Design of Precast Prestressed Girders

Computer programs are available which produce designs using either the gross or the net and transformed sections methods for both pretensioned and post-tensioned girders.

Our current standard sheet for precast, prestressed I-girders suggests the use of pretensioning. Therefore, we can achieve uniformity regarding the manner in which force and strength values are shown on our plans by adhering to the following guidelines:

1. Use of low relaxation, 270 ksi, ½" diameter strand.
2. Working Force (P_f) to the nearest 10 kips as determined by the net and transformed section of pretensioned girder design.
3. Concrete strength requirements (both f'_{ci} and f'_c) to the nearest 100 psi; again based on the net and transformed section method of pretensioned girder design. (Minimum f'_{ci} for pretensioning is 4,000 psi.) Concrete strengths of up to 6,000 psi are readily obtainable. Strengths above this carry a significant cost penalty.
4. A tabulation of individual girders for which P_f varies by more than 30 kips, or for which concrete strength requirements change by more than 100 psi.

A portion of the total losses in prestressing steel occur during the stressing operation. The losses that remain subsequent to stressing are used in the determination of f'_{ci}.

Losses of prestress for pretensioned members may be assumed as follows:

		Total System Losses	Losses After Transfer
Normal Weight Concrete	Normal Relaxation Strand	45,000 psi	26,000 psi
	Low Relaxation Strand	35,000 psi	22,000 psi
Lightweight Concrete	Normal Relaxation Strand	50,000 psi	30,000 psi
	Low Relaxation Strand	40,000 psi	25,000 psi

Refer to the *Bridge Design Specifications* for losses in a post-tensioned girder.

Losses for structures carrying railroad traffic should be calculated to ensure that they conform to the assumed losses shown above.

Supersedes Memo to Designers 11-8 dated September 1992

Shop Plan Review Checklist

1. Effective prestress force is within range given on contract drawings for chosen eccentricity. Center of gravity of strand should be checked, but allow for tolerance at girder ends and harping points (minimum 2 harp points required).
2. Check f'_{ci} using losses after transfer.
3. Check initial prestressing force (P_j) calculations using total system losses. For a post-tensioned girder, friction loss would have to be added to total system losses.
4. Temporary and permanent concrete stresses calculated at critical locations. Such locations would include harping points and at girder ends if harping is not used.
5. Lifting loops positioned so no undesired stresses are placed on the girder.
6. Time dependent camber calculations shown but not reviewed for accuracy. Specifications put responsibility for obtaining proper bridge profile on contractor.

A few additional points worthy of consideration are:

1. Deflection components shown on the plans shall be the instantaneous values due to (1) the cast-in-place slab, and (2) the barrier rail. These will be used to set screed grades in the field.
2. Girders may, at the option of the fabricator, be cast in a flat casting bed, so vertical clearances shall be checked for this condition. Widenings and extreme vertical curves may present circumstances in which flat casting is inappropriate. In these cases, camber shall be specified on the plans and the Special Provisions shall be changed to eliminate the flat casting option.
3. The fabricator should be alerted if any special inserts or anchorages are required.
4. The dimension shown to the C.G. of prestressing force at the end of the girder should allow for a tolerance to aid the fabricator in locating anchorages. Usually ±4 inches is sufficient. The effect of this variation on deflection can be readily checked by the computer program.
5. Set the fixed end of precast girders on a minimum of ¼" elastomeric pad. Use 1" minimum elastomeric pad at the expansion joints, or whatever greater thickness is required by design.
6. The typical section sheet of the bridge plans should show a structure depth at the supports which provides for a two-inch minimum filler between the top of a precast girder and the lower surface of the deck slab and a minimum depth at

midspan equal to the sum of the girder depth plus the slab thickness. Girder design should be based on this minimum depth. Girders used on small radius curves may not provide this minimum depth at midspan. To account for this, the depth of the filler should be increased at the supports.

7. The designer should be cognizant of girder deflections, due not only to various dead loads and prestress force, but also to the timing of application of such loads. This is especially important for widenings.

