Quality Engineering Design and Construction in Malaysia: *A Fast Disappearing and Endangered Commodity?*

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Note: This article is the first of two parts. Part two of the article would be published in the December 2010 issue.

In the construction industry, the quality of engineering input can have an impact on those nature of work which can be categorised in the following manner, *i.e.*:

- Planning and organising
- Design and creation
- Construction and site supervision
- Project management and maintenance

These four categories of work can encompass all fields or disciplines in engineering, whether it refers to chemical, civil, mechanical or electrical engineering. For these areas of work to be effectively crafted and implemented for use, the quality is of most importance. For example, if the structural engineer did a proper design of a building, which uses high quality materials and workmanship that requires less maintenance, then the lifespan of the building will be ensured or even exceeded. Likewise, if a mechanical engineer specifies the use of high quality and longer-lasting water pumps in a manufacturing plant, then the productivity of the plant will not suffer or get disrupted due to frequent breakdowns for maintenance of the water pump.

Since the topic of this paper is on the design and construction aspects, the last category, *i.e.* project management and maintenance, would not be emphasized. Similarly the emphasis will be more civil engineering aspects rather engineering aspects than on other engineering branches.

As examples of quality engineering practices are being called into question, the recently released investigation report on the massive roof collapse at the Kuala Terengganu sports stadium will be discussed to highlight the causes of the failure. Poor quality design, construction and even management had been mentioned numerous times in the report as the main causes of collapse.

WHAT DOES IT MEAN BY QUALITY ENGINEERING DESIGN?

The word 'quality' means 'essential nature, a trait or characteristic which denotes superiority, relatively considered to others'. An engineering design would cover prescriptions or specifications usually set by the designer or design engineer, as to how a tool, product or even a system can be created, adopted or even adapted for eventual implementation for usage in the industry.

Figure 1: Urban planning design requires quality engineering input

Hence, quality engineering design would mean a designed article of a superior characteristic by an engineer, which can produce maximum output at the highest efficiency rate, resulting in a desirable outcome to the expectation of the client or consumer.

Figure 2: Quality engineering input resulting in a quality living environment for consumers

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One may ask, how is this related to the construction industry? What is the current scenario in the industry in terms of quality control and safety adherence?

CURRENT STATUS IN THE CONSTRUCTION INDUSTRY

The construction industry faced many problems of late. Recently, there was a spate of structural collapse of bridges, demolished buildings, and even the roof of a newly built stadium was not spared. Lives were lost and property damages were incurred. All these add up to severe economical loss in the industry, not only in cost, but also in resources needed to refurbish or rebuild.

The most pertinent issue that arises from these events is the quality, or the lack of it, of construction and engineering design that are being practiced in the industry. Both the Government and private sectors have to be involved in seeking solutions.

The quality of engineering works in design and construction has always been a contentious issue for all parties involved, especially when economical considerations set in. Another issue that affects the quality of work on site is the quality of the workforce from the top down, *i.e.* designers and engineers, down to the technicians and site workers. In a developing country like Malaysia where cheap labour is available in abundance, the need for machinery or automation is kept at bay. Hence, this has an effect on the overall quality control.

PLANNING AND ORGANISING

The quality of the overall design depends very much on the coordination between all the parties involved in the

