- Direction of Flow

For design for the most critical flow and the superflood condition, the following criteria shall be used unless more severe criteria is recommended in the Drainage Report.

Design calculations of stream forces on piers over natural water courses shall assume a 0.6 meter increase in pier width per side due to blockage by debris with a shape factor k = 1.40 for the first 3.5 meters of depth. For flows with depths greater than 3.5 meters, only the top 3.5 meters shall be assumed blocked by debris with lower sections using the actual pier width and a shape factor in accordance with AASHTO. For uncased drilled shafts, a 20% increase in diameter should be assumed to account for possible oversizing of the hole and any irregular shape. The force distribution on the pier shall be assumed to vary linearly from the value at the water surface to zero at the bottom of the scour hole as described in AASHTO.

When the clear distance between columns or shafts is 5.00 meters or greater, each column or shaft shall be treated as an independent unit for stream forces and debris. When the clear distance is less than 5.00 meters the greater of the two following criteria shall be used: 1) Each column or shaft acting as an independent unit or 2) All columns or shafts acting as one totally clogged unit with 0.6 meters of debris normal to the flow added on each end.

The average main channel velocity for the appropriate flow condition shall be used in calculating the stream forces. The water surface elevation shall be the high water elevation for the appropriate flow condition. A minimum angle of attack of 15 degrees shall be assumed.

Scour may be categorized into two main types: general and local. General scour is the permanent loss of soil due to degradation or mining while local scour is the temporary loss of soil during a peak flow. Local scour may consist of two types: contraction scour and local pier or abutment scour. Contraction scour occurs uniformly across the bridge in the stream width. Local pier and abutment scour occurs locally at substructure units due to the turbulence caused by the presence of the substructure unit.

Bridges over natural water courses shall be investigated for four different streambed ground lines. Refer to Figure 200.01 for an illustration of these cases.

Case 1 represents the "as-constructed" stream cross section. For this case, the bridge shall be designed to withstand the forces from the AASHTO Groups I to VII load combinations.

Case 2 represents the long term dry streambed cross section, i.e. the "as-constructed" stream cross section minus the depth of the general scour. For this case, the bridge shall be designed to withstand the same forces as for Case 1. The requirements contained in AASHTO 4.4.5.2 need not be met.

Case 3 represents the streambed cross section condition for the most critical design flow. Abutment protection is designed to withstand this event and abutments may be assumed to be protected from scour for this condition. Piers will experience the full general and critical flow local scour. For this case, the bridge shall be designed to withstand the forces from the AASHTO Groups I to VI load combinations.

Case 4 represents the streambed cross section conditions for the superflood condition. For this case, all bank protection and approach embankments are assumed to have failed. Abutments and piers should be designed for the superflood scour assuming all substructure units have experienced the maximum scour simultaneously. For this case, the bridge shall be designed to withstand the following forces: DL + SF + B + 0.5W. For members designed using the WSD Method an allowable overstress of 140% shall be used. For members designed using the LFD Method a gamma factor of 1.25 shall be used.