Industrial Engineering and Innovation Management (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/ieim.2024.070309
ISSN 2522-6924 Vol. 7 Num. 3

Characteristics of structural design under EPCM in internationalized projects

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Keywords: Internalization, EPCM, General Contracting Management, Structural Design

Abstract: With the increasingly fierce competition in the domestic design market and the continuous development of internationalization, the knowledge-intensive enterprises represented by the design institutes, in order to get rid of the development dilemma brought by the single-growth model, and then transform into an engineering company is inevitable. EPCM's general contracting management mode can give full play to the design institute's dominant role in the design for the project's quality, schedule, safety, and cost, and at the same time, avoid the design institute's lack of experience in the construction cost control. At the same time, it also avoids the lack of experience of design institutes in construction cost control. Under EPCM general contracting management mode, there are higher requirements for the structural professional drawing and the professional ability of designers.

1. Connotation of EPCM

EPCM, is the abbreviation of Engineering, Procurement, Construction Management, that is, EPCM contractors are responsible for the design and procurement of engineering projects, and provide construction management services during the construction phase, EPCM has higher requirements for the general contracting ability, comprehensive ability, technology and management level of the project management party[1].

Under the EPCM contract model, the Owner enters into a contract directly with the EPCM General Contractor Management, each specialized subcontractor is recommended by the EPCM General Contractor Management or recommended by the Owner and enters into a contract directly with the Owner, and each specialized subcontractor has no contractual relationship with the EPCM General Contractor Management. The Owner bears and pays for all direct costs incurred in the execution of the Project, including the costs of procuring materials, equipment and all field work for the Project, and pays for the actual direct costs incurred by the EPCM General Contractor Manager as a result of providing the Engineering Services, principally labor costs.

In the EPCM general contracting management mode, there are owners, EPCM general contracting management, equipment suppliers and construction and other responsible parties, and owners often need to bear the main responsibility, and bear and project subcontracting all the risks

alone.[3] But many foreign owners are still willing to use EPCM general contracting management reasons, because the EPCM general contracting management mode, the owner of the project has a comprehensive decision-making power and control, the owner can be involved in all phases of the project and aspects of the project, for the project's quality, safety, schedule has a relatively strong right to control.

2. The need for engineering firms transforming from design institutes to do EPCM

With market competition and internationalization heating up, design institutes are generally faced with the situation of too many monks and too little porridge to grow, the old single design income business model is difficult to resist the changes of external risks, and also unable to meet the needs of the development of the enterprise, and at the same time, reduce the risk-resistant ability of the design institutes, so the design institutes need to enter the international market, to open up more diversified business, to stand on a higher platform for the development of the EPC and EPCM business.

In summary, it can be seen that the EPCM contract mode is a kind of service contract to provide professional management. EPCM contractor's main work is to cooperate with the owner to select and manage the project contractors, and bear the risk of management in the process of the project, and only bear the direct management responsibility for the project implementation process on the cost of the budget, schedule, design and construction quality and safety, so EPCM is a professional and comprehensive requirements, but less risky and benefit from the relative stability of the project management services, so that EPCM is a professional and comprehensive requirements, but less risky and benefit from the relative stability of the project management services.

3. Strengths and weaknesses of engineering firms transitioning from design institutes to execute EPCM

Design institutes are knowledge-intensive enterprises, and such enterprises have an inherent advantage in transforming into engineering companies to participate in EPCM management.

3.1. The talent pool and organization of the design institute are more suitable for EPCM general contracting management

The design institute has strong technical force, sufficient professional talents, complete professional knowledge, high professional quality of designers, and strong program design and innovation ability. These high-quality technical personnel can quickly adapt to the EPCM general contracting management mode of work, and can quickly grow into excellent project management personnel, and then better promote the efficient and high-quality completion of EPCM; in addition, the organizational structure of the design institute and the EPCM organization is very similar to the division of labor, according to the needs of the project, set up supporting functional departments, efficient resource integration to support the smooth progress of EPCM. And it can also support the smooth promotion of EPCM.

3.2. The project schedule, cost, quality, safety, technology and other factors can be well controlled from the source

For engineering projects, design is the leader, throughout the whole process of engineering construction, is the soul of engineering construction, is to determine the progress of the project, the quality, the cost of the key stage, the construction of the entire project has a great impact. Once the

design program is determined, after the design work is completed, all parts of the project are basically determined, and the cost, schedule, and construction program of the whole project are basically determined.

