Reid,

See my answers in red to your questions below. Let me know if you have more questions.

Hope this helps,
Arielle

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DEPARTMENT OF TRANSPORTATION

From: Reid Castrodale [mailto:reid.castrodale@castrodaleengineering.com]
Sent: Tuesday, February 5, 2019 3:56 PM
To: Ehrlich, Arielle (DOT) <arielle.ehrlich@state.mn.us>
Subject: MnDOT "hat" bar detail

Arielle,

I am preparing for a PCI regional association meeting with our DOTs on Thursday (GA, NC, SC).

One item on our agenda is the use of “hat” bars to extend stirrups when the stool or build up is higher than usual.

I was looking in the MnDOT Bridge Design Manual the other day as I was reviewing your article for *ASPIRE* (which was very well written – thanks!) and stumbled across the hat bar detail. I have extracted it from the manual – see attached.

Do you have any design criteria beyond what is discussed that was used to develop the detail? No

Has the detail worked well? Yes

Also, I was a bit surprised to see 4 in. clear on each side from the hat bar to the face of the stool. What is the reason for such a large cover? We understood that we needed 2-#4 bar legs to match that of the stirrup, and the width wasn’t really important. The contractor often has brackets in the outside 4”, so we wanted to leave adequate space.

Do you often use bars with different leg heights to accommodate cross slopes? Or is that only required when the cover requirements can’t be satisfied on both sides? Typically, we would use the same leg height on both sides, but we allow for different leg lengths when the cross slope dictates. It doesn’t happen often, but we have done it on occasion.

I see that the hat bar is not allowed to sit on the top of the girder, but it is pulled up for 1 in. clear. What was the reason for that, and has it worked well in the field? The bar is held up an inch to provide some concrete cover. It prevents the bar from sitting right at the cold joint where moisture could potentially get to the bar and cause deterioration. To the best of my knowledge, it has worked well.

Have longitudinal bars at the bottom of the hat bars been considered to enhance the anchorage at the bottom? That is a detail I have seen somewhere. The reason the details requires the leg to come up over the bottom longitudinal bars is to help anchor the bars. We’ve seen that detail a couple of times, but we don’t really think there’s a need.

Has any testing been done on the detail – or do you know of others who may have tested such a detail? No

Thank you for any input that you can provide for us on this.

Best regards,

Reid

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hold-down force and the number of draped strands required. Keep in mind that changes may affect the mid-beam stresses.

End Strength at Top of Beam

If the required initial strength is greater than 7.0 ksi, raise the center of gravity of the strands at the end of the beam. This can be accomplished by draping strands that were previously straight or increasing the height of the draped strands.

Midpoint Strength at Top of Beam

If the required initial strength is greater than calculated at the bottom end or midpoint:

1) The center of gravity of the strands may be moved higher at the center.
2) The number of strands may be reduced to decrease the required strength.

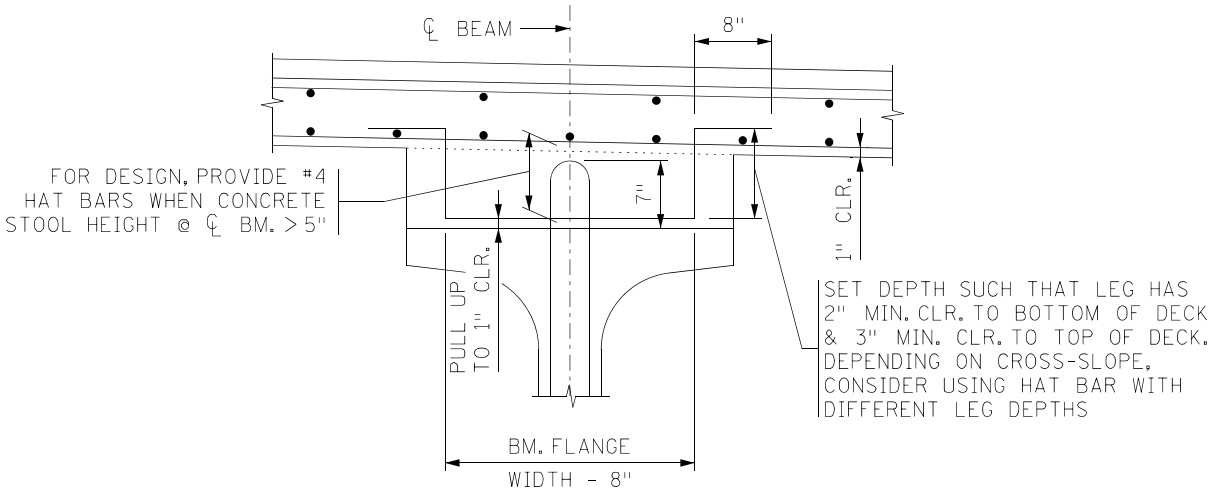
If the guidance above results in an initial concrete strength greater than 7.0 ksi, the initial strength may be increased up to a maximum value of 7.5 ksi. Note that this will likely increase the beam cost.

Ensure that adequate shear and splitting reinforcement is provided in the ends of beams. The maximum size for stirrup bars is #5. Based on the concrete mix used for prestressed beams, the minimum stirrup spacing is $2^1/_2$ inches. If the required amount of reinforcement cannot be provided within $^h/_4$ of the end of the beam, provide the remainder at a $2^1/_2$ inch spacing.

Design shear reinforcement using the "General Procedure" provisions given in LRFD Article 5.8.3.4.2.

Horizontal shear reinforcement must be provided to ensure composite action between the beam and deck. MnDOT standard beam sheets accomplish this by extending the beam stirrups into the deck (G402E & G508E with 7" projection for RB, M, MN shapes and G404E & G508E with 7¼" projection for MW shapes). In order to ensure composite action, the shear reinforcement must extend into the deck far enough to engage the deck bottom mat of reinforcement. Check the stool heights over the length of the beams. For regions where stool heights are found greater than 5 inches at beam centerline, do not increase the stirrup length or pull up the stirrups, but rather provide #4 "hat" shaped bars as shown in Figure 5.4.3.2. Set the leg depth to provide 2 inches minimum clear to the bottom of deck and 3 inches clear to the top of deck for the upper hook, and 1 inch clear from the bottom of the bar to the beam flange. In

cases where field personnel report excessive stools not anticipated in the bridge plan, discuss with them whether one "hat" bar or two "Z" bars would be better for rebar placement.



HAT BAR FOR BEAMS WITH LARGE STOOL HEIGHTS

Figure 5.4.3.2

Due to the height of the "MW" series beams, investigate whether a deck pour sequence is needed to reduce the effects of beam end rotation on the end region of the deck.

5.4.4 Detailing/ Reinforcement

Identify the beam type on the beam sheet by depth in inches and length rounded to the next highest foot. In the superstructure quantities list, identify the beam type by depth. For example, an MN45 beam, 72'-4" long would be "MN45-73" on the beam sheet and "MN45" in the quantities list. Group beams of similar lengths with the same strand pattern into one type on a beam sheet. The pay item quantity will be the total length of beams (of each height) in feet.

On the framing plan, show the beam and diaphragm spacing, staging, type of diaphragms, centerline of piers, centerline of abutment and pier bearings, working points, beam marks (B1, B2 etc.), the "X" end of beams, and the type and location of bearings. One end of each beam is labeled the "X" end after fabrication. This is used during erection to ensure that the beams are properly placed. Many times diaphragm inserts are not symmetric and beams can only be placed one way.

5.4.5 Camber and Deflection

The standard beam sheets contain a camber diagram where designers are to provide camber information. Knowing the deflection values