QUALITY IMPROVEMENT OF DESIGN RESULTS

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ABSTRACT: The process of design requires that the client and the design firm work together. Design can not be done by only the design firm. The client also bears great responsibilities for establishing the design conditions before ordering, giving definite direction, selecting a proper length of time for the work, and confirming the design results. Client and design firm must have systematic and proper meetings in the planning phases to eliminate design mistakes and to produce design results that are good in terms of safety, workability and economy. Results need to be based on checking by the design firm and on design review by the client or the third parties. And the client must properly manage and supervise the design firm to get good performance from the design firm's checking system, and to improve the quality of design results that it receives from the design firm.

In this report, we state the outline for the client to check the state of the work by the design firm and for design meetings with the design firm at every working step, for the purpose of quality improvement of design results. And we give brief statements of the rules for checking by the design firm and for design review by the client or by third parties. In addition, we introduce standard drawings of planning and actual cases that give a graphic representation of established reasons of for these standard measures which we must observe by law in design of structures.

KEYWORDS: design review, design check, requirement drawings

1. INTRODUCTION

It is clear that design is crucial for constructing high-quality and easy-to-use civil engineering structures. But there are many cases of failure caused by the persons who work out a design.

The process of making design results has the meaning that the client and design firm undertake the work together. Design can not be worked by only the design firm. The client also bears great responsibilities for establishing the design conditions before ordering, giving definite direction, selecting a proper length of time for the work, and confirming the design results.

In this paper we explain the work flow for the case of outsourcing the design work to a design firm, which the construction sector of our company currently is doing, and in addition, introduce new efforts which were recently started.

2. TOTAL WORKFLOW OF DESIGN WORK

Figure 1 is a general flow diagram for when we outsource design working to a design firm. In this paper we list and explain the items that the client should be especially careful to check.

2.1 Definitions

2.1.1, "Supervisor" means the person who receives supervision orders from the person responsible for the contract.

2.1.2, "Referee etc." means the persons who evaluate design results that the design firm submits with respect to safety particulars, so that they can appropriately lead and direct the design form at each working step.

2.1.3, "Chief engineer" means the person who exercises technical control over the designing. He belongs to the design firm. He is a person who has adequate experience of design of railway structures, has working experience for a period of time, and has ability comparable with his experience.

2.1.4, "Check engineer" means the person who checks the design results at each steps of

