1. Analysis - Using Gross Section Properties

The gross section properties are calculated by building up parts determined by the section dimensions. AY, AYZ and IØØ are the summations of the properties of the parts used to build up the section. these numbers can vary depending on how the section is split into parts. The area, YB, and ITOT are the overall section properties.

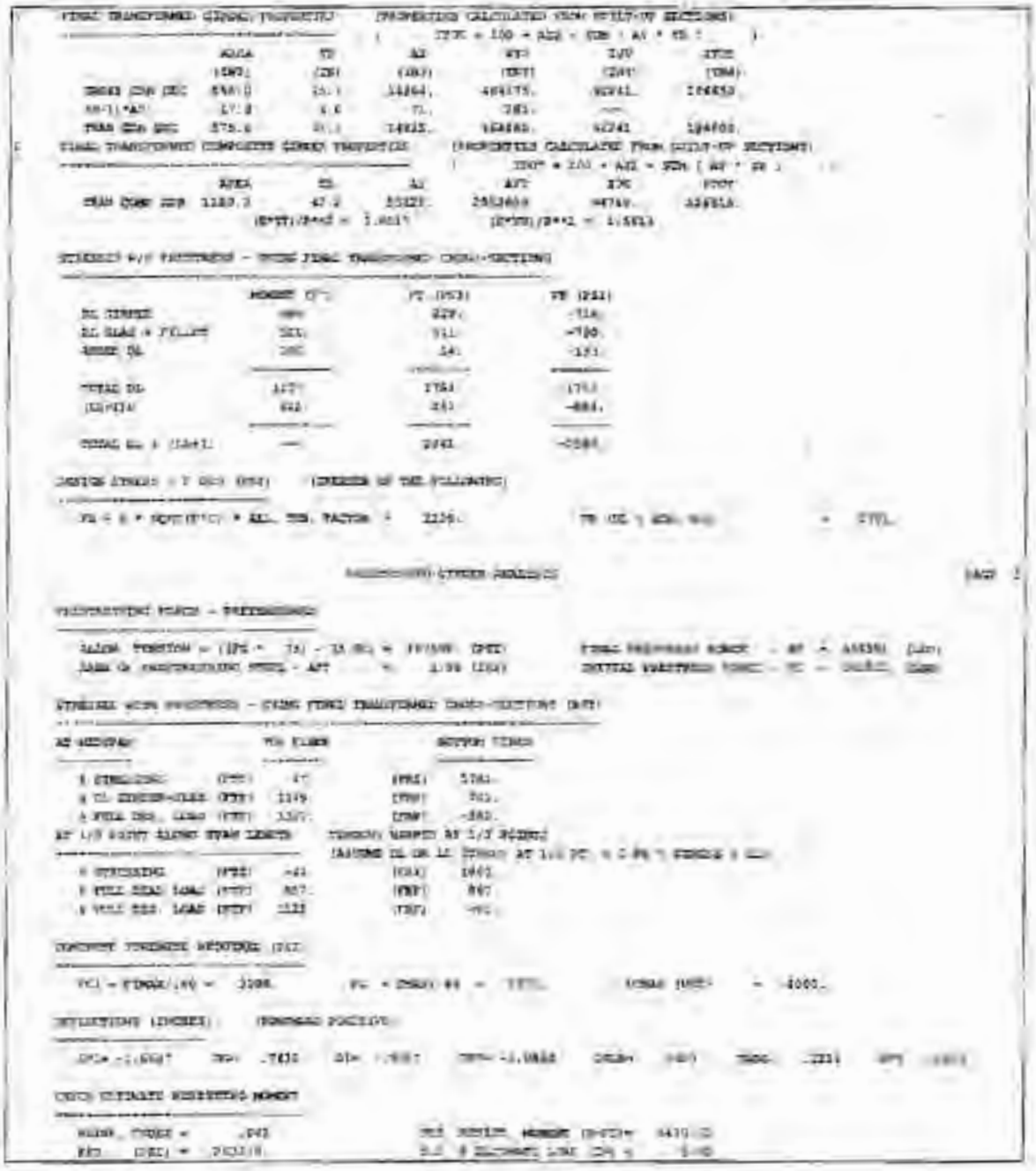
- The calculated moments are the program calculated simple beam moments or the moments input by the user.

- The ultimate applied moment is calculated using the beam moments listed. If the live load moment is calculated by the program, then the

P-truck moment will also be calculated to determine the maximum applied moment.

- Note the ultimate applied moment = 0.95 x nominal moment strength of a section.

2. Analysis - Using Transformed Section Properties



- Transformed section properties are calculated using N = 7. The net transformed girder properties are calculated for post-tensioned girders.

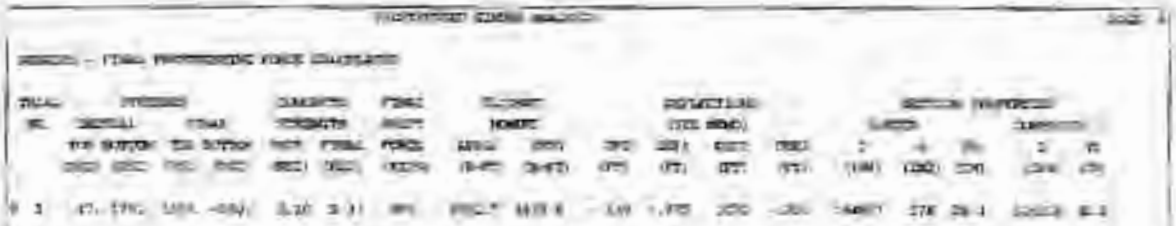
- Note: stresses with prestress are calculated at 1/3 span only for pretensioned girders with program calculated live load moment.

- The calculated deflection are based on the input P/S f'_c or P/S $f'_{c\ max}$ required.

- The distance between top of the slab and the natural axis at the ultimate load is calculated for the girder section. However, the value may not be correct for some non-standard sections. For example, trapezoidal sections.

3. Results - Final Prestressing Force Calculated

A sample output is shown below:



This report contains the following output:

- Midspan Fiber Stresses, both Initial (at the time of stressing) and Final (under full design load) in psi (English Units) or kPa (Metric Units).