EPCM general contracting management, in the project before the full communication with the owner, very clear about the owner's needs and the owner about the core concerns of the project, is more concerned about the schedule or more concerned about the cost? Arranging the design work under this general principle can greatly reduce the design rework caused by the owner's changes in the design scheme.

Design is the foundation of the design institute, the design institute's strong technical strength, high-quality technical personnel, very rich engineering experience, these advantages can be the implementation of various aspects of the project and the stage of optimization proposals to greatly save costs. In addition, construction is essentially an extension and expansion of the design work, EPCM general contractor for the construction unit of construction machinery and staffing and other understanding of the more detailed, in the construction phase of the project through the stationing of design representatives stationed at the project site, at any time to solve the design problems encountered by the construction unit, to better carry out the construction intentions, the design and construction closely linked, and then fundamentally control the progress and quality of the project .

3.3. Design-as-you-go sourcing to improve sourcing efficiency

Design institutes can fully use their own technical strength and resource integration capabilities to improve sourcing efficiency. On the one hand, design institutes can control the design, procurement and logistics aspects during the starting stage of a project. Design institutes can do designing and procurement simultaneously. The procurement do not need to wait until the design is completed. This method can not only greatly enhance the efficiency of the procurement, but also save the construction period as well.

4. Engineering companies transformed from design institutes to do EPCM general contracting management also have disadvantages

4.1. Heavy on design management, light on project management

EPCM general contracting management mode, in the design and procurement by the EPCM contractor, construction by the owner entrusted by the construction unit to implement the case, project management plays a role in the beginning and end. Since the construction unit is not a subcontractor of the EPCM contractor, the problems that occur in the preliminary stage of design, procurement, processing and logistics must be dealt with in a timely manner, and the problems cannot be delayed to the site and then dealt with in a uniform manner, because the construction unit will claim from the owner for the loss of time due to non-construction reasons[2]. If the subsequent construction activities are affected by the unresolved problems in the early stage, the owner will think that the EPCM contractor has poor project management capability. The design institute, due to the design business, receives most of the design contracts subcontracted by the EPC general contractor, the main part of the project management is managed by the EPC general contractor, and the design institute needs to focus on design management, so it leads to the result of heavy design management and light project management.

4.2. Weak cost control capability without forming its own CBS (Cost breakdown system)

Design institutes in the cost control analysis, often relying on domestic budget estimates and

quota system, and international projects, materials, equipment, generally from several countries, the price of which fluctuates with the international economic and political situation is relatively large, design institutes on the pace of updating in this area is relatively lagging behind, so the part of the cost of cost and cost control is generally subcontracted to the unit responsible for the foreign country.

4.3. Inadequate talent pool for project commissioning and operations and weak management

The commissioning and operation of EPC or EPCM projects undertaken by design institutes are generally led by the owners and subcontracted to subcontracting units with the corresponding capabilities, and the design institutes have insufficient talent reserves and weak management capabilities in project commissioning and operation[4].

In summary, for knowledge-intensive engineering companies transformed from design institutes, EPCM can capitalize on their strengths and avoid their weaknesses, give full play to their advantages in design, procurement and consulting management that they are good at, and avoid the lack of experience in construction cost control.

5. Characteristics of structural design under the EPCM general contracting management model

Structural design codes and drawing principles: Foreign-led owners generally have low acceptance of Chinese standards for design and drawing rules, and generally require the use of international European or American standards or local standards for design and drawing. At present, the common finite element calculation software, for each country and region's code support is relatively high, the structural designer needs to understand the core parameters of the structural calculations have a greater impact on the value of the following: the general principles of structural design; the wind load, seismic load and load combination coefficients of the provisions of the concrete reinforcing principles and structural requirements; node design of the steel structure; the foundation of the calculation principles and so on; the calculation principles of foundation, etc.

5.1. Structural drawings are produced in English as the common language, and the principle of the drawings is that engineers all over the world with basic engineering literacy can understand them without the need for special instructions

Take beam-column reinforcement as an example, the size information of longitudinal reinforcement, the size information of hoop reinforcement, encrypted and non-encrypted areas should be clearly labeled in the drawings. Another principle about the drawings is that the Chinese atlas cannot be indexed directly, if you want to refer to the relevant contents of the atlas, you need to express the contents in the drawings: if you want to refer to the connection nodes in the steel crane beam atlas, you can draw the specific dimensions of the nodes into the drawings, but you cannot index the nodes directly.

