



Hydraulics Engineering Instructions (HEI)

Distribution: Structures, Bureau Chiefs, Chief of Contract Admin., Consultants

Approved: _____

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Subject: **Horizontal, Vertical, and Local Abutment Scour: Bed Material Stratification Considerations & Guidance**

Administrative Information:

Effective Date: This HEI shall be considered effective for the Structures & Hydraulics Section from the date of approval.

Superseded HEI: None.

Exceptions: None.

Disposition of HEI Content: The technical information transmitted by this HEI will be incorporated into the next revision of the VTrans Hydraulics Manual.

Purpose:

The VTrans Hydraulics Manual does not provide guidance on bed armor layer or bed material stratification considerations as it relates to scour evaluations. VTrans will now provide such guidance.

Technical Information:

FHWA recommends that VTrans considers bed stratification when evaluating horizontal and vertical contraction and local abutment scour potential. Based on this feedback, VTrans provides the following guidance:

References:

Federal Highway Administration, 2012b, "Evaluating Scour at Bridges" [Report FHWAHIF-12-003 Hydraulic Engineering Circular No. 18](#), Washington, D.C

Federal Highway Administration, 2023, "Highways in the River Environment: Roads, Rivers, and Floodplains" [Report FHWAHIF-23-004 Hydraulic Engineering Circular No. 16](#), Washington, D.C

Federal Highway Administration, 2012b, "Stream Stability at Highway Structures" [Report FHWAHIF-12-004 Hydraulic Engineering Circular No. 20](#), Washington, D.C

United States Bureau of Reclamation, 1984, "[Computing Degradation and Local Scour](#)", Technical Guideline for Bureau of Reclamation

Definitions:

Armoring occurs naturally when the hydraulic forces (drag and lift) are sufficient to transport smaller particles within the streambed material but insufficient to move the coarser material. Under these conditions, the smaller material is transported and removed from the bed leaving the coarse material or an armor layer known as the **Bed Armor Layer** or **Channel Armoring**. Armoring will also form naturally as flow recedes following a storm event, coarse material ceases motion, and finer material continues to be transported downstream. Artificially, an armor layer can be created by placing large rocks to resist erosion.

Compromised Streambed Material occurs when the bed material, specifically the armor layer, is removed via fluvial geomorphic processes such as headcutting or is obstructed by large debris during extreme flow events. Therefore, exposing substrate layers to hydraulic forces.

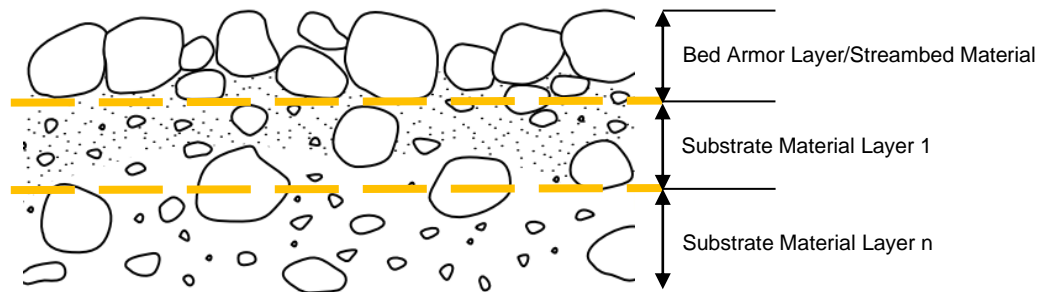


Figure 1: Stratified Bed Material



Figure 2: Example of Bed Armor Layer and substrate layers (image taken from HEC-16)

Guidance:

Bed material stratification as shown in Figure 1 and 2 shall be considered when evaluating horizontal and vertical contraction scour and local abutment scour. If there is potential for compromised streambed material, the streambed and substrate material gradations shall be considered to determine if a live-bed or clear-water scour condition is experienced.

Streambed Material considerations to determine the potential of a compromised streambed during the lifetime of the crossing:

The considerations are listed below for convenience and are not limited to the following.

- Will the streambed/armor layer be compromised at the approach and bridge (contraction) section during a large event by large debris, downstream head cutting, nickpoint, degradation, etc.?
 - Is there more potential for streambed degradation, aggradation, channel widening, channel incising, etc.?
 - In addition to section 7.2 of the VTrans Hydraulics Manual, refer to FHWA Publication No. FHWA-HIF-12-004, Stream Stability at Highway Structures (HEC-20), Section 6.4 for additional guidance.
- Is the Streambed/Armor Layer consistent across the channel? Are there portions that are already compromised?

Non-Compromised Streamed Material Guidance:

Clear-Water Scour Evaluation:

- If the bed armor layer is scoured away within the crossing during the design event, and the streambed material size at the approach indicates a clear-water condition, for stratified bed material the depth of scour can be determined by using the horizontal contraction and local abutment clear water scour equation sequentially with successive D_{50} of the substrate material layers.

Live-Bed Scour Evaluation:

- If the bed armor layer is mobile at the approach section during the design event. Perform the scour evaluation using the horizontal contraction and local abutment live-bed scour equation.

Compromised Streamed Material Guidance:

Clear-Water Scour Evaluation:

- In cases where the bed armor layer or streambed material is compromised at both the approach and bridge section, and the substrate material size indicates a clear-water condition, for stratified bed material the depth of scour can be determined by using the horizontal contraction and local abutment clear water scour equation sequentially with successive D_{50} of the substrate material layers.
- If the substrate material at the approach section is not attainable. The substrate gradation at the approach section can be assumed to be the same as the bridge section substrate gradation.

Live-Bed Scour Evaluation:

- In cases where the bed armor layer or streambed material is compromised at both the approach and bridge section, and the substrate material size indicates a live-bed condition, the live-bed contraction and local abutment

scour values can be used. In these cases, the bed armor layer and/or streambed material can be ignored.

- If the substrate material at the approach section is not attainable. The substrate gradation at the approach section can be assumed to be the same as the bridge section substrate gradation.

Implementation:

The content of this HEI will be implemented immediately on all projects.

Transmitted Materials:

No supplemental materials are transmitted with this HEI.