- Concrete Strength Requirement, both Initial (temporary stress condition) and Final (design load stress condition) in psi (English Units) or kPa (Metric Units).

- Final prestressing force required in kips (English Units) or kN (Metric Units).

- Ultimate Moments, both applied and resisting, in kip-ft (English Units) or kN-m (Metric Units). If a moment is entered by the user under Note D, that moment is used to calculate the ultimate applied moment rather than any program calculated live load moment for HS and P ultimate moment.
- Deflections in feet. Four deflections (DP1, DEF1, DEF2, DEF3). These deflections have different meanings when analyzing the structure as a box girder than they do when analyzing the structure as single stringer elements. Deflections are positive downward. To interpret your results, see the chart below:

Deflection No.	Cause of Deflection	
	Box Girder (Non-Composite)	Single Girder (With Composite Slab)
DP1		Stressing Only
DEF1	Stressing Only	Stressing + DL Girder
DEF2	DL Only	DL Slab
DEF3	DL Additional	All Above + Creep

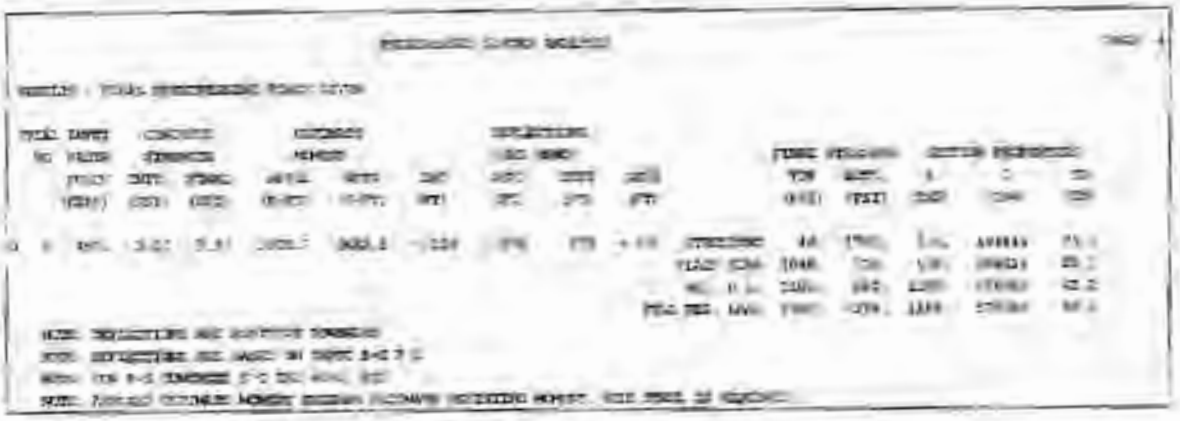
For a single Girder, DEF3 is the total amount the girder deflects from its original position. The deflection due to creep is not listed but may be found by adding DEF2 and DEF3 and subtracting DEF1 from the sum. A coefficient of creep of 1.5 is used by the program. See Appendix 1 for deflection evaluations.

Section Properties - Results shown under Girder are the moment of Inertia (I), the area (A) and the distance from the bottom of the girder or soffit to the centroidal axial of the cross section (YB). For composite girder construction the results shown are for the girder only. Results shown under composites are the moment of inertia (I), and the distance from the bottom of the girder or soffit to the the centroidal axial of the cross section (YB). For composite girder construction, the top slab has been included. For a noncomposite construction, the I and YB should be same as shown under Girder. Moments of inertias are in in^4 or mm^4, areas are in in^2 or mm^2, and distances are in inches or millimeters.

Note: For the output in metric units, "10^4" is shown as "10^4" and "10^6" is shown as "10^6".

4. Results - Final Prestressing Force Given

A sample output is shown below:



This report contains the following output:

- Concrete Strength Requirement both initial and final in ksi (English Units) or MPa (Metric Units).
- Ultimate Moments both applied and resisting in kip-ft (English Units) or kN-m (Metric Units).
- Deflections in feet (English Units) or m (Metric Units).
- Midspan fiber stresses at the time of stressing, after slab placement, after addition of added dead load, and under full design load. Results are in psi (English Units) or kPa (Metric Units).
- Section Properties: Results shown are the moments of inertia (I) in in^4 (English Units) or mm^4 (Metric Units), the area (A) in in^2 (English Units) or mm^2 (Metric Units), and the distance (YB) in inches (English Units) or mms(Metric Units) from the bottom of the girder or soffit to the cross section.
- Notes are included for the P-S concrete f'_c to use (either minimum allowed by the specs or maximum required by the analysis), if the applied ultimate moment exceeds the ultimate resisting moment, or if the allowable tension has been exceeded.

The following table shows the section properties and the elements considered for the various stages of a pretensioned bridge:

Loading Stage	Method of Calculation	Elements Considered	Remarks
Time of Stress	Transformed Sec./Net	Girder Only	
Slab Placement	Transformed Sec./Gross	Girder Only	
Added D.L.	Transformed Sec./Gross	Girder and Slab	Composite Girder
Added D.L.	Transformed Sec./Gross	Girder Only	Non-Composite Girder
Full Design Load			Same as added D.L.

The following table shows the section properties and the elements considered for the various stages of a pretensioned bridge:

Loading Stage	Method of Calculation	Elements Considered	Remarks
Time of Stress	Transformed Sec./Net	Total Cross Section	
Slab Placement			Ignore Results
Added D.L.	Transformed Sec./Gross	Total Cross Section Excluding Rails	
Full Design Load			Same as added D.L.

For more information on the results calculated for ultimate moments and deflections, see the "Results - Final Prestressing Force Calculated" portion of these instructions.

