Roller-Compacted Concrete

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Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Define** Roller-Compacted Concrete (RCC) according to industry standards and identify obsolete terminology.
- **Evaluate** project suitability for RCC based on geometric, economic, and structural discontinuities.
- **Identify** the major economic and schedule advantages of RCC compared to conventional concrete and embankment dams.

Executive Summary: RCC provides the structural integrity of conventional concrete with the rapid, high-production placement characteristics of embankment materials, typically resulting in cost savings of 25% to 50% for gravity structures.

Design Purpose and Scope

The primary purpose is to provide technical guidance for the application of **Roller-Compacted Concrete (RCC)** in dams and other civil works structures.

- **Focus Areas:** Materials investigation, mixture proportioning, design and construction considerations, equipment, and performance.
- **Exclusions:** This module does **not** cover RCC applications for pavements.

Applicability

These standards apply to all USACE Commands with civil works responsibilities.

References

Required and related technical publications are detailed in Appendix A.

Engineering Definition

ACI 116R defines RCC as concrete compacted by roller compaction; it is a material that, in its unhardened state, will support a roller while being compacted.

- **Hardened Properties:** While properties can be similar to conventional concrete, RCC can be engineered for performance ranges outside typical conventional limits.
- **Process:** "Roller compaction" is the process of compacting concrete using a roller, typically a vibrating roller.
- **Nomenclature Note:** The terms **"rollcrete"** and **"rolled concrete"** are obsolete and should no longer be used.

Application Selection

RCC is suitable for applications where no-slump concrete can be transported, placed, and compacted using earth and rock-fill construction equipment.

Ideal Project Characteristics

- **Geometry:** Large placement areas facilitate continuous production.
- **Low Complexity:** Projects with little or no reinforcement and few embedded metal discontinuities (e.g., piles) are preferred.
- **Economic Choice:** RCC should be used when it is economically competitive with other construction methods.

Common Use Cases

- **Gravity Structures:** Concrete gravity and arch-gravity dams.
- **Erosion Control:** Bank protection (in lieu of riprap), aprons, and work pads.
- **Massive Fills:** Massive open foundations, base slabs, cofferdams, and emergency repairs.
- **Embankment Protection:** Overtopping protection for embankment dams.

Objectives of RCC Operations

The design of the structure must be closely coordinated with the material performance requirements and construction specifications.

💡 **Design Tip:** To maximize cost-effectiveness, design structures to be **placed as quickly as possible** with **minimal manpower**. Avoid complex construction procedures or multiple mixture types that interrupt production momentum.

Major Advantages

Costs and Economic Factors

RCC unit costs are significantly lower than conventional concrete.

- **Cost Savings:** Approximate costs range from 25% to 50% less than conventionally placed concrete.
- **Driving Variables:** Savings depend on aggregate costs, placement complexity, and total concrete volume.
- **Source of Savings:** Reduced forming, placement, and compaction costs combined with shorter construction windows.