Floyd L. Mellon

Jerry A. McKee

EKT:jgf

11-8 DESIGN OF PRECAST PRESTRESSED GIRDERS

Computer programs are available which produce designs using either the gross or the net and transformed sections methods for both pretensioned and post-tensioned girders.

Our current standard sheet for precast, prestressed I-girders suggests the use of pretensioning. Therefore, we can achieve uniformity regarding the manner in which force and strength values are shown on our plans by adhering to the following guidelines:

1. Use of low relaxation, 1 860 MPa, 12.7 mm diameter strand.
2. Working Force (P_f) to the nearest 50 kN as determined by the net and transformed section of pretensioned girder design.
3. Concrete strength requirements (both f_{ci}' and f_c') to the nearest 1 MPa; again based on the net and transformed section method of pretensioned girder design. (Minimum f_{ci}' for pretensioning is 28 MPa.) Concrete strengths of up to 42 MPa are readily obtainable. Strengths above this carry a significant cost penalty.
4. A tabulation of individual girders for which P_f varies by more than 200 kN, or for which concrete strength requirements change by more than 2 MPa.

A portion of the total losses in prestressing steel occur during the stressing operation. The losses that remain subsequent to stressing are used in the determination of f_{ci}'.

Losses of prestress for pretensioned members may be assumed as follows:

Concrete Type	Strand Type	Total System Losses	Losses After Transfer
Normal Weight Concrete	Normal Relaxation Strand	310 MPa	180 MPa
	Low Relaxation Strand	240 MPa	150 MPa
Lightweight Concrete	Normal Relaxation Strand	350 MPa	210 MPa
	Low Relaxation Strand	280 MPa	170 MPa

Refer to the *Bridge Design Specifications* for losses in a post-tensioned girder.

Losses for structures carrying railroad traffic should be calculated to ensure that they conform to the assumed losses shown above.

Memo converted to metric.

Shop Plan Review Checklist

1. Effective prestress force is within range given on contract drawings for chosen eccentricity. Center of gravity of strand should be checked, but allow for tolerance at girder ends and harping points (minimum 2 harp points required).
2. Check f_{ci}' using losses after transfer.
3. Check initial prestressing force (P_j) calculations using total system losses. For a post-tensioned girder, friction loss would have to be added to total system losses.
4. Temporary and permanent concrete stresses calculated at critical locations. Such locations would include harping points and at girder ends if harping is not used.
5. Lifting loops positioned so no undesired stresses are placed on the girder.
6. Time dependent camber calculations shown but not reviewed for accuracy. Specifications put responsibility for obtaining proper bridge profile on contractor.

A few additional points worthy of consideration are:

1. Deflection components shown on the plans shall be the instantaneous values due to (1) the cast-in-place slab, and (2) the barrier rail. These will be used to set screed grades in the field.
2. Girders may, at the option of the fabricator, be cast in a flat casting bed, so vertical clearances shall be checked for this condition. Widenings and extreme vertical curves may present circumstances in which flat casting is inappropriate. In these cases, camber shall be specified on the plans and the Special Provisions shall be changed to eliminate the flat casting option.
3. The fabricator should be alerted if any special inserts or anchorages are required.
4. The dimension shown to the C.G. of prestressing force at the end of the girder should allow for a tolerance to aid the fabricator in locating anchorages. Usually ±100 mm is sufficient. The effect of this variation on deflection can be readily checked by the computer program.
5. Set the fixed end of precast girders on a minimum of 6 mm elastomeric pad. Use 25 mm minimum elastomeric pad at the expansion joints, or whatever greater thickness is required by design.
6. The typical section sheet of the bridge plans should show a structure depth at the supports which provides for a 50 mm minimum filler between the top of a precast girder and the lower surface of the deck slab and a minimum depth at midspan equal to the sum of the girder depth plus the slab thickness. Girder design should be based on this minimum depth. Girders used on small radius curves may not provide this minimum depth at midspan. To account for this, the depth of the filler should be increased at the supports.
7. The designer should be cognizant of girder deflections, due not only to various dead loads and prestress force, but also to the timing of application of such loads. This is especially important for widenings.

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