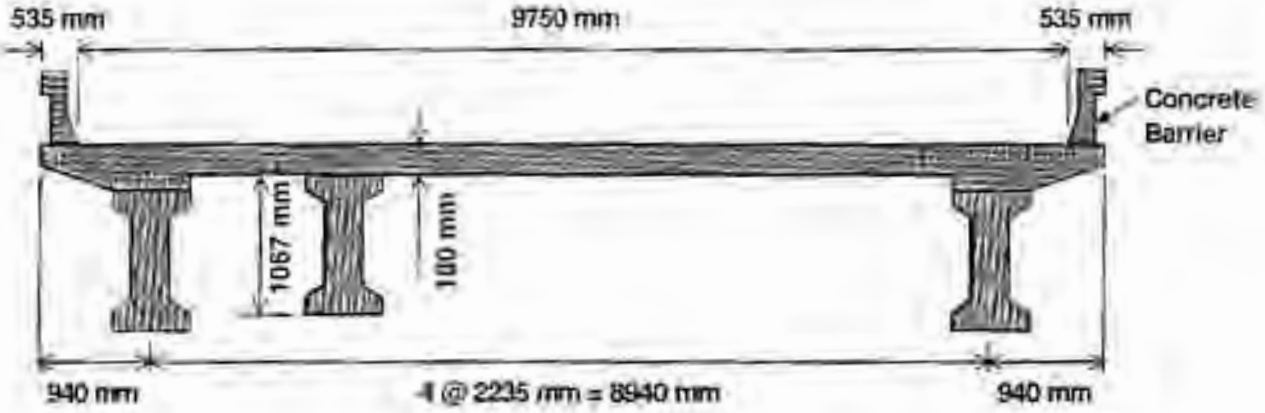
Example Problems

Attached are example problems to illustrate how the program works. Only important portions of the example problems are shown here. The following table lists the type of bridge being analyzed, and the special characteristics of each of the sample problems.

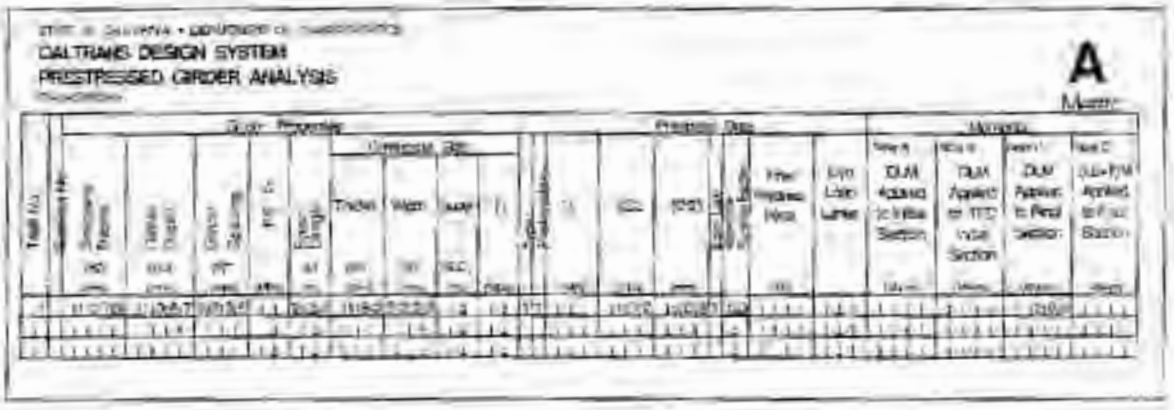
Problem No.	Bridge Type	Units Used	Special Characteristics
1	Std. "I" Girder	Metric	None.
2	Std. "I" Girder	English	Continuous for LL using max HS20 LL + IM.
3	Std. "I" Girder	Metric	Illustrates use of Symmetric Section Dimensions Sheet.
4 (with Text file)	Non-Std. "I" Girder	Metric	Illustrates use of Non-Symmetric Section Dimensions Sheet.
5	Special Girder	English	Illustrates use of Section by Parts Sheet. All moments are specified.
6 (with Text file)	Cored Slab	English	Illustrates Analysis of Cored Slab Bridge.

Example Problem 1 (Metric)

