State of California Business, Transportation and Housing Agency

M E M O R A N D U M

To: All Computer Program Manual Holders Date: Dec. 13, 1988

From: Department of Transportation Mickey Horn,
Division of Structures Computer Operations and Support

Subject: Change Letter No. 52
Changes to the PSGIRDR Program - EFFECTIVE DATE 1/3/88

Please replace Section 6-1, Prestressed Girder Analysis, (dated November 1980) and the accompanying memo (dated October 20, 1986) of the Bridge Computer Manual with the attached revised Section 6-1.

The following changes have been made to the PSGIRDR Program.

1. New data fields have been added to the input form, therefore:

   OLD PSGIRDR DATA FