CHAPTER 1 – INTRODUCTION

Hollow bar soil nails (HBSNs) have been used in the United States (US) in earth retention systems for over 10 years. HBSNs are commonly used in place of solid bar soil nails (SBSNs) when the solid bar installation would require temporary casing of the hole. For permanent structures in corrosive environments where failure of the structure could result in loss of life, personal injury or significant property damage, the general approach has been to not use HBSNs. For such applications the use of SBSNs with factory-installed encapsulation-type of corrosion mitigation measures is preferred. However, regardless of these concerns, the use of HBSNs has increased steadily. Therefore, the FHWA initiated a systematic evaluation of HBSNs. As a first step, a state-of-the-practice (SOP) report was prepared by the authors for the Federal Highway Administration (FHWA) in 2006 (FHWA, 2006) to identify (a) peculiarities of HBSNs in comparison with conventional SBSNs, and (b) areas of further research that would help agency personnel and design professionals understand the potential of HBSNs as a mainstream technology for permanent soil nail applications. Chapters 1 and 2 of FHWA (2006) provide information on HBSN and SBSN technologies. The reader should review FHWA (2006) to gain a better appreciation of the two technologies. A free copy of the FHWA (2006) document can be downloaded from http://www.cflhd.gov.

FHWA (2006) identified a number of specific areas for further study and research. One of these areas was corrosion mitigation guidance. Based on the 2006 FHWA report and the additional studies performed by FHWA in collaboration with the Association of Drilled Shaft Contractors – The International Association of Foundation Drilling (ADSC), it is recognized that the surrounding grout body and/or bar coatings cannot be reliably counted on to protect HBSNs in corrosive environments. Therefore, the study in this report was commissioned to investigate the efficacy of various corrosion mitigation measures in the context of HBSNs.

In general, both HBSNs and SBSNs are encased in a grout body, which is understood to provide one level of corrosion protection. Centralizers are typically used to assure that the grout cover has a minimum thickness over the length of the nail. However, even if centralizers are used, HBSNs will probably not have the same degree of grout cover uniformity as SBSNs given the fundamental differences in the way each type of nail is installed. As noted in FHWA (2006) the grout body can crack under tensile strains regardless of whether HBSNs or SBSNs are used for retaining walls. Bending stresses can further contribute to the cracking of the grout body. Once the grout body has cracked, the cracks that penetrate the full depth of the grout can provide pathways for corrosive elements to reach the steel bar. In the case of SBSNs, encapsulation in corrugated sheaths can provide positive protection against corrosion, but in the case of HBSNs any coating or galvanization may be suspect because it might be damaged during the installation processes. The potential for corrosion in HBSNs may be further enhanced by the fact that greater pullout resistances are often assumed for HBSN applications that may result in greater tensile loads and associated strains leading to an increased potential for cracking of the grout body. Thus, the corrosion issue takes on more importance for HBSNs. The purpose of this study is to explore corrosion issues with respect to HBSNs. It may be noted that some of the issues explored in this report are equally applicable to SBSNs, e.g., cracking of the grout body under

tensile strains. Thus, the recommendations developed herein may also be considered for walls with SBSNs.

SCOPE OF THE WORK

This work concentrates on the collection of existing data related to corrosion and corrosion mitigation of HBSNs and on providing guidelines to evaluate the corrosion phenomena in HBSNs. The scope of the work for the present study is as follows:

- Preparation and distribution of a questionnaire to evaluate various parameters for HBSNs as they relate to corrosion,
- Preparation of a summary of responses to the questionnaire and observed trends,
- Review of existing corrosion mitigation guidance and issues, and
- Identification of parameters to be considered in HBSN corrosion studies.

ORGANIZATION OF THE REPORT

Chapter 2 identifies the various factors that can affect the corrosion of HBSNs. In Chapter 3, the questionnaire development and its distribution are discussed. Chapter 4 presents a summary of the responses to the questionnaire. Chapter 5 presents an overview of the existing corrosion guidance and issues related to soil nails in the US and international practice. Chapter 6 identifies parameters that should be considered in HBSN corrosion studies. Conclusions and recommendations are presented in Chapter 7.

As alluded to earlier, this report builds on the information presented in FHWA (2006). Therefore, it is assumed that the reader is familiar with the 2006 report. If not, then the reader should obtain a copy of the 2006 report and study it in conjunction with this report. As noted earlier, a copy of the 2006 report may be obtained from Central Federal Lands Highway Division (CFLHD) of the FHWA located in Lakewood, Colorado, USA, or from its website http://www.cflhd.gov/.

Units

English units are the primary units in this report. SI units are included in parenthesis in the text. Where SI units are reported in referenced material they are maintained as primary units, e.g., the CEN (2009) reference shown in Tables 5 and 6 in Chapter 5. In this case, the English units are included in the parenthesis. In either event, all unit conversions are “hard,” resulting in rounded and rationalized values.