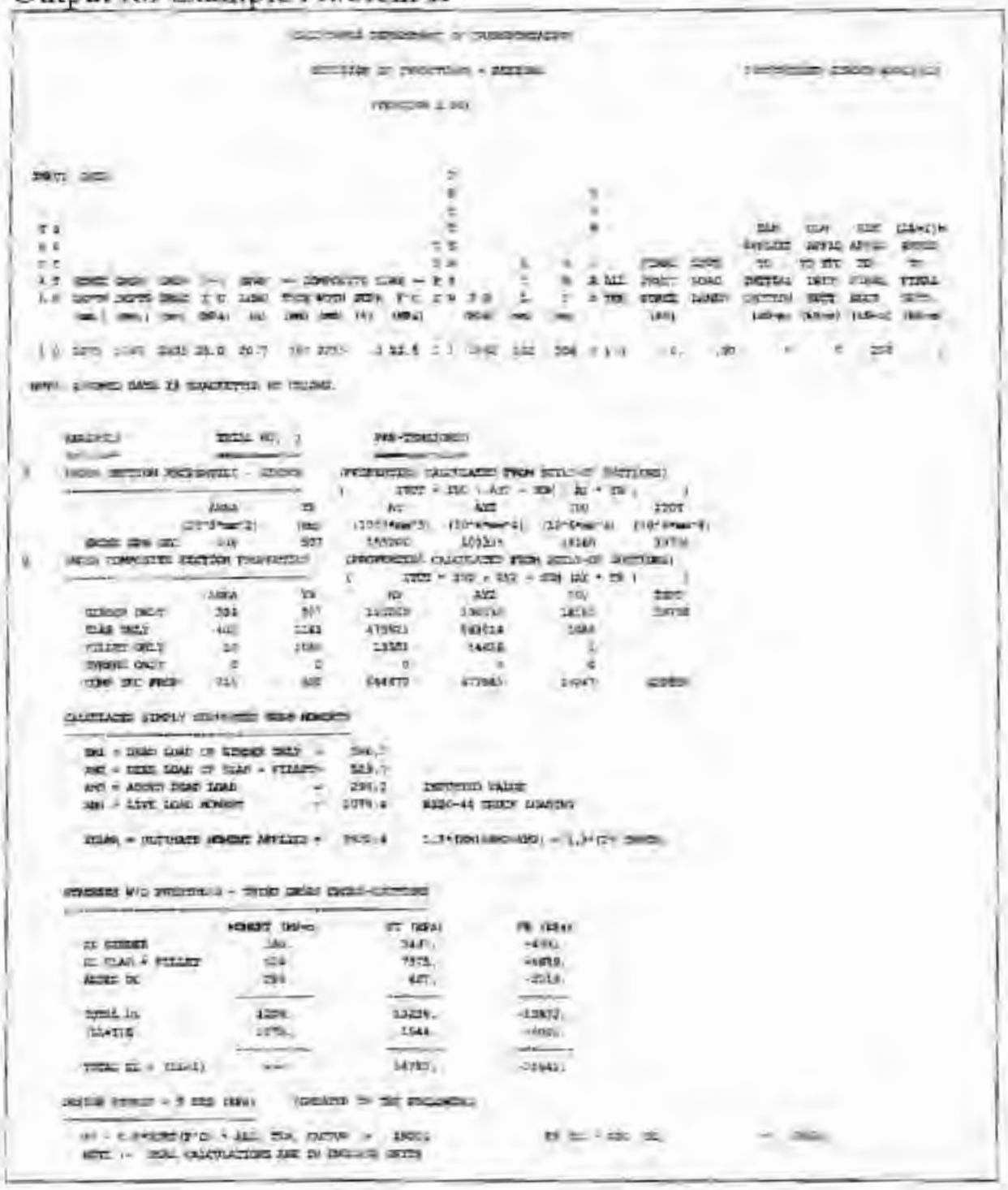
Simply Supported

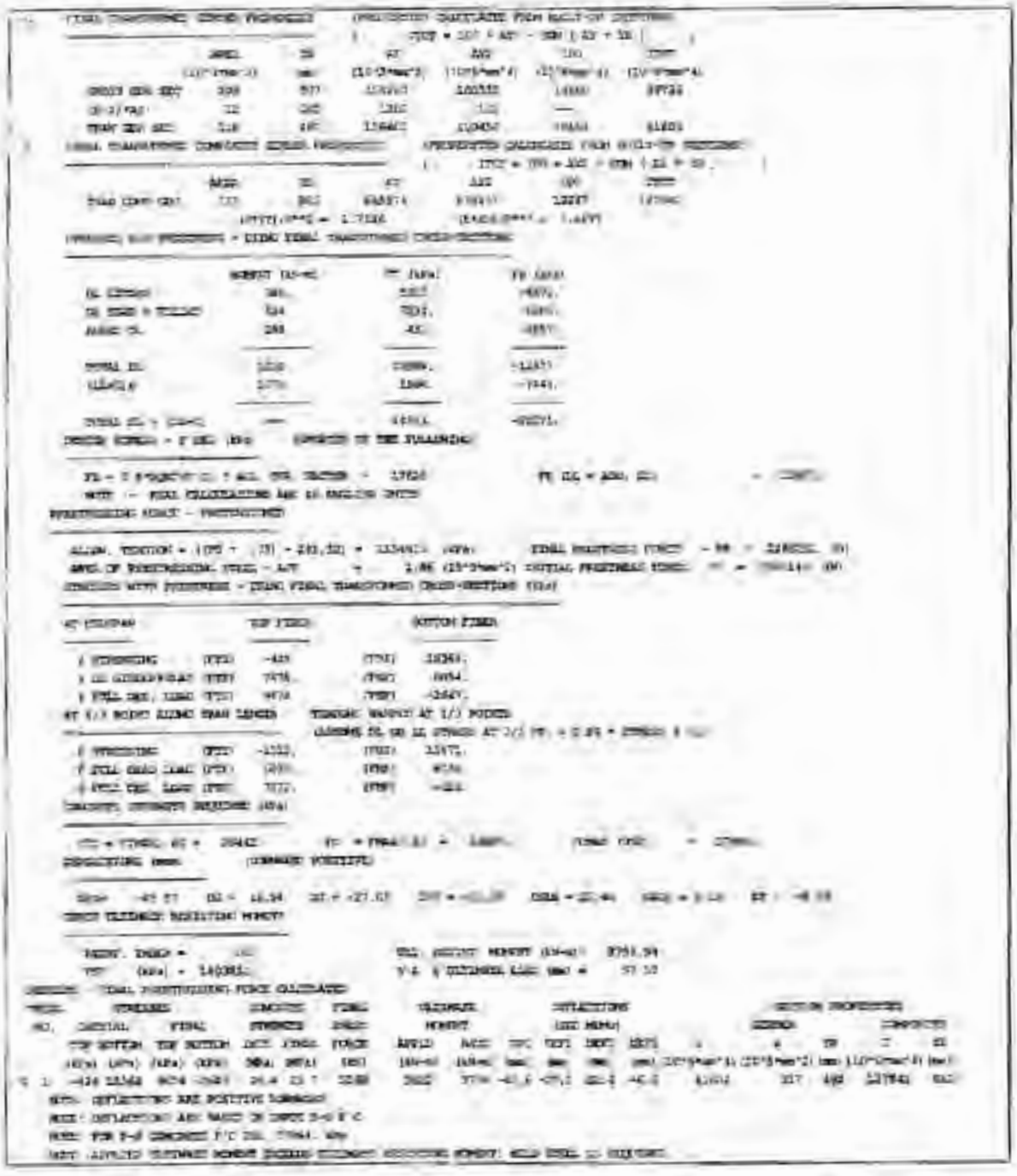


Design span = 20.7 m
DL moment barrier + AC = 298 kN-m



Output for Example Problem 1:





Example Problem 2 (English)

Simply supported for dead load of girder

Span continuous for added dead load and live load.

