DATE: January 29, 1993

TO: All Bridge Designers

FROM: A. J. Siccardi

SUBJECT: Technical Memorandum #12
Haunch for Precast Concrete Deck Panels

When precast concrete deck panels are to be used on a bridge, the haunch sizing procedure outlined below shall be used. The Contractor is allowed the option of using precast concrete deck panels when the following items are included in the contract documents:

1) The note "PERMANENT DECK FORMS ARE OPTIONAL" (usually located within the General Notes),
2) CDOT Staff Bridge Worksheets B-601-4_ and B-601-5_, and
3) Special Provision Revision of 601, Alternate Bridge Deck Forms.

The use of precast concrete deck panels makes the dimension used for the girder haunch critical since a minimum of 1" clearance beneath the precast concrete deck panel is essential.

PRECAST PRESTRESSED CONCRETE GIRDERS

The haunch for a precast concrete girder, measured from the top of the girder to the bottom of the deck, most account for the effects of roadway geometry, predicted camber, dead load deflection, prestressed girder production tolerances, and 1" clearance beneath the precast concrete deck panel.

The effects of roadway geometry, which include sag vertical curves, crest vertical curves, grade, superelevation, superelevation transitions, and horizontal curvature, must also be taken into account when sizing the girder haunch and when establishing girder seat elevations.

The prestressed girder worksheets have been revised to specify PCI MNL-116, except as noted on the plans, as the specification for prestressed girder dimensonal telerances. The following are key tolerances for three particular girder types:

Box Girders	I-Girders	Bulb T-Girders
Camber:		
±1/8" per 10 ft	±1/8" per 10 ft*	±1/4" per 10 ft
±1/2" max.*	±1/2" max. up to 80 ft	±3/4" max.*
	±1" max. over 80 ft	
Depth:		
+1/2", -1/4"	±1/2", -1/4"	±1/4"

* Tolerance may not apply when the span to depth ratio approaches or exceeds 30.

Setting the camber tolerance equal to 1" for all sections is conservative since the actual span to depth ratio is usually less than 30 for sections presently in use. Adding the camber tolerance (1") to the depth tolerance (1/2") yields 1 1/2".

Bridge Design Manual Subsection 9.1, originally dated March 20, 1989 (and subsequent revision dated May 1, 1992), requires the design of a prestressed girder "...be such that no design changes or rebar shifts will be needed if the predicted camber is exceeded by 1.5 inches." The 1.5" is the sum of the 0.5" added to the camber by PRESGIR and the 1" cover beneath the bottom mat of transverse deck reinforcing steel. Since the girder cannot project above the bottom of the precast concrete deck panel, 1" must be added to the haunch. Historically, the 1.5" has not accounted for the girder depth tolerance therefore, the girder depth tolerance should be considered as being part of the 1.5".

Presently, PRESGIR gives the minimum haunch for a simple span prestressed girder as follows:

CAMBER AND GIRDER DL + SUM OF OTHER DEAD LOADS =
TOTAL DEFLECTION

TOTAL DEFLECTION + 0.5" = MINIMUM HAUNCH

(The SUM OF OTHER DEAD LOADS is the sum of the non-composite dead load deflection and the composite dead load deflection.)

The 0.5" added to the TOTAL DEFLECTION needs to be changed to 2.5" due to the 1.5" added to comply with Bridge Design Manual Subsection 9.1, plus 1" added for the minimum clearance between the girder and the precast concrete deck panel. PRESGIR will be revised to change 0.5" to 2.5". In the mean time, designers need to adjust the PRESGIR results by hand accordingly.
Taking the value for predicted camber from the CAMBER AND GIRDER DL column reported by PRESGIR, adding the camber tolerance (1"), the depth tolerance (1/2"), the effect of superelevation on half the flange width, the clearance beneath the precast concrete deck panel (1"), and the dead load deflection yields the following expression for minimum haunch:

MINIMUM HAUNCH = CAMBER AND GIRDER DL + 2 1/2" +
DL DEFLECTION + SUPERELEVATION FT/FT x (FLANGE WIDTH)/2 +
OTHER APPLICABLE ROADWAY GEOMETRY CONSIDERATIONS

Designers are advised that the minimum haunch from PRESGIR does not include the effects of roadway geometry and must be taken into account when sizing the haunch.

The value to use for DL Deflection (Δ on the prestressed girder worksheets) is the sum of the non-composite dead load deflection (not including girder dead load deflection) and the composite dead load deflection reported by PRESGIR. For multiple span structures, the composite dead load deflection may be more accurately modeled by the deflection (multiplied by 3 for long term deflection) from a continuous beam analysis since the load is applied when the girder has been made continuous.

