Framework for Estimating Appropriate Construction Duration of CFRD in the Planning Phase

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Abstract: To secure quality of dam construction needs appropriate construction duration. Tight construction schedule may have negative influence on infrastructure quality, work safety and maintenance cost. It is necessary to reflect proper construction duration in the planning phase. There have been standards for estimating construction duration of building and industrial complex development but dam construction have not. In order to estimate construction duration of CFRD, feasible study reports and design reports were analyzed to acquire available information. After that, considering on construction duration methods such as comparison with similar cases, approximate estimating formula, approximate quantity assumption were adapted to Critical Path items. Hence, this study present framework for construction duration estimating of CFRD in the planning phase. This framework can be applied other types of dam along the same line.

Keywords: Construction Duration, Estimating Duration, Dam construction, Concrete-Faced Rock-fill Dam (CFRD)

I. INTRODUCTION

A. Back ground and Purpose

Annual average precipitation in South Korea is 1.6 times more than the world annual average precipitation but large population compared to the national land area, per capita precipitation is one over sixth compared with the world. Dam construction is essential to manage and develop limited water resources efficiently (Korea Ministry of Land, Infrastructure and Transport, 2012).

On the construction of dam if construction quality is not secured, it will lead to severe accident such as the Pennsylvania Astin dam collapse in 1911(Daniel F. Martt et al, 2005). In order to prevent such accidents, the high quality of construction is required. It must also ensure reasonable construction duration. However, dam construction projects in Korea there are difficulties to establish construction schedule and process planning because of the absence of appropriate construction duration standards. Particularly in most cases, construction duration in the planning phase is estimated subjectively based on the scale of the similar cases and it will result in lack of construction duration in the construction phase. Thus, this study developed framework for estimating appropriate construction duration in the planning phase.

B. Object and Method

The framework in this study, it is an object of the construction duration estimating of CFRD by considering among CFRD (Concrete Faced Rock fill Dam), CGD (Concrete Gravity Dam), and ECRD (Earth Core Rock fill Dam) which are most constructed in Korea. The items on the C.P was derived from collected feasibility study reports and design reports of CFRD cases, and available information of each project phase is analyzed.

II. FRAMEWORK

A. Critical Path and Estimating Method

The critical path generally consist of temporary facilities, diversion tunnel excavation, diversion tunnel lining concrete, main dam excavation, main dam plinth, main dam construction, main dam concrete face, discharge facility, power station in sequence.

It is too difficult to estimate construction duration in the planning phase because of lack of relevant information of detail construction works. Therefore, after reviewing the estimating method in different way, it is necessary to derive feasible construction duration as possible. As below three methods are commonly used (Samoo C.M, 2015).

1) Comparison with similar cases
2) Approximate estimating formula
3) Approximate quantity assumption

Estimating methods each C.P which reflect available information are shown in the Table 1.

B. Temporary Facilities

Available information of temporary facilities in the planning phase is site area, total amount of concrete demand, total amount of aggregate demand. There is no basis of duration estimation in the design phase.

Thus, historical data are used in order to estimate temporary facilities construction duration. However CFRD cases are insufficient to estimate construction duration, other types of dam such as CGD, ECRD are utilized.

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C.P	Estimating method
Temporary Facilities	Comparison with similar cases
Diversion Tunnel Excavation	Comparison with similar cases
Lining Concrete	Approximate formula
Main Dam Excavation	Approximate quantity
Plinth	Comparison with similar cases
Main Dam Construction	Approximate quantity
Concrete Face	Approximate quantity
Intake & Discharge	Comparison with similar cases
Power Station	Comparison with similar cases

Table.1 Estimating method for each C.P

C. *Diversion Tunnel Excavation*

Available information of diversion tunnel excavation in the planning phase is tunnel length and section of diversion tunnel. Construction duration is decided by daily excavation length through a cycle time in the design phase.

The cycle time calculation is impossible because quantity of each pattern is not known in the planning phase. Thus, daily excavation length of diversion tunnel excavation cases and similar cases such as tunnel emergency spillway and water conveyance tunnel are used in order to estimate construction duration of diversion tunnel excavation.

	Tunnel length	Daily excavation length
A dam	279m	3.48m
B dam	356m	3.56m
C dam	290m	3.00m
D dam	510m	5.00m
E dam emergency spillway	1,763m	4.18m
Average		3.8455m

Table.2 Daily exaction length of diversion tunnel

D. *Diversion Tunnel Lining Concrete*

There is no available information of diversion tunnel lining concrete in the planning phase and basis of construction duration estimation in the design phase. However, it can be calculated by using cycle time, diversion tunnel length and system form length.

$$Lining\ Con'c\ Duration = \frac{Diversion\ Tunnel\ Length}{System\ Form\ Length} \times Cycle\ Time$$

Fig.1 Approximate formula of lining concrete

E. *Main Dam Excavation*

Available information of main dam excavation in the planning phase is total excavation amount of earth and sand, ripping rock, blasting rock. Construction duration is decided by daily excavation equipment workload. This workload is calculated by "Korean standard of estimate". Thus, the smallest productivity per unit time of excavation equipment is used in order to estimate construction duration of main dam excavation.

F. *Main Dam, Plinth and Concrete Face Construction*

Available information of main dam construction in the planning phase is height, length, width, the amount of construction. And construction duration is decided by daily compaction equipment workload. However, the amount of construction of each zone isn't known in the planning phase. Thus, approximate quantity of each zone according to standard section of CFRD is assumed. Then daily compaction workload of each zone is used in order to estimate main dam construction duration.

Available information of concrete face in the planning phase is width of block. And construction duration is decided by the number of blocks which are designated a series of construction duration in sequence. Thus, the number of blocks of concrete face is calculated by dividing main dam length and width of concrete face block then, construction duration is estimated by the number of blocks.

However, also construction duration is decided by the same way with concrete face, all the length of the block is different and there is no information about block length in plinth. Therefore, construction duration of plinth is change according to dam length. Then, historical data which reflect dam length is used in order to estimate plinth construction duration

G. Intake, Discharge Facilities and Power Station

There is no available information of intake, discharge facilities and power station in the planning phase and basis of construction duration estimation in the design phase. But these works construction duration are not much changed. Thus, historical data is used in order to estimate intake, discharge facilities and power station construction duration.

III. CONCLUSION

In this study, historical data is analyzed to present Critical Path for estimating proper construction duration of CFRD at planning phase and framework is presented based on the C.P. This framework can be applied other types of dam along the same line. In the future, additional estimating construction duration study will be performed by using this framework.

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