tubular/hollow sections for some aspects of structure results in less material consumption and reduced site jointing work. Another essential part of structural design is keeping the utilisation ratio closer to 1.0, provided it meets the serviceability criteria. Using the limit state design method in place of the working stress method will also improve structural efficiency, leading to cost savings. The slenderness ratio check may be eliminated if parallel flange sections are used.

Material Selection: Careful selection of building materials is essential for reducing costs. Locally sourced, recycled, or repurposed materials can be more affordable than imported or new ones. Using low-cost but durable materials, like concrete or brick, can also help cut costs. On the other hand, fully recyclable steel has a higher end-of-life valuation and can lead to lower lifecycle costs. The steel structure is more amenable to prefabrication, reducing site activities and the associated cost and time.

Some of the alternate materials that can be used in the buildings to reduce weight of the buildings are as follows:

- Concrete is the obvious choice for material construction due to cost economics compared to structural steel. But a concrete building poses another set of challenges in high seismic zones due to higher self-weight. Hence, all the engineering efforts shall be channelised towards reducing the overall weight.
- Structural Steel, on the other hand, is costlier than concrete and hence shall be used where the construction schedule is very challenging. In addition, steel structures in areas subjected to fire or in highly corrosive environments need special protective coating, increasing cost and completion time.
- External Brick Masonry walls can be replaced with AAC Blocks, and Internal Brick Masonry walls can be replaced with either AAC blocks or Drywall partitions. This will help in the reduction of lump-mass, reduction in seismic shear, and, thereby, reduction in column and beam sizes.
- Use integral water-proofing compound in fresh concrete for roof elements, sunshades, and basement structures.
- Use modular toilet blocks instead of conventional brick-wall partitioned toilets.
- Conventional concrete or brick masonry storm water drains can be replaced with 'pre-cast' drains.

Energy Efficiency: Incorporating energy-efficient systems into a building can help reduce long-term operating costs. Natural lighting, high-efficiency heating and cooling systems, and insulation can significantly reduce energy consumption and costs. Installing rooftop solar plants is an added advantage for lowering energy costs. The use of high SRI index roof sheeting will result in more heat reflection, and less heat absorption, reduction in internal temperature by 3 to 5 degrees and saving in HVAC recurring load and cost.

Standardization: Standardization of most repeated type of engineering designs and drawings or proven designs saves time. Such designs and drawings can be used with or without minimal customization. Standardization helps in saving time of conceptualization and engineering of such designs and drawings.

Modular Construction: Prefabrication and modular construction techniques can help reduce labour and construction costs. These methods involve manufacturing prefabricated components off-site, which are assembled on-site, reducing construction time and labour costs. Prefabricated concrete panels, for example, can be manufactured off-site and quickly made on-site, reducing construction time and labour costs.

Effective Project Planning and Management: Proper project planning and management involves creating a detailed project schedule and monitoring progress to identify potential cost overruns and delays. Proactively addressing issues can prevent costly mistakes and ensure the project is completed on time and within budget. Digitising the complete workflow from design to procurement, fabrication, construction, supervision, and quality control using digital tools can have better control of the activities and material flow, resulting in improved economics of project execution.

Agile Stage-Gate Process: A well-designed stage-gate process reduces the project risks of reworking and ensures higher level of certainty on the project cost, schedule, and quality. Such stage-gate process also helps in identifying areas that need more attention to clear the bottlenecks to achieve optimization project cost.

Prioritising Sustainability: Incorporating sustainable practices into a building's design and construction can help to reduce long-term operating costs and minimise its environmental impact. This can include using renewable energy sources, reducing waste, and incorporating green spaces into the building design. Incorporating sustainable practices, such as using recycled materials, reducing waste, and maximising energy efficiency, can lower the long-term operating costs of the building and reduce its environmental impact.

Conclusion

Engineering cost optimisation of concrete and structural buildings is essential for ensuring the sustainability and financial feasibility of construction projects. By carefully selecting materials, using prefabrication and modular construction techniques, effective project planning and management, and prioritising sustainability, adopting digitisation engineering systems (BIM), engineers can create efficient and cost-effective buildings that meet the needs of their users while minimising their impact on the environment. By implementing these strategies, construction projects can be made more affordable, sustainable, and financially viable.