The attached prestressed girder worksheets, B-618-BX and B-618-54 have been revised as noted by the areas circled. Worksheets B-618-68 and B-618-72 have been similarly changed but are not attached. Of the changes made, one involves the terminology used for elastomeric bearing pads. Designers are advised to refer only to elastomeric bearing pads, rather than elastomeric leveling pads, throughout the plans to be consistent with the Standard Specifications.

The use of precast concrete deck panels with the larger haunch may require other changes, such as increasing the projection of stirrups. Ranges of stirrup projections for the girder may be necessary to insure that a 2" minimum projection into the slab is attained.

STEEL GIRDERS

Rolled Sections

The haunch for a rolled section, measured from the flange to the bottom of the deck, must account for the effects of roadway geometry, induced camber (if any), dead load deflection, rolled section production tolerances, and fabricated girder tolerances. Usually, the only camber rolled sections have is that which is allowed by ASTM A6. ASTM A6 provides the following production tolerances for W shapes likely to be used as bridge girders:

Camber:

$$\frac{1/8'' \times \text{No. of ft of total [member] length}}{10}$$

Depth:

±1/8"

For a pictorial definition of the production tolerance terms, see the attached sheet containing selected tables from ASTM A6.

In addition, Subsection 509.21 (k) of the Standard Specifications allows the girder camber to deviate from the design camber as follows:

$$\frac{+1/4'' \times \text{length in ft between supports}}{25}$$

$$\frac{-1/8'' \times \text{length in ft between supports}}{30}$$

The fabrication tolerance as provided by AWS D1.5 Subparagraph 3.5.1.7 allows flange warpage and tilt to be 1/100th of the flange width or 1/4", whichever is greatest.

For a 60" simple span W shape girder, neglecting the effects of roadway geometry other than superelevation (0.02 ft/ft), with a 12" wide flange, including 1" clearance between the girder and the precast concrete deck panel, the minimum haunch is as follows:

MINIMUM HAUNCH = 2.25"

For a multiple span, continuous W shape girder with 60’ span lengths, neglecting the effects of roadway geometry other than superelevation (0.02 ft/ft), with a 12" wide flange, including 1" clearance between the girder and the precast concrete deck panel, the minimum haunch is as follows:

MINIMUM HAUNCH = 2.10" SAY 2.25"

The use of precast concrete deck panels may require other dependent changes such as increasing the edge distance of the shear connectors and increasing the projection of the same in the deck. A reduction in the number of shear connectors placed in a row along with a corresponding reduction in the longitudinal spacing may be necessary in order to accommodate the increased edge distance.

The effects of roadway geometry which include sag vertical curves, crest vertical curves, grade, superelevation, superelevation transitions, and horizontal curvature, must also be taken into account when establishing girder seat elevation.

Welded Plate I Sections

Since the fabricated shape of a welded plate girder incorporates the camber necessary for roadway geometry and DL deflection, the haunch, measured from the top of the web to the bottom of the deck, is relatively uniform throughout the length of the structure. The variation in concrete thickness above the flange is due to: 1) the fabrication tolerances allowed by AWS D1.5 and the Standard Specifications, 2) changes in flange plate thickness, and 3) changes in flange plate width.

The following is from AWS D1.5 Subparagraph 3.5.1.3:

"Permissible variation in specified camber of welded beams or girders, before erection, regardless of cross section, shall not exceed

0, +1/4", nor:

$$-0, +1/4" \times \frac{\text{No. of ft of test length}}{10}$$

but not to exceed 3/4", nor:

$$-0, +1/8" \times \frac{\text{No. of ft from nearest end}}{10}$$

whichever is greatest..."

Subsection 509.21(k) of the Standard Specifications, as given above, applies to welded plate I sections.

AWS D1.5 Subparagraph 3.5.1.7 allows flange width or 1/4", whichever is greatest.

Tolerance in the fabricated girder depth from that which is specified in the plans is provided by AWS. The following is from AWS D1.5 Subparagraph 3.5.1.8:
"The maximum permissible variation from specified depth for welded beams and girders, measured at the web centerline, shall not exceed

For depths up to 36 in. inclusive ±1/8 in.

For depths over 36 in. to 72 in. inclusive ±3/16 in.

For depths over 72 in. inclusive ±5/16 in., -3/16 in.

Bridge Design Manual Subsection 10.1.11, gives four factors which contribute to the dimension used for the haunch. The fourth factor is as follows:

"Excess haunch to allow for fabricating tolerance in girder camber; allow 1" for spans 100 feet or less. Allow 1-1/2" inch minimum for spans over 100 feet."

While the excess haunch is assigned only to the camber tolerance, the depth and flange tilt tolerances should also be included in the excess haunch. The sum of the tolerances for camber, flange tilt, and depth is shown graphically on the attached sheet titled Excess Haunch vs. Span Length.

The haunch expression for welded plate girders is as follows:

HAUNCH = K1 + K2 + K3 + K4 + K5 + 1", WHERE

K1 = CAMBER TOLERANCE:

3/4" FOR 30′ $\leq$ SPAN $\leq$ 75′

$\frac{1}{4}$" x $\frac{\text{SPAN}}{25}$ AT MIDSPAN FOR SPAN 75′

0" AT A POINT OF SUPPORT

K2 = (FLANGE WIDTH)/100, BUT NOT LESS THAN 1/4"

K3 = 1/8" FOR d $\leq$ 36"
3/16" FOR 36" < d $\leq$ 72"
5/16" FOR d > 72"

K4 = SUPERELEVATION FT/FT x (FLANGE WIDTH)/2

K5 = FLANGE THICKNESS

1" = CLEARANCE BENEATH PRECAST CONCRETE DECK PANEL

Use the greater of the haunch dimensions calculated at the supports and at the midspan locations.

The use of precast concrete deck panels may require other dependent changes such as increasing the edge distance of the shear connectors and increasing the projection of the same into the deck. A reduction in the number of shear connectors placed in a row along with a corresponding reduction in the longitudinal spacing may be necessary in order to accommodate the increased edge distance.

Welded Plate Box Sections

All of the aforementioned fabrication tolerances which apply to welded plate I sections apply to welded plate box sections. The dimension to use for the haunch is the same as the welded plate I section with the exception of the effect of superelevation on the flange. The flanges of a box girder are parallel to the cross slope of the deck thus, does not enter the haunch computation.

CLOSING

The elevation at which a girder seat is constructed has a direct bearing on the haunch size. Since the girder seat elevations are so important to the haunch, a project special provision has been created (see attached) which requires the Contractor to provide the Project Engineer with an as constructed survey of the substructure prior to girder erection. This survey provides details of the constructed girder seat elevations, anchor bolt locations, and anchor bolt projections. This project special provision should be used on all projects regardless of whether the Contractor has the option of precast concrete deck panels or not. Presently, the project special provision is in the process of becoming a standard special provision.

When precast concrete deck panels are allowed as an option, the total deck thickness must be adequate to provide cover for the top mat of reinforcing. Although unrelated to the haunch depth, this is another very important item that must be considered by designers when using precast concrete deck panels. For example, if an 8" deck with 3" of cover over the top transverse mat of reinforcing specifies #9 longitudinal reinforcing, the total thickness of the deck will need to be increased to accommodate the #9 longitudinal reinforcing if precast concrete deck panels are allowed.

Other than girder sweep for alignments with horizontal curvature, designers need not and should not consider additional fabrication dimensional tolerances as provided by PCI MNL-116, ASTM A6, or AWS D1.5. The effect of girder sweep is usually minor; however, designers must verify it does not significantly effect the haunch.

Remedial measures will be required whenever the clearance beneath the precast concrete deck panel is less than 1". The note concerning camber on the prestressed girder workshees states that the remedial measures taken "...shall be free of any adverse impact." The remedy selected will vary from situation to situation. For example, the roadway grade cannot be raised without impact if an adjacent structure shares the same PI of a vertical curve. Any remedial measure(s) selected shall be approved by and issued to the construction Project Engineer by the Staff Bridge Construction Assistance Unit. The followingremedial measures, which may be free of impact depending on the situation include, but are not limited to the following:

Where 0" < clearance beneath the deck panel < 1", pour a grout pad on the girder the width of the deck panel bearing area and set the deck panel on the plastic grout to insure complete bearing.

In the case of a precast concrete girder, check the depth of the girder and remove the concrete which exceeds the plan dimension where the haunch is less than 1".

Raise the grade of the roadway. The projection of the shear connectors or stirrups must be 2" into the deck. The shear connectors or stirrups may need to be extended by appropriate means.

Where -1" < clearance beneath the deck panel < 0", abandon the precast concrete deck panels across the width of the bridge and form the deck with timber forms. The precast concrete deck panels would be abandoned only in the limited portion of the span where the problem with the haunch exists. The deck formed with timber may have the girder projection 1" into the deck. The designer will need to develop special details for the deck reinforcing in this situation since 1) the distribution reinforcing steel must transition between the precast concrete deck panel and the portion of the deck formed with timber forms and 2) a skewed bridge will have triangular areas where the bottom mat of transverse deck reinforcing steel cannot be placed since the shape of the precast concrete deck panel is rectangular.

The CDOT Bridge Design Manual will be revised to conform with this memorandum. Until that time, this memorandum shall govern over the contents of the manual as stated in the Bridge Design Manual Article 1.1.4.A.

Attachments:
- B-618-BX
- B-618-54
- Selected Tables from ASTM A6
- Excess Haunch vs. Span Length
- Revision of 601, Substructure Survey
- Haunch Calculations, Haunch Dimension Expression