Table 1: Typical planning application flowchart

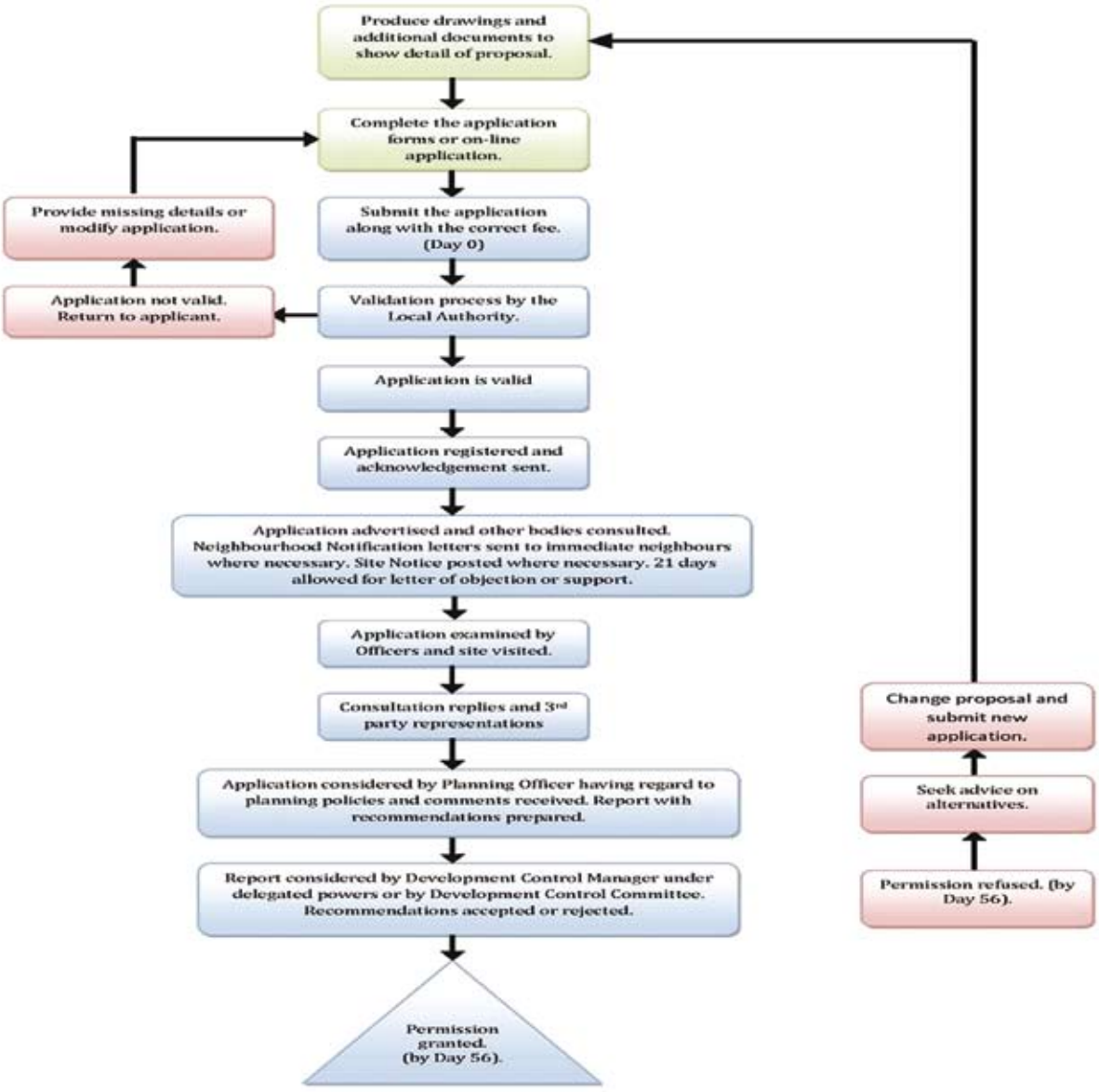

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Figure 3: Typical formwork and props in a building facade

project, right from the very beginning. Communication between client and consultants, engineers with architects, contractors and designers, and also engineers with suppliers, are essential in getting the right information across. The roles and responsibilities of everyone involved have to be identified and followed through:

- The client has to convey clearly his aim and intention, so that the design will eventually serve his purpose, and the quality has to be specified from the beginning and is adhered to throughout the project. Budgetary and cost controls also come into play insofar as to capture the essence and size of the overall project and the structural performance expected.
- Besides fulfilling the wishes and vision of the client, the architect has the responsibility to ensure that the breadth and scope of his finished design is practical and constructible from an engineering point of view. For example, it is physically impossible to have a floating element without a tangible support system in place. To ensure quality engineering design, the architectural input into the specified exposed finishes is very critical.
- From a civil and structural engineer's viewpoint, the design of the structure starts from the conceptual stage, based on the results of the architectural plan and layout. Precision and detailing are very important steps to ensure a quality piece of engineering outcome, and these are conveyed to the contractor via drawing plans and material schedules, and various specifications and instructions – even at the point of construction stage, where variations and amendments are very common.
- The role of the contractor is the key, as it is his output that will determine the success or failure of the client's vision. The quality of the work produced by the contractor is, in a way, influenced heavily by the designers, i.e. both the architect and engineer. The effectiveness of the engineering design comes into the picture at the tail end of the project. The diligence and skills of the contractor in getting the job done is only half the reason for an effective and quality design, because interaction and collaboration with the designers is also paramount to ensure the right information and ideas are communicated and implemented fully.
- Likewise, the supplier is considered the supporting player, as he is asserting his influence through the quality and timely delivery of the materials, products or services as specified and requested by either the consultants or the contractors. His pride in his product performance is the key to ensure a constant and predictable supply, delivery and even the commissioning of a quality finish outcome, be it a floor or wall system.

The matter and manner of planning and organising the work of this group of people or organisation is important, and the role of the coordinator is very critical. In a traditional construction project, the supervisory officer is the overall coordinator and is taken up by the architect. But in a modern project setup, where the client himself may want to have a say in the running of the project, then he will usually appoint a project manager to run the project on a day-to-day basis, managing the consultants in design, and supervising the contractor's on site work progress.

Figure 4: The architect or project manager needs to have an overall view of things

One typical example is the planning and usage of proprietary formwork and falsework in a construction site. Nowadays, to ensure good quality control on site and also to ensure a high quality finish in cast concrete, proper design and planning is needed for the placement and sequencing of such temporary structures. Engineering input is required by a structural engineer to ensure the proper alignment and finishing of the cast elements, as well as the safety of the workers on the job sites.

DESIGN AND CREATION

In the world of architecture, the output of an architectural design is considered a work of art, which may transcend logic with its uniqueness in abstract and peculiarity, the hopes and dreams of both the designer and the owner. Its quality comes in the form of serving the intended purpose of the client, as well as to fulfil the wishes and fantasies of the designer in its final form.

But for engineering design purpose, the structural form, shape and size have to be designed by the structural engineer, in such a way that all elements and supporting frames are in place, to ensure its reality and practicality in construction. Nowadays, besides the creation of a structural form, the economical aspects also come into play, and both the engineer and architect are very much aware of the cost constraints placed on them by the owner. In such cases, creativity and innovation may be secondary, should the client chooses.

Hence, the design and creation part of the work by both the architect and the engineer are very distinct, but so long as it serves the purpose of the client, in its function and aesthetics, then the quality of work produced is acceptable.

By international standards and codes of practice, all design projects are expected to conform, and it is up to the ingenuity of the designer to come up with a design system which can work yet within the limits of international standards while retaining its unique features. International recognition is also a measure of attaining the highest quality in design.

In March 2010, the United Kingdom (UK) has withdrawn, most if not all, the British Standards (BS) on structural engineering design, and replaced them with their Eurocode counterpart. For example, BS 8110 (for structural concrete design) and BS 5950 (for structural steel design) have been replaced by BS EN 1992-1-1:2002 and BS EN 1993-1-1:2003 respectively. The main difference is the state-of-the-art engineering design approach in Eurocode, which is very much performance-based compared to the prescriptive provisions in the withdrawn BS, which has been widely adopted in Malaysia since the colonial days.

In 2010, through the initiative and leadership of The Institution of Engineers, Malaysia (IEM), the way forward has been established, in which four Eurocodes have been adopted into the Malaysian Standards for structural engineering design. They are:

- MS EN 1990 Basis of structural design
- MS EN 1991-1-1 Actions on structures: Densities, self weight and imposed loads
- MS EN 1992-1-1 Design of concrete structures: General rules and rules for buildings
- MS EN 1993-1-1 Design of steel structures: General rules and rules for buildings

Two more Eurocodes are in the pipeline for adoption in Malaysia. They are:

- MS EN1997-1 Geotechnical design: General rules
- MS EN1998-1 Design of structures for earthquake resistance: General rules on seismic actions and rules for buildings

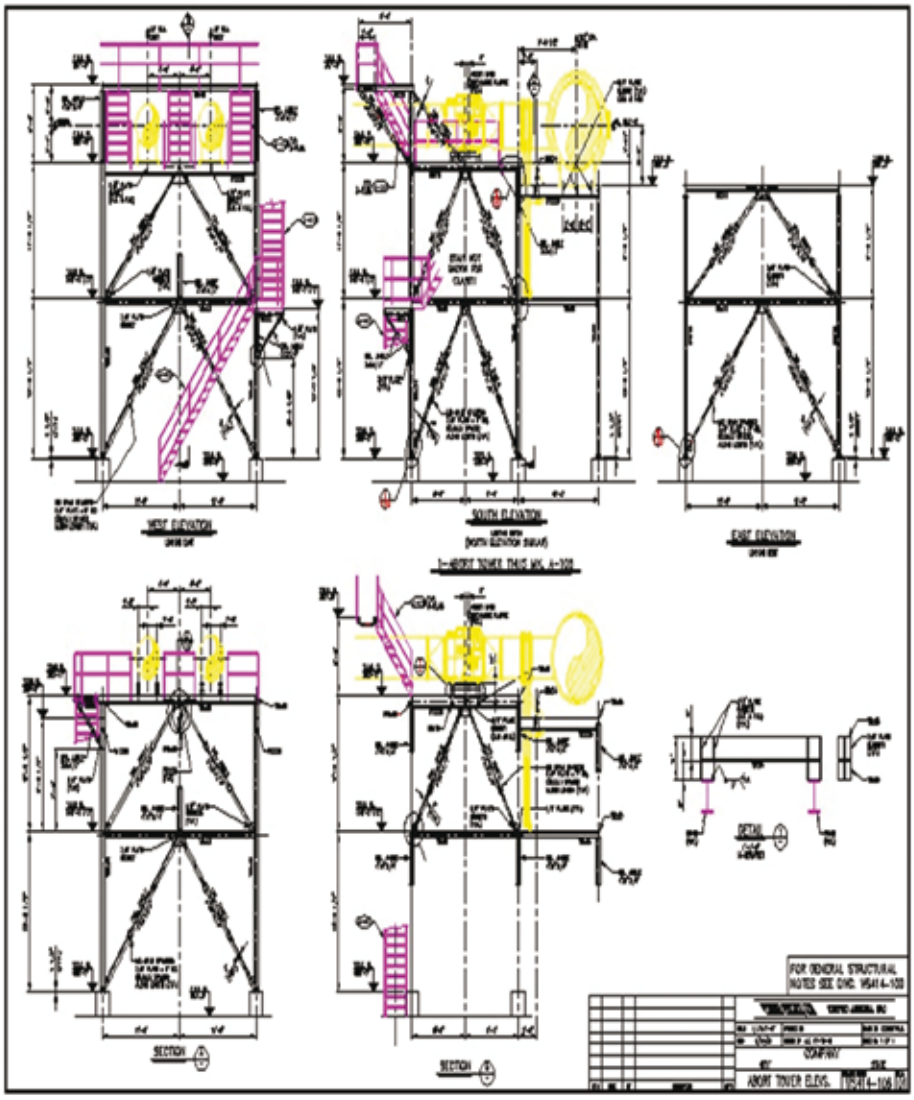

Figure 5: Quality and detailed engineering design drawing for construction purpose

As there are a total of 58 parts of the Eurocodes for structural design, Malaysia still has a long way to go in studying the adoption of the remaining 54 parts. In line with the UK's design practice, Malaysia has enhanced its competitiveness in the international design of structures in a very globalised market. In years to come, local engineers will be able to export their expertise overseas even in the UK and Europe, where Eurocodes are going to be widely used in civil engineering design and construction. We assume the switchover will be smooth during the period of transition.

Figure 6: Drafts of MS EN1990 and MS EN1991-1-1 produced in 2009 for public comment