Design of Span 1

Span Length = 80 ft Girder Spacing = 8'-6" Girder Depth = 4'-0"

Top Slab = 7.625" Structure Depth = 5'-4"

- Added DL Moment = 195
- $(LL+D)_{Pr}$ = 888 k-ft $(LL-D)_{Pr}$ = 1618 k-ft
- Moments or continuous spans must be determined by an analysis program that allows continuous spans (eg., Frame, BDS, etc.)
- Moments are at centerline of span.
- P-Truck moment to be input = $\frac{1618}{5/3}$ = 971 k-ft

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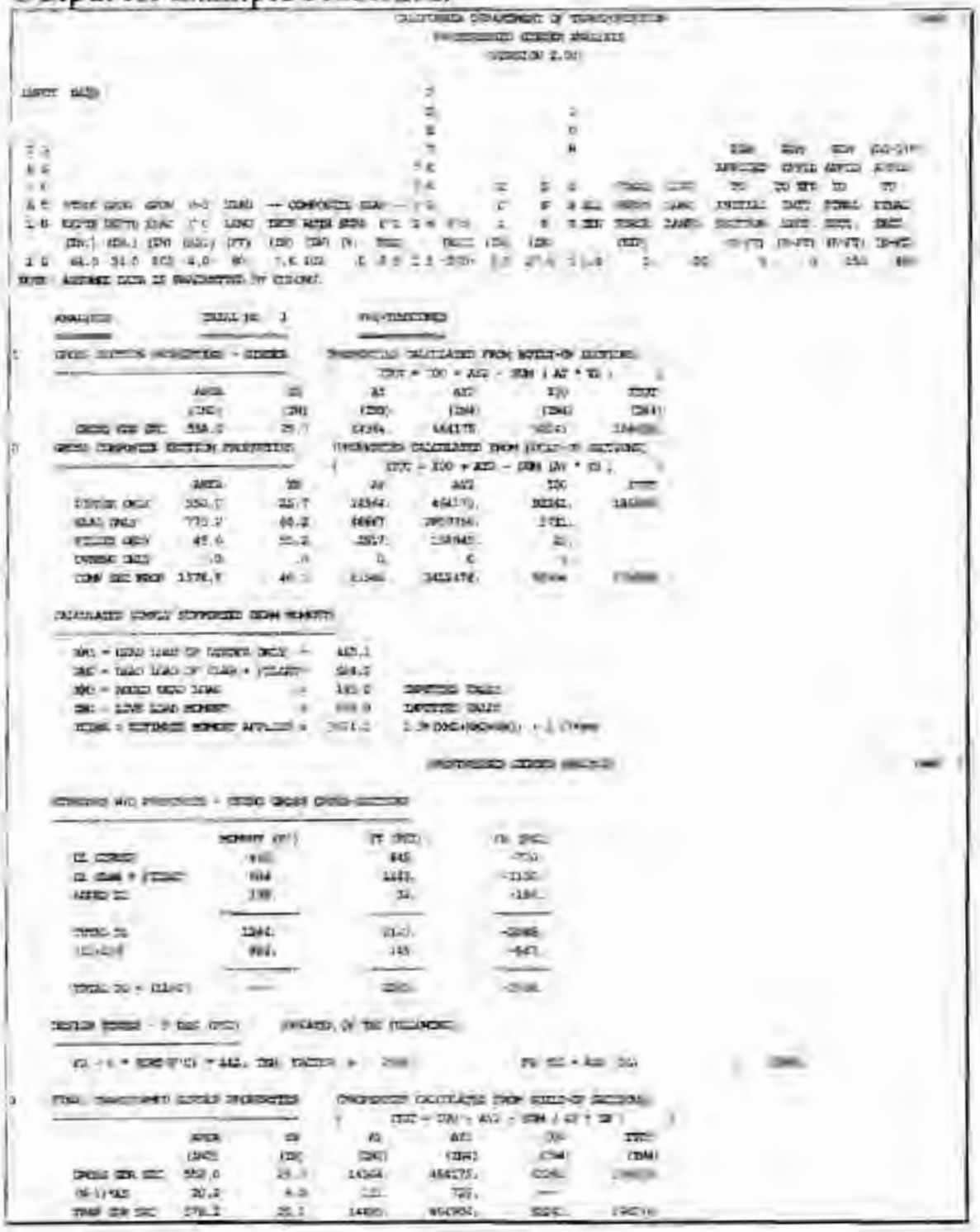
PRESTRESSED GIRDER ANALYSIS
DESIGN (REV. 11/97)

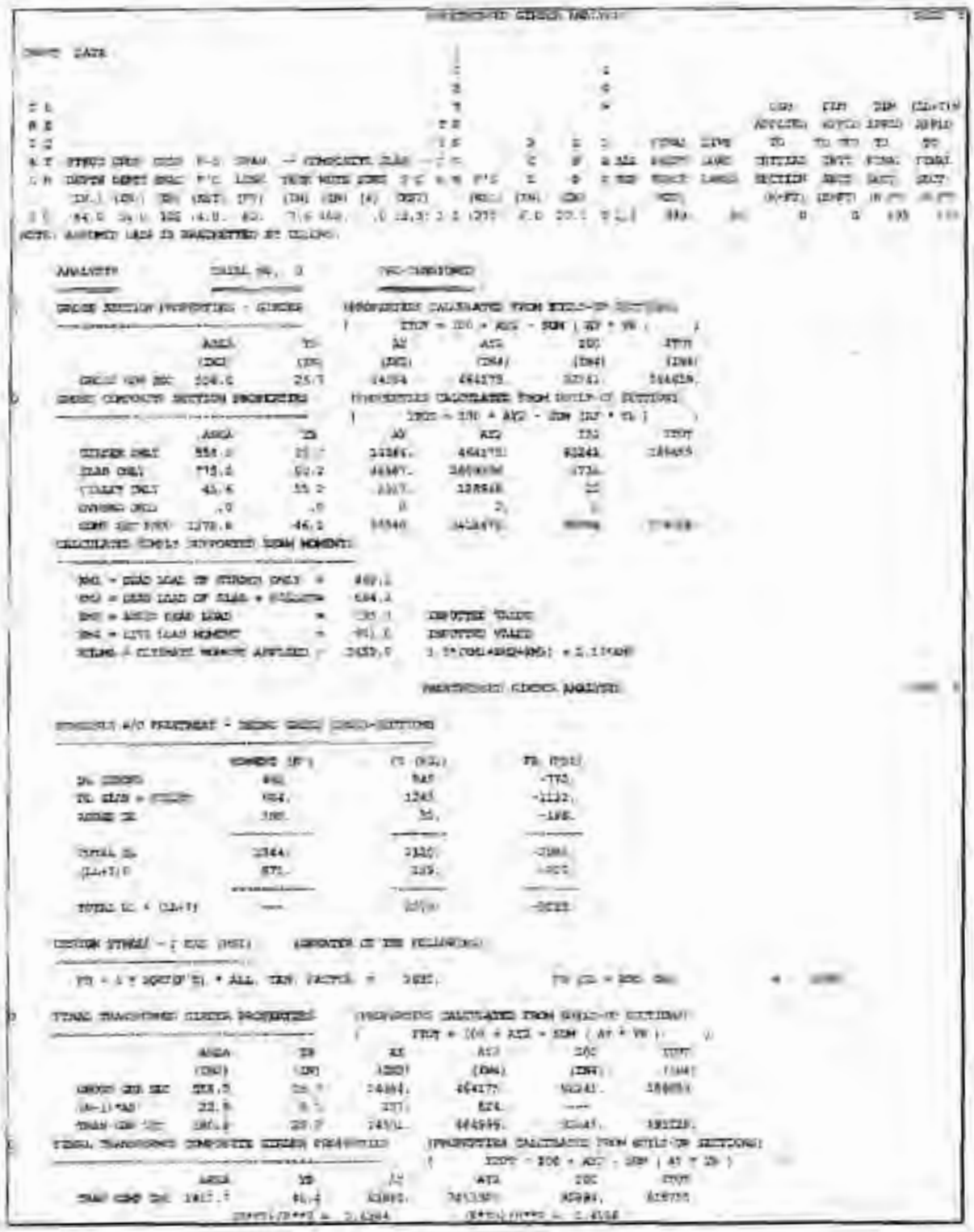
A
English

| Test No. | Section No. | Girder Length (ft) | Girder Spacing (ft) | Girder Depth (in) | PS Yr | Girder Weight (lb) | Composite Slab Thick (in) | Composite Slab Width (in) | Composite Slab Sup | Fc | Fc | Fc

Output for Example Problem 2:



```
FINAL TRANSFORMED COMPOSITE CROSS-PROPERTIES      (PROPERTIES CALCULATED FROM BEGIN-OF SECTION)
                                                  Y      CGC = 120 * CG - EBM ( CG * CG )
                  AREA        CG          EI          EIY          YCG          CGC
  DWG: CMP CSR: 1995.3       35.0      62010.      3422000.      1584.       -2.200
                  D-CGC DWG = 1.0000          (CTOP/PTOP = 1.000)

INTERNAL AND PRESTRESS - BEGIN FINAL TRANSFORMED CROSS-SECTIONS

                    MOMENT (K')        ST (KSI)        TO (KSI)
  DL CONTRB           [illegible]        [illegible]     [illegible]
  SL DLAB + PRESET    [illegible]        [illegible]     [illegible]
  (ADDED DL)          [illegible]        [illegible]     [illegible]
                      ---------          ---------       ---------
  TOTAL DL            [illegible]        [illegible]     [illegible]
  (DL+SL)             [illegible]        [illegible]     [illegible]
                      ---------          ---------       ---------
  TOTAL DL + (DL+SL)  [illegible]        [illegible]     [illegible]

DESIGN STRESS = F DEC (KSI)      (STRESS OF THE STRANDS)

  TO  /( * [illegible] * ALL DEL STATIC =   [illegible]        FR DEC F DEC (KL)        =   [illegible]

                                  PRESTRESSING STRESS ANALYSIS                                    PAGE 1

PRESTRESSING FORCE - PRESTRESSING

  ALLOW. ZERO/DEN = (FCI + .75) - [illegible]) = [illegible]. (KSI)      FINAL PRESTRESS FORCE  = PF  = [illegible]. (LBS)
  AREA OF PRESTRESSING TOTAL - ASP      =    3.37 (IN2)                 INITIAL PRESTRESS FORCE = PI  = [illegible]. (LBS)

STRESSES WITH PRESTRESS - BEGIN FINAL TRANSFORMED CROSS-SECTIONS (KSI)

  AT MIDSPAN                  TOP FIBER                BOTTOM FIBER
  ----------                  ---------                ------------
  ( CONTROLS)      (KSI)      [illegible]      (KSI)   [illegible]
  ( SL DESIGN-BLAB (KSI)      [illegible]      (KSI)   [illegible]
  ( FULL DES. LOAD (KSI)      [illegible]      (KSI)   [illegible]

CONCRETE STRESSES BEYOND (KSI)

  FTC = FTMAX/ SC =  [illegible]        FC = FMAX/ AC =   [illegible]        FCMAX DEC     =   [illegible]

DEFLECTIONS (INCHES)      (CAMBER POSITIVE)

  DPD= -1.6704    DSW=  [illegible]    DSW= -[illegible]    DPW= -1.0519    DSLW= 1.1227    DSDL= .1016    DL=  .2164

CHECK ULTIMATE RESISTING MOMENT

  MOMT. INDEX =      .36                    ULT. RESIST. MOMENT (K-FT)=  [illegible]
  FPU    (KSI) =  [illegible]              N.A. @ ULTIMATE LOAD (IN) =     3.79

                                  ULTIMATE STRESS ANALYSIS                                        PAGE 1

NOTES: - FINAL PRESTRESSING FORCE CALCULATED

TOTAL    STRESSES          CONTROL   FINAL     ULTIMATE          DEFLECTIONS                 SECTION PROPERTIES
 NO.   INITIAL    FINAL    STRESSES  STRESS    MOMENT          (NOT MEAS)                 (CGS)          COMPOSITE
       TOP BOTTOM TOP BOTTOM SLAB FINAL FORCE  ACTUAL   RATIO   DL   DPT   DSTT   DSTB    I    A    YB     I    YB
       (KSI) (KSI) (KSI) (KSI) (KSI) (KSI) (KIPS) (K-FT) (K-FT) (FT) (FT)  (FT)   (FT)   (IN4) (IN2) (IN)  (IN4) (IN)

1  1   [illegible] 1997. 1560. -[illegible]  [illegible] [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]

  NOTE: DEFLECTIONS ARE POSITIVE DOWNWARD

  NOTE: DEFLECTIONS ARE SHOWN AT [illegible] POINTS

  NOTE: FOR [illegible] CONCRETE [illegible] SEE [illegible]
```