5.2. With regard to the accuracy and completeness of drawings, the EPCM model requires far more design drawings than the EPC model

All parties related to the design drawings: purchaser, supplier, fabricator, constructor, etc., will claim against EPCM for changes and modifications to the design drawings that are not caused by their own parties. If the project is located in an extremely backward economy, all the project raw materials need to be imported, then a small design change may be magnified into a more serious

event, and even affect the critical path, resulting in a relatively large construction period and cost claims, EPCM party will be in a passive situation.

5.3. Under the contract mode of EPCM, the structural designer should have the overall awareness of the project structure and strengthen the communication with the owner, purchaser, processor and constructor. Equations

EPCM is responsible for the quality, schedule and progress of the project, so any events that have an impact on the quality, schedule and progress of the project should be avoided as much as possible, no matter whether they are the responsibility of the EPCM party or not. The design of the core sub-projects should be fully discussed and communicated with the owner at the early stage of the design, so as to avoid the owner to put forward opinions that are different from the initial design program, which may cause rework of the design and affect the schedule.

Under EPCM general contracting management mode, civil and steel structure construction is generally subcontracted to two units, so the structural designer should try not to adopt steel structure as the main load-bearing system when designing the sub-projects belonging to the scope of civil construction unit, because the civil construction unit has very little reserve of structural steel profiles for steel structure, and it mainly reserves angles, steel plates and purlins used in civil construction. In this context, if the designer adopts the steel structure as the main load-bearing system and the block as the maintenance structure program, the subsequent design changes are undoubtedly necessary. Design changes, apart from increasing the construction period, may even give rise to claims[5].

At the same time, when designing steel structure, for the components that need to be processed and manufactured on site, in addition to the need to consider the safety, applicability and durability of the structure, it is also necessary to consider the equipment processing capability of the on-site steel structure constructor. Take steel structure color steel tile as an example: in order to facilitate transportation, color steel tile are transported in the state of unpressed rolled sheet, rolled sheet is transported to the site, steel structure constructor presses the groove to meet the requirements with tile press at the site, and then carries out the installation work. For the pressing of flat sheet, the site production is generally not a big problem, but if the building modeling needs, the eave should be done curved processing, then the tile press machine needs to be the flat sheet to do bending processing, tile press machine for bending curved plate is a clear plate thickness requirements, more than the thickness of the mechanical processing, curved plate can not be bending. If the thickness of the plate transported to the site happens to exceed the processing capacity of the on-site tile press, then the part of the curved roof will not be able to be processed, and then re-procurement to meet the capacity of the on-site tile press plate, and then transported to the site, which undoubtedly affects the progress of the installation of the site steel structure.

5.4. EPCM general contracting management mode, the structural designer should have a relatively strong sense of anti-claims

Under the EPCM contract model, there are many parties involved in the project and they belong to different interest groups, so if the problems related to the design drawings are not handled timely and accurately, it will lead to unnecessary claims. Structural design drawings and the purchaser, supplier, processor and constructor are intersected, and all parties will send out Technical Query (TQ) when they have questions about the design drawings. The second is to pay attention to accuracy, comprehensiveness and rigor. Before replying to the questions, the structural designer must figure out the logic of the questions themselves, and on the basis of this logic, organize professional, accurate and comprehensive language to reply to the TQs, so as to avoid the loopholes

in the language or logic that will give rise to claims.

6. Conclusion

EPCM general contractor management party, provides professional services, the purpose is to better serve the project, value-added for the project. EPCM general contractor management party, as the owner's representative, is the bridge and link of communication between all parties involved in the project and the owner's side, if a party in the process of the project implementation of the need to solve the problem, the EPCM party to put forward professional and constructive advice for the owner to make a choice. In some cases, these opinions may not be consistent with the views of the owner wishes to take, at this time, the EPCM party needs to start from the overall situation of the project, through the provision of targeted calculations, reasonable data to prove to the owner of the reasonableness of their own program, rather than simply do the owner and the project between the parties involved in the sounding board, which is the significance of the existence of the EPCM general contracting management and the value of EPCM party!

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