

CHAPTER 1 – INTRODUCTION

The Federal Lands Highway Division (FLH) of the Federal Highway Administration (FHWA), along with its partner federal land management agencies (FLMA's), is responsible for the repair, rehabilitation and construction of roadways within our nation's forests, parks and refuges. By promoting a "Light on the Land" construction philosophy, FLH projects further seek to preserve sensitive historic, cultural and other similar environmental features, including unique geologic features and man-made structures. Preservation requirements, which can be particularly stringent within National Parks, often call for stabilization measures that do not impact or detract from the historic, visual, or aesthetic significance and appeal of the feature.

Identified as a technology for helping transportation projects meet these preservation requirements, polyurethane resin (PUR) injection, often referred to as "rock gluing", has been used since the 1960's to stabilize unstable strata units in underground coal mines. The successful application of these high-density polyurethane grouts quickly became a popular and cost effective alternative to traditional mining roof control technologies. Shortly after introduction of this technology to the U.S. mining industry, polyurethane and epoxy resins began to be used for stabilizing roadways and concrete structures, including historic buildings and bridges. Review of the existing state-of-practice suggests that polyurethane resin injection has a wide range of applications useful for transportation and historic or environmentally sensitive features. Figure 1 depicts the cured form of the PUR within a test sample cast at a project site.



Figure 1. Photo. PUR and rock fragments test sample prepared at project site.

Polyurethane resin (PUR) injection has been employed for civil applications, including:

1. Soil stabilization;
2. Roadway subsidence remediation;
3. Tieback anchor repair;
4. Slope stabilization;
5. Tunnel repair;
6. Concrete structure rehabilitation; and
7. Erosion control.

These applications have employed both one- and two-phase component mixes that are easily transported, require only modest equipment to inject, and are environmentally inert once fully cured.

The objective of this study was to evaluate the application of PUR technologies for the preservation and/or rehabilitation of historic structures, unique geologic features, tunnels and other environmentally sensitive features typically found on public lands. Based on the findings of two field evaluations and an extensive literature search, this manual summarizes current PUR injection practices for stabilizing sensitive historic, cultural and environmental features and provides general guidelines for the use and specification of (PUR) products. More specifically, the following topics are addressed:

1. Review and general description of cement and chemical grouts.
2. Applications of polyurethane and epoxy grouts.
3. Hydrophilic and hydrophobic interaction of polyurethane with water.
4. Case histories in which polyurethane products have been used.
5. Field demonstrations depicting applications of the technology for highway related use for rock slope and dry-stack retaining wall stabilization and mitigation.
6. Considerations/specifications for implementation of polyurethane technologies.
7. Procurement specification and constructability issues related to PUR product systems.

This report has been developed to serve as an FLH reference for projects where stabilization of similar features may require PUR injection methods. In addition, federal land management agencies, state departments of transportation (DOT) and others may also find the results and recommendations provided herein useful.