[illegible]

	MOMENT (K')	FC (KSI)	FS (KSI)
DL [illegible]	[illegible]	[illegible]	[illegible]
DL [illegible] + [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TOTAL DL	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TOTAL DL + [illegible]	—	[illegible]	[illegible]

[illegible] PRESTRESSED GIRDER ANALYSIS [illegible]

PRESTRESSING [illegible] - [illegible]

AREA OF PRESTRESSING STEEL - APS = [illegible] (IN2)

[illegible] WITH PRESTRESS - USING FINAL TRANSFORMED CROSS-SECTIONAL (PST)

AT MIDSPAN	[illegible]	[illegible]
1 [illegible] (FT)	[illegible]	[illegible]
1 DL [illegible] (FT)	[illegible]	[illegible]
1 TOTAL DEL. LOAD (FT)	[illegible]	[illegible]

[illegible] REQUIRED (PST)

FCI = [illegible] = [illegible] FC = [illegible] = [illegible] [illegible] = [illegible]

[illegible] (CHANGE POSITIVE)

[illegible]

CHECK ULTIMATE RESISTING MOMENT

[illegible] = [illegible] [illegible] MOMENT (K-FT)= [illegible]

[illegible] (PST) = [illegible] [illegible] % ULTIMATE LOAD (%) = [illegible]

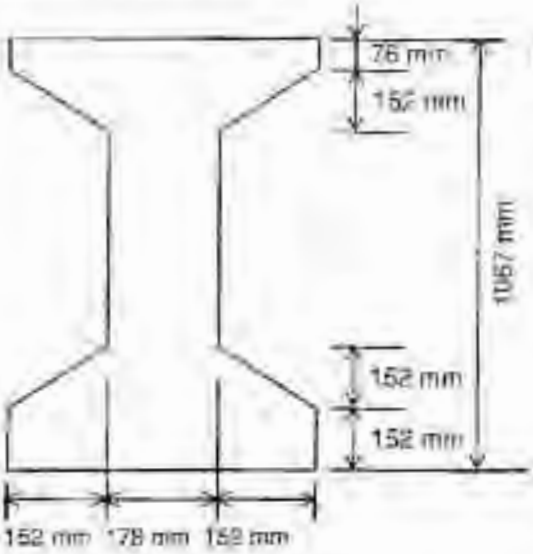
[illegible] PRESTRESSED GIRDER ANALYSIS [illegible]

[illegible] - FINAL PRESTRESSING FORCE [illegible]

[illegible]															
[illegible]															
[illegible]															
[illegible]															

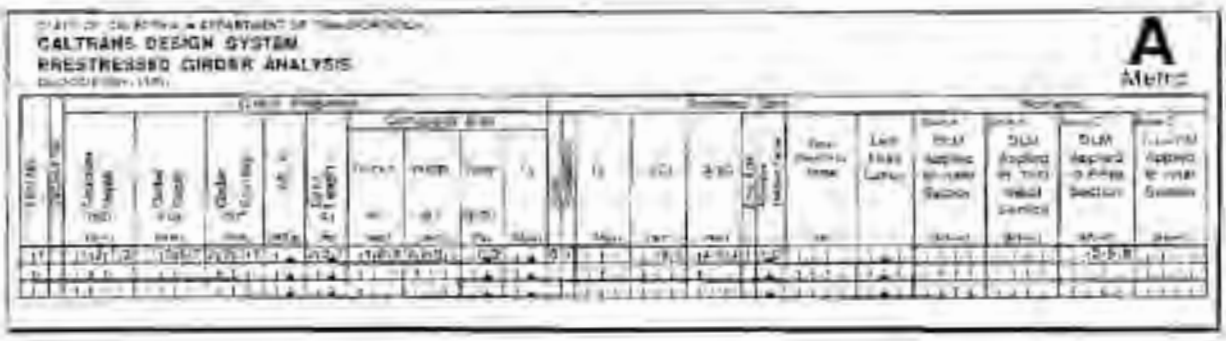
Example Problem 3 (Metric)

Standard Symmetric "I" Girder

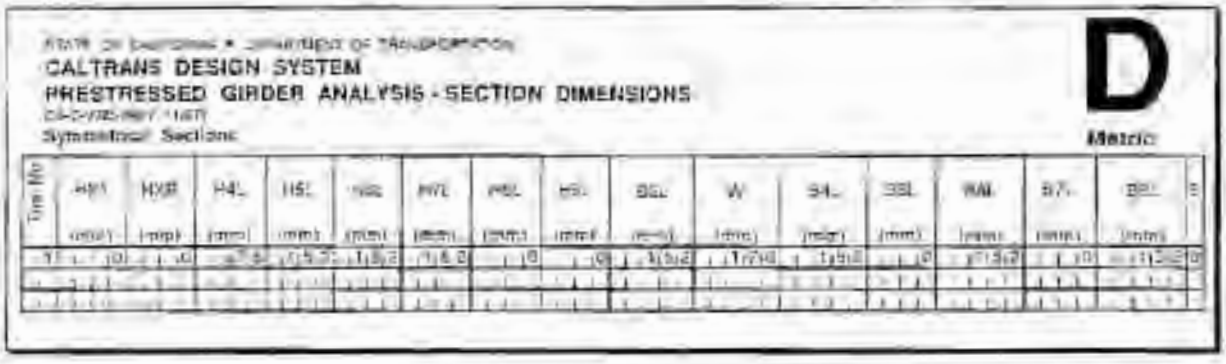


Using section dimension cards

Girder spacing = 2235 mm
Span length = 20.7 m
Slab thickness = 180 mm
Structure depth = 1235 mm