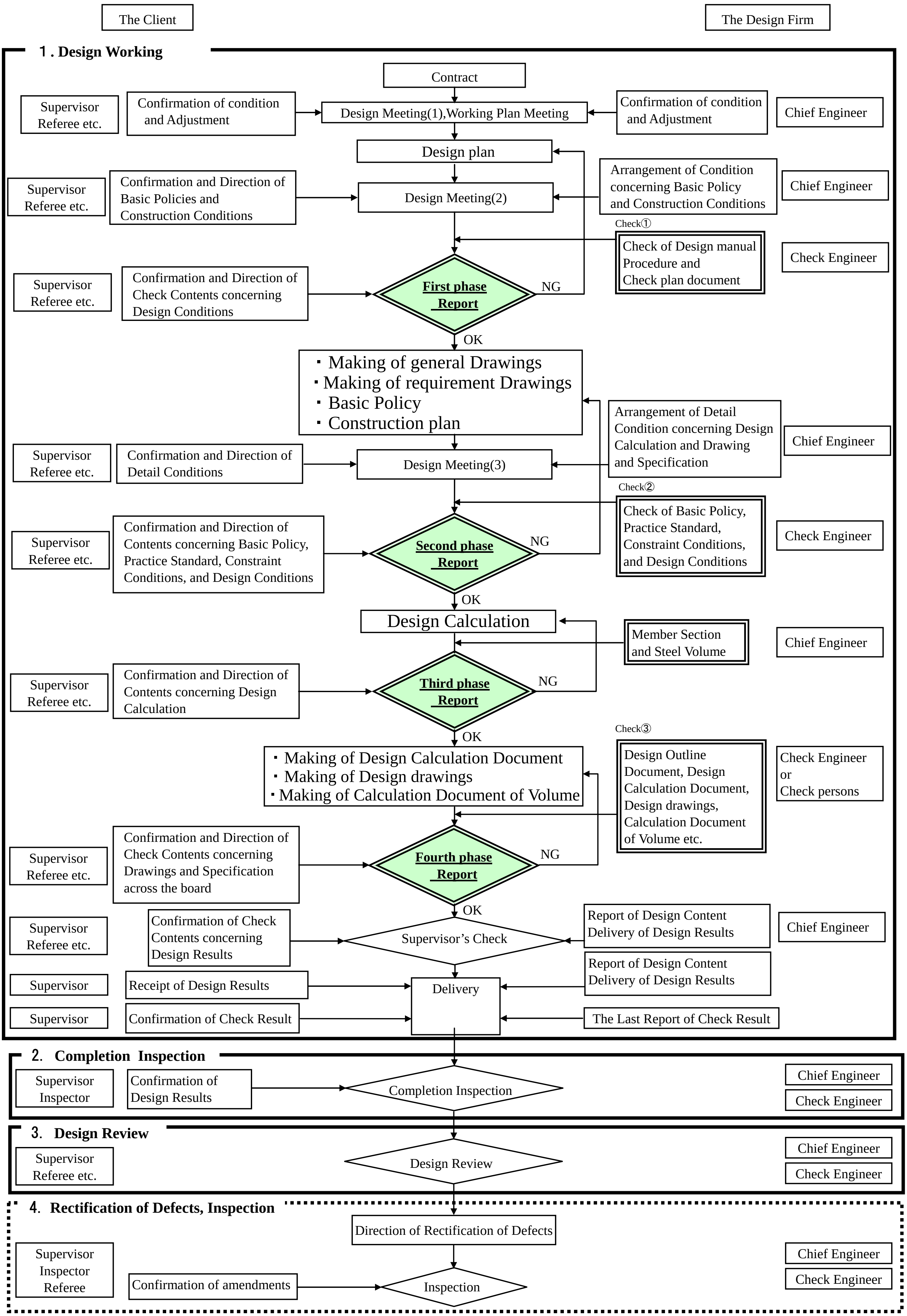
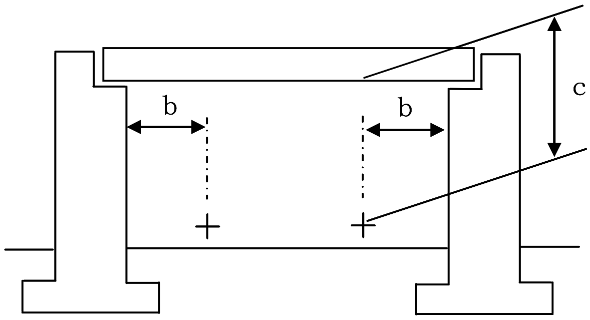


Figure 1 General Flow Diagram in Design working

The policy for the distance from the track center line to the near surface of a bridge abutment and an vertical distance from the rail level to the lower surface of the bridge



■Distance from the track center line to the near surface of the abutment・・・b
※Caution（snow removal lines）
【Engineering details】
・ snow removal lines of 4.5 meter width
：over 3200mm
・snow removal lines of 6 and 7 meter width
：over 5000mm

■Vertical distance from rail level to the lower surface of the bridge・・・c
【example of fact】

From rail level to contact wire	：4800mm
From contact wire to support wire	： 700mm
Basis of electricity	：300mm
Other allowance, such as margins	： 300mm
	6100mm

Figure 2 Example of items we should check in requirement drawings

design and when all steps are completed. He also belongs to the design firm. He is a person who has adequate experience in design of railway structures, has working experience for a period of time, and has ability comparable with his experience, but he does not engage in the actual design.

3. PRESENTATION OF CONDITIONS PRECEDING THE DESIGN WORK

After the client informs the design firm as to the estimate, the client organizes and confirms the constraint conditions, design conditions, and construction conditions which govern the design of the structure, contents of the commission from the client, contents of design results that the client expects, term period of the design work, and data that will be provided. Then the client presents these items to the design firm, and the client has a meeting with the referee etc. about those items.

4. CONFIRMATION OF DESIGN WORKING AND CHECK

The supervisor has a design meeting with the design firm at each working step for improving the quality of design result, preventing delays in the design work, and maintaining efficiency of design review. Accordingly, the supervisor verifies that the contents of the design work satisfy the capability requirements and are adequate. When they have a design discussion, the design firm records in the minutes and has the supervisor (with, if necessary, the referee etc.) confirm and sign documents giving the contents of each discussions and instructions that the design firm receives by word of mouth, telephone, and FAX. And the supervisor ensures that the design firm carries out what is indicated in the contents and signs a record of confirmation.

The following are the main items of confirmation of the report from the design firm in each design working step.

4.1 First phase report (Report of design plan)

The supervisor (joined as necessary by the referee etc.) confirms that the designing guide prepared by the design firm corresponds to the conditions and standards required by the client, as described and explained here.

And they also confirm the contents of the working plan document.

4.1.1, Concrete confirmation items

- Items related to standard practice (railway line shape, load conditions) satisfy the standards.
- Design conditions for the final structure

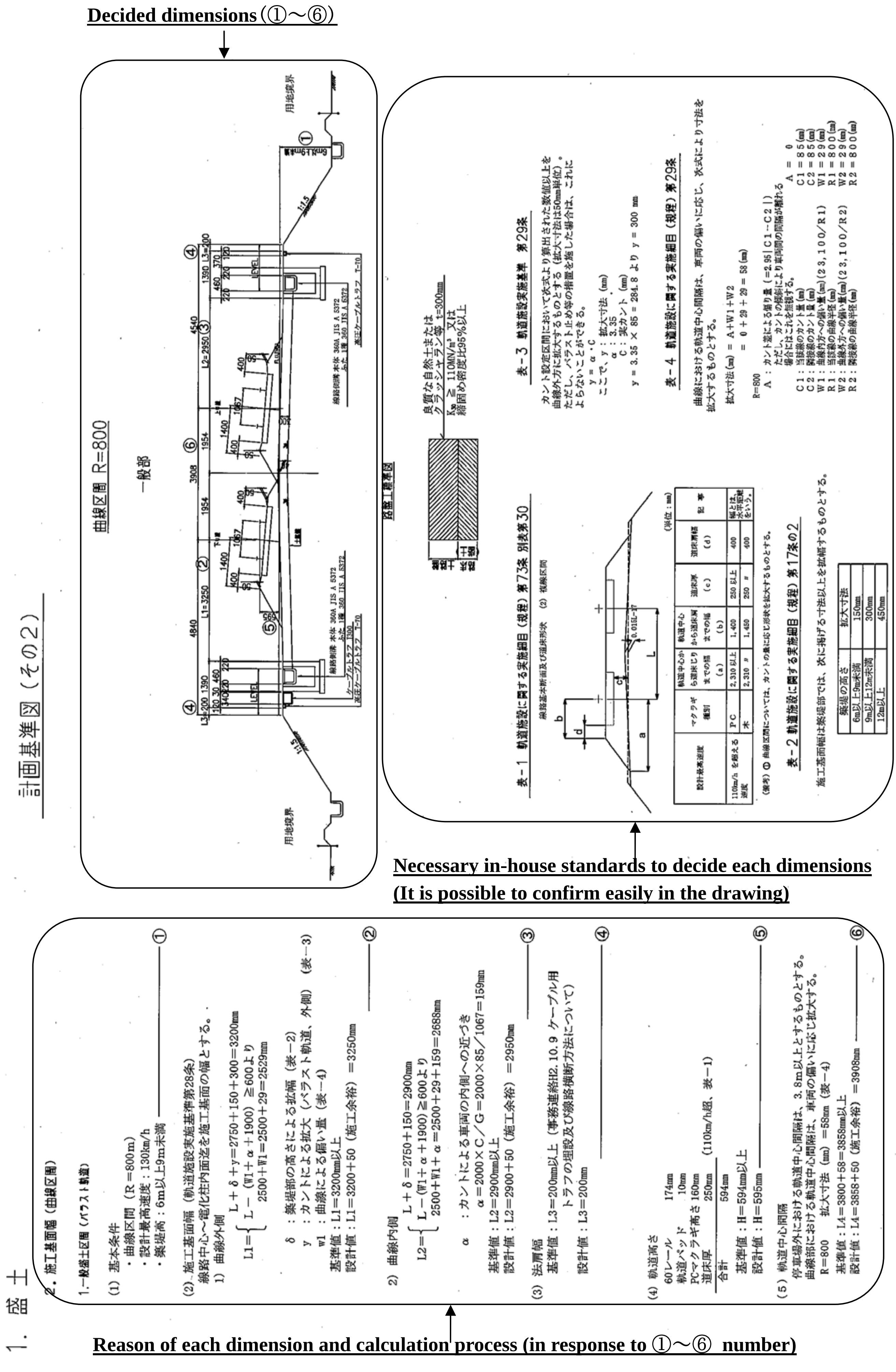


Figure 3 Example of requirement drawings（About a width of formation level of embankment ）

(structure type, design conditions, construction method, whether or not the railway line is adjacent) satisfy the standards.

4.2 Second phase report

(Making of general drawings and requirement drawings, basic policy, report of construction plan)

Supervisors confirm that basic conditions such as width of formation level and overhead clearance satisfy conditions they specified, and confirm the contents of meetings concerning standard practice and applied technical standards, including general and specific requirement drawings.

4.2.1, Concrete confirmation items

- Adequate setting of constraint conditions
- Compatibility with standard practice, technical standards and applied conditions
- Agreement of structure type and scale with ground and construction conditions.

4.2.2, Requirement drawings

The level of mapping is based on standard practice, constraints, and determining conditions on structure plan "requirement drawings". Figure 2 is an example of an item we should confirm in requirement drawings. This example shows the distance from the track center line to the near surface of a bridge abutment and the vertical distance from the rail level to the lower surface of the bridge when we design beams above the track; we need to know these conditions. Developing requirement drawings means that we can easily confirm various design and construction conditions and standard limits for construction on the map. Figure 3 is an example of a requirement drawing. This example shows requirement conditions and standards when we decide on the width of the formation on a double track section.

4.3 Third phase report

(Report of design calculation)

After the design firm has made the design calculations and has calculated the necessary dimensions of each structural member and the volume of steel (and before the design firm makes the design calculation document and design drawings), supervisors have a meeting with the design firm and confirm that the design firm work is satisfactory. This shows that the design firm will not cause delays in design work.

4.3.1, Concrete confirmation items

- The dimensions and volume of steel of main structural members that were computed by design calculation are consistent with applied technical standards and construction conditions, and design is rational.

4.4 Fourth phase report

(Making of design calculation document and design drawings, and Report of calculation of volume)

Scale and section data satisfy technical standards and construction conditions that the client requires, with reference to completed design calculation document and design drawings.

4.4.1, Concrete confirmation items

- Contents of meetings at intermediate steps is reflected in final design results.
- Main members, such as columns, beams and piles, are designed by a method that corresponds to applied technical standards, so that required performance is ensured and design results are economical.
- Main members satisfy member data and structure details that were generated by design calculations in design drawings.

Next is the confirmation method for check results. (The check engineer belongs to the design firm and makes the design check.) The design firm gives the client the check sheet that the check engineer uses for the design check, the design calculation document, and the design drawings that have been verified by the check engineer. After the client confirm that contents.

5. COMPLETION INSPECTION

If the check of the design results that was performed by the design firm was satisfactory as stated in **4.confirmation of design working and check**, the client conducts the completion inspection. The completion inspection is conducted by an appointed inspector in charge of the contract. The inspector examines the status of the design results and the inspection and confirmation of the design outline and check states, and confirms the implementation of the first through fourth phase reports with the supervisor and the chief engineer and the check engineer (who belong to the design firm). Also, contents of the design calculation document and design drawings are confirmed in the design review described in **6.**

6. DESIGN REVIEW

After **5.completion inspection**, the client conducts a design review. The referee confirms and judges that the design results satisfy the requirements defined in the contract papers and the conditions required and presented by the supervisor and the referee, that the method of structure analysis has found any mistakes, and that the safety of main members is ensured. The items that the referees confirm in the design review are as follows.

6.1 Confirmation items by referees

- Main members, such as columns, beams and piles, are designed by a method that corresponds to applied technical standards, so required performance is ensured, and design results are economical.
- Main members use section data that has been computed by the design calculation document in the drawings.
- Design results are in accordance with standard practice and structure details.

7. DIRECTION OF RECTIFICATION OF DEFECTS

If the supervisor or referee allowed modification items that do not satisfy standard practice or required performance in **6.design review**, the client treats these items as defects, and a “Direction of rectification of defect” is sent from the person in charge of the contract to the design firm. On this occasion, the client sets a time period for modification based on the content of the modifications, so that the design firm will have enough time for this work.

When the design firm finishes the rectification, an inspector appointed by the person in charge of the contract performs an inspection.

8. CONCLUSION

We have shown the workflow which the construction section of our company currently implements in case of outsourcing design works to a design firm, especially focusing attention on work to be done by the client.

In the workflow, we are starting new some approaches to achieve better design results.

One is a revision of the schedule for the client to make a design review. From this revision, the design review is separated from design work, and the design review is conducted after the completion inspection. The client directs rectification of defects for modification items at the time of the design review.

Another is the addition of report and confirmation times. After the design firm has made the design calculation and calculated the dimensions of structural members and the volume of steel, the client receives a report about those items and has a meeting with the design firm. This will verify that the design firm has made correct calculations and drawings, and will reduce the delay time if there has been a mistake.

Both of the organizations, the client and the design firm, are involved with moving the structure design work forward. It is essential that not only the design firm but also the client plays its own role with necessary ability and responsibility. We, as the client, must keep the fact that we are responsible for completed design results firmly in our mind.

We want to conduct various approaches to build up an organizational structure so that we will adequately perform our work in the future. As a result of those approaches, we are going to produce structures that are of good quality and convenient to use.

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