Roller Compacted Concrete

ACI Committee

- Roller compacted concrete (RCC) is a concrete of no-slump consistency in its unhardened state that is transported, placed, and compacted using earth and rockfill construction equipment.
- Properties of hardened RCC are similar to those of conventionally placed concrete.

- This report applies to the use of RCC in structures that require measures be taken to cope with the generation of heat from hydration of the cementitious materials and attendant volume change to minimize cracking. Mixture proportioning, physical properties, mixing, placing, consolidating, curing, protection, testing, inspection, design and construction are covered.

Chapter 1:Introduction

- Roller compaction: A process for compacting concrete using a roller, often a vibrating roller.
- Roller compacted concrete: Concrete compacted by roller compaction; concrete that in its unhardened state will support a roller while being compacted.

- RCC was developed as a result of efforts to design more economical concrete dams that could be constructed rapidly.
- Use of continuous placement methods, similar to those used in earth dams, would generate savings in time and money as compared with traditional concrete gravity dam construction.

- In the late 1970s, an extensive research program on high fly-ash content RCC was conducted.
- In Japan, research into RCC for dams was initiated in 1974 under the guidance of its committee on Rationalized Construction of Concrete Dams.

- The results led to the use of RCC (referred to as the “rolled concrete dam” [RCD] method in Japan) in the main body for the Shimajigawa Dam.

Chapter 2- Materials and Mixture Proportioning

2.1 General

- The objective of RCC proportioning is to provide a compactible and stable mass that meets the strength, durability and permeability requirements for the application.

- The mixture design for Shimajigawa Dam in Japan used conventionally graded 3 inch (7.6 cm) maximum size aggregate (MSA) with 219lb/yd3 (130kg/m3) cementitious materials.
- RCC must be proportioned so that it has the ability to support a roller and spreading equipment.

Simajigawa Dam (yamaguti Prefecture

- A major concern in RCC design is obtaining adequate bond between layers of RCC.
- Improved bond may be obtained by restricting the time interval between placement of lifts, by providing supplemental joint treatment such as mortar or bedding layer, or by increasing the paste content of the mixture.

2.2 Consistency

- The energy required to compact RCC mixtures to their maximum densities is much greater than for concrete of measurable slump.
- For example, a Vebe time of approximately 15 sec was judged to be appropriate at Upper Stillwater and Elk Creek Dams.

- The selected water contents for a given RCC mixture will be influenced by the size, shape, and gradation of aggregates and the volume of cementitious materials.

2.3 Cementitious materials

2.3.1 General

- RCC can be made with any of the basic types of cement or a combination of cement and pozzolan.
- The strength of RCC is primarily dependent upon the quality of the aggregate; degree of compaction; and the proportions of cement, pozzolan, and water.

- At the ages beyond 28days, the difference in strength contributions for the various cementitious materials decreases, with slower strength development materials ultimately producing higher strengths.
- Fig.2.1 can be used as a guide to proportioning equal strength RCC for varying proportions of cement and Class F pozzolans.

- Considerations must be given to the generation of heat by cementitious materials of the RCC mass. It is desirable to use low or moderate heat generating cements and the maximum amounts of pozzolans commensurate with (釣り合った) strength requirement.
- Structures requiring higher strength or paste contents have used higher % of pozzolan with both economic and reduced temperature benefit.

2.3.2 Cement

- For mass applications, cements with lower heat generation are beneficial. They include TypeⅡ (low heat), Type ⅠP (portland pozzolan cement), and Type ⅠS (portland blast furnace slag cement).

2.3.2 Pozzolans

- Nearly all RCC projects using pozzolans have used Class F fly ash, due primarily to the effect of its spherical particles on workability.
- Class C fly ash has been also used (Thailand).

2.4 Aggregates
2.4.1 General

- 2.4.2 Coarse Aggregate
- For RCC there is not enough material-cost savings from using aggregate sizes larger than 3in. (76mm) to offset the added batching cost of correcting the increased segregation problems associated with the larger aggregates.（骨材および機器次第）

- In massive concrete placement, control of the temperature rise should have a greater significance than material costs in the selection of MSA (maximum size aggregate).

2.5 Mixing proportioning methods for RCC

- A number of mixture proportioning methods have been used for RCC structures throughout the world, making it difficult to generalize any one procedure as being standard.
- I believe Japanese method is one of the best.

Japanese method

α : volume of paste/vacancy of fine aggregates

β : volume of mortar/ vacancy of coarse aggregates

The method is to determine the suitable values of α and β by experimental works.

Usually, α is around 1.3 and β is around 1.1 to 1.3.