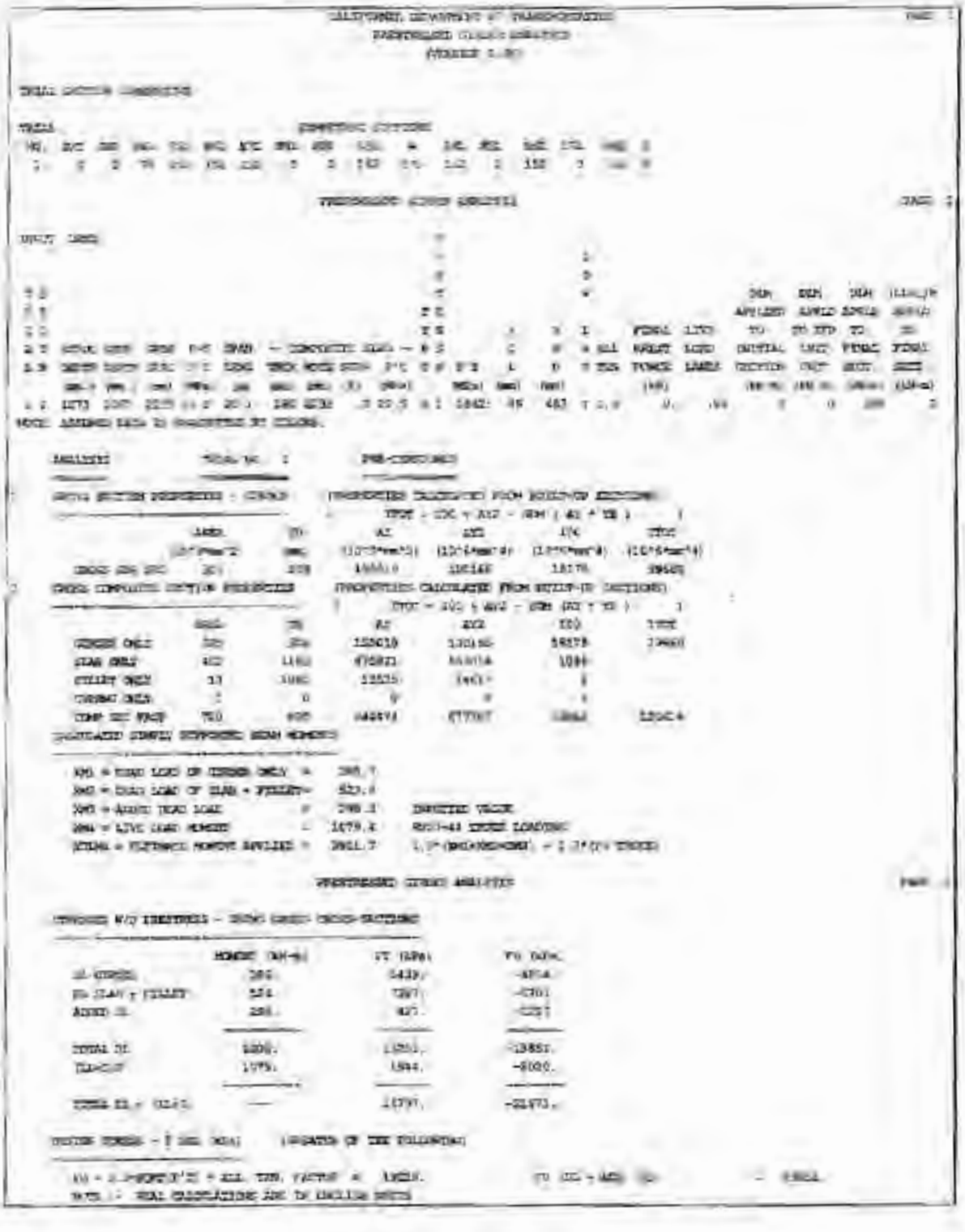

CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS

A
Metric


CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS - SECTION DIMENSIONS
Symmetrical Sections

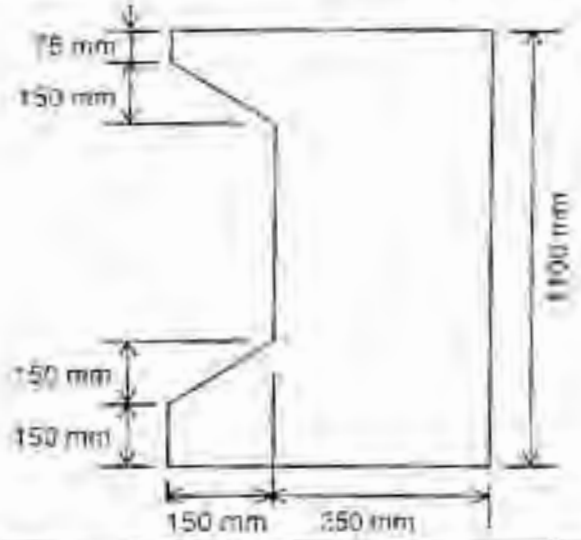
D
Metric

Output for Example Problem 3:



Example Problem 4 (Metric)

Non-Standard Non-Symmetric "I" Girder



Using section dimension cards

Girder spacing = 2300 mm
Span length = 20.5 m
Slab thickness = 200 mm

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PRESTRESSED GIRDER ANALYSIS

A
Metric

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PRESTRESSED GIRDER ANALYSIS - SECTION DIMENSIONS
Symmetrical Sections

D
Metric

Card No	H1T	H1B	H4L	B1L	H2L	H3L	H2R	H3R	B1R	W	H4R	B5L	B5R	B7L	B4R
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
01															

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PRESTRESSED GIRDER ANALYSIS - SECTION DIMENSIONS
Unsymmetrical Sections

E
Metric

Card No	B3R	B4R	B6R	B8R	B9R	B6R	H4R	H5R	H6R	H7R	H8R	H9R
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
01												

Text File for Example Problem 4

```
[illegible]
```

Output for Example Problem 4:

```
[illegible]
```