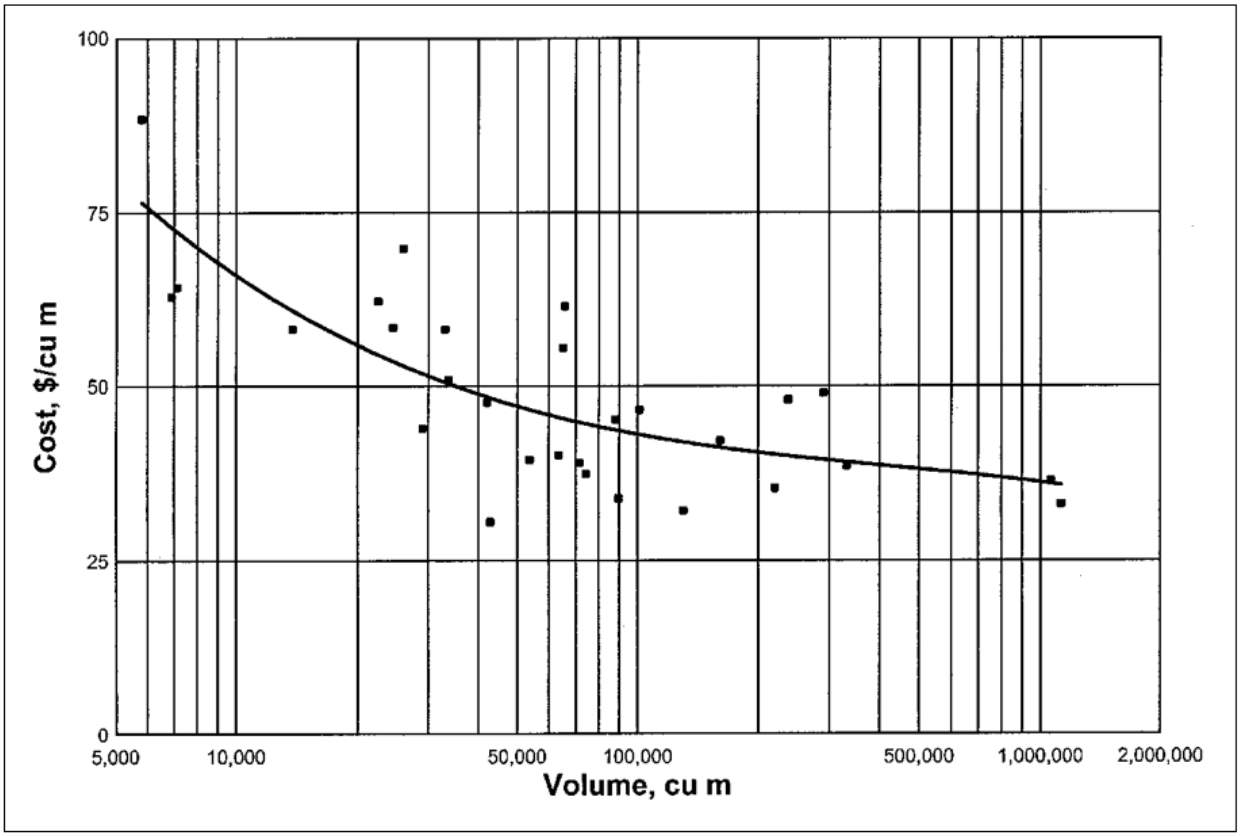

Figure 1-1. RCC costs (1998 price level)

Rapid Construction

The RCC process encourages near-continuous placement, enabling very high production rates.

- **Schedule Reduction:** Construction time for large projects can be reduced by several months to several years.
- **Administrative Benefits:** Rapid builds lead to lower administration costs and earlier project benefits.
- **Site Flexibility:** Shorter timelines may allow the use of dam sites with limited construction seasons.

Integral Design Features

RCC allows spillways and appurtenant structures to be incorporated directly into the main structure.

- **Spillways:** Typical layouts discharge flows over the dam crest, which is generally more costly in embankment dams requiring separate abutment spillways.
- **Intakes:** Intake structures can be anchored to the upstream face rather than requiring freestanding towers.
- **Foundations:** Shorter base dimensions compared to embankment dams reduce the length of conduits and penstocks and lower foundation preparation costs.

Diversion and Cofferdam Benefits

- **Reduced Risk:** Shorter construction periods decrease the probability of high-water events during the build.
- **Erosion Resistance:** RCC's high erosion resistance minimizes damage if a cofferdam is overtopped.
- **Diversion Logistics:** Diversion conduits for RCC dams are typically shorter than those for embankment dams.

Engineering Responsibilities

The design team must balance structural requirements with material performance and construction specifications to achieve a cost-effective design.

Critical Analysis Requirements

- **Feasibility:** Perform preliminary thermal studies to establish gross performance.
- **Design Phase:** Conduct detailed thermal studies to identify specific crack control features.

Multidisciplinary Coordination

- **Geotechnical:** Evaluations of foundation conditions by geologists or geotechnical engineers.
- **Hydraulic:** Evaluation of spillway and outlet structures.
- **Structural:** Design of the dam structure.
- **Materials:** Mixture design and coordination of construction requirements.

Checkpoint Quiz

1. **Which term is no longer considered acceptable for use in engineering documentation?**
   a) No-slump concrete
   b) Rollcrete
   c) Roller-compacted concrete
   d) Vibrating roller compaction

Answer: (b). The terms "rollcrete" and "rolled concrete" are no longer to be used.

2. **What is the primary reason RCC is considered an economically competitive alternative to embankment dams for projects with integral spillways?**
   a) It requires less aggregate than embankment dams.
   b) Embankment dams require separate, costly spillway structures in the abutment or a natural saddle.
   c) RCC does not require foundation preparation.
   d) Embankment dams cannot be used in high seismic areas.

Answer: (b). Embankment dams usually require separate spillways, which are generally more costly than integral RCC spillways.

3. **When should a detailed thermal study be performed to identify specific crack control features?**
   a) During the feasibility stage only.
   b) After the dam is filled.
   c) During the preconstruction engineering and design (PED) phase.
   d) Only if the project uses multiple RCC mixtures.

Answer: (c). A detailed study is performed during the PED phase to better identify crack control features.

Purchase this course to see the remainder of the technical materials.