CHAPTER 7 – CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of an industry survey related to the use of HBSNs with respect to various criteria currently used to identify corrosion potential and current practices to protect against corrosion. Based on the responses it was found that there is a lack of guidance on corrosion protection, which is limiting the use of HBSNs for permanent soil nail wall applications. For example, the answers to some of the questions suggest that there is an overall lack of consistent assessment of corrosivity and an absence of any application of corrosion mitigation. Many respondents admitted to not even testing for or addressing soil corrosivity. This suggests that procedural guidance is critically required.

There are three major considerations related to the corrosion of HBSNs:

1. Performance of protective coatings during the installation process,
2. Cracking of the grout body, and
3. Metallurgy of HBSN steel.

Based on the results of this study, the following conclusions are made:

1. A coating, whether by fusion bonded epoxy, galvanization, metallization, or a combi-coating, has a finite life that may be less than the routine design life of 50 to 75 years for a permanent retaining wall even under ideal conditions. From the photos in Figure 1 it is apparent that damage to epoxy coatings is inevitable due to the rotary "whipping" action of HBSNs during installation. The same type of damage may be expected in other coatings. Therefore, the effective service life of coatings may be severely shortened in HBSN applications. The potential for excessive coating damage during installation seems to be the biggest differentiator between the SBSN and HBSN applications for permanent walls. This is not to say that coatings of SBSNs are completely free of damage due to nicks and scratches during handling and installation. If corrosion protection of HBSNs can be assured by some other means, then more confidence can be developed in the use of HBSNs for permanent applications on a par with the use of SBSNs. The obvious options for HBSNs are to concentrate on the grout body and its performance in addition to the use of sacrificial steel.

2. The potential for corrosion of HBSNs because of damaged coatings can be minimized by assuring that the grout body is not compromised. The development of cracks in grout appears to be a function of a variety of factors. These factors are identified in the report. Once cracks form in the grout body, corrosive elements can migrate through the cracks and initiate corrosion of the soil nail steel if the coating has been compromised. Of course, the corrosion potential in the bar is also a function of whether or not the cracks in the grout body occur at or near the location of damage to the coating. However, since damage to coatings due to the installation process is random and cannot be quantified reliably, an assumption has to be made the probability of the occurrence of a crack at the location of coating damage is great enough so that the onset of corrosion cannot be discounted. In this context, the

cracking of the grout body becomes very important since it is applicable to both SBSNs and HBSNs because both are susceptible to some level of coating damage.

3. At this time the metallurgy of HBSN steel is not regulated and the source of HBSNs available in the marketplace today can be traced to a variety of international sources, which may not be regulated in accordance with US standards. Thus, although high strength is claimed by various manufacturers, the HBSNs available in the US marketplace may have distinctly different behavior in terms of ductility and corrosion characteristics.

4. Numerous sources of information and personal communications reveal that there are several on-going studies in Europe related to corrosion mitigation that are at an advanced stage. Based on the review of US and international practice presented in Chapter 5, it appears that the European guidance in this regard is superior to the current US guidance in terms of scope and clarity in assessment of soil corrosivity (Tables 3 and 4) as well as in the estimation of the magnitude of steel loss (Table 5) and thickness of grout cover (Table 6).

In view of the uncertainties related to the current US practice for corrosion mitigation and the lack of uniform procedural guidance in this regard, the following recommendations are made:

1. It is recommended that field, laboratory and numerical simulation studies be performed to assess the factors that influence the development of cracks in grout as discussed in Chapter 6. In this context, it is recommended that formal contact be initiated with researchers in Europe to further understand their on-going experiments. Knowledge of the details of their investigations and an independent evaluation of their results may help to define the details of the study program described in general in Chapter 6.

2. At this time it seems to be more appropriate to concentrate on the concept of sacrificial steel as the preferred method of corrosion mitigation for HBSNs. Therefore, it is recommended that the guidelines in Tables 3 through 6 based on European studies described in Chapter 5 be considered as the interim guidance for corrosion mitigation in the US. Use of larger nail cross-sections to account for corrosion loss over the design life of the structure will also help limit the potential for the formation of grout cracks due to tensile strains in nails during proof testing.

3. For all HBSN projects the performance of at least one suite of all applicable tests noted in Table 4 for each geologic unit anticipated to be encountered within the soil nailed mass should be made mandatory as a part of the soil nail design process. The distribution of the geologic units may be determined based on the recommended subsurface investigation program outlined in FHWA (2003).

4. The requirements of ASTM A615 (AASHTO M 31) should be made mandatory for all HBSNs. This will serve to regulate the metallurgy of HBSN steel to be conformance with the US standards.