

EXECUTIVE SUMMARY

A rockery is a retaining or protection structure that consists of stacked rocks without mortar, concrete, or steel reinforcement. Although the rocks are stacked in an “interlocking” pattern, there are no mechanical connections made between the individual rocks. Rather, these structures rely on the weight, size, shape, and interface friction of the rock elements to provide overall stability. Other “structures,” such as riprap revetments, dry-stack rock walls, and grouted rock walls, use rocks as a primary construction material, although they are not considered rockeries.

For the purpose of this study, a rockery is defined as an engineered system of stacked angular rocks placed without mortar in an approximate “running bond” pattern. Rock dimensions are generally greater than 450 mm (18 in) and rock weights generally greater than 90 kg (200 lb). Stability of the system is achieved through the mass of the rocks and inter-rock friction. A rockery can be defined as either **protecting** (i.e., it only supports itself and armors the underlying slope) or **retaining** (i.e., it supports itself and resists lateral earth pressures).

Worldwide, unreinforced stone structures have been constructed for thousands of years. In the United States, rockeries still exist that were constructed in the late 1800s. However, it is doubtful these historic rockeries were “engineered” in the current sense of the term. In addition, rockeries were constructed along many Forest Highway and National Park roads by manual labor in the 1930s with various levels of quality. Many of these roads have subsequently become part of the national highway system, and some of the rockeries are still in use today. The Federal Lands Highway (FLH) Division of the Federal Highway Administration (FHWA) continues to find situations where new rockery construction would be advantageous or where repair or modification of existing historic rockeries is required. In 2005-06, rockeries were designed and constructed by the FLH for the Guanella Pass Road project in the Pike and Arapaho National Forests in Colorado. Commercially, rockeries have been constructed in the Pacific Northwest for the past four decades, and have seen increasing use in northern California and Nevada over the last 10 years.

The objectives of this study are to review existing analytical methods and construction techniques currently in use and to develop a unified framework for design and specification of rockeries in modern highway construction. The ultimate goal of the project is to provide designers, inspectors, and contractors with a basis for evaluating existing rockeries and specifying and constructing new rockeries.

The recommended design procedure is analogous to the design of gravity retaining walls. The rockery is designed to resist static and seismic earth pressures and lateral pressure surcharges that are defined using traditional retaining wall design concepts. Accordingly, the rockery is checked for an adequate factor of safety against sliding, overturning, and bearing capacity failure. Additionally, an allowable displacement method for seismic design proposed by Richards and Elms (1979) for gravity walls is provided for cost-effective rockery design.

Using the recommended design procedure, gravity rockeries can generally be constructed to between 2.4 m (8 ft) and 3.7 m (12 ft) tall in fill conditions without geogrid reinforcement, and up to 4.6 m (15 ft) as a facing for a mechanically stabilized earth (MSE) fill. Regardless, a maximum single-tier height of 4.6 m (15 ft) should be used in cut or fill conditions. Taller rockeries should be tiered.

For most civil works, the performance of a structure is directly related to the quality of construction. For a rockery, this concept is magnified several times by the fact that rockeries are constructed from irregularly shaped, naturally occurring materials. Therefore, this study provides recommendations for constructing and specifying rockeries consistent with the recommended design procedure. Standard rockery plans and specifications, compatible with the Federal FP-03 specification format, have been developed in conjunction with FLH. Field inspection checklists and forms are also included to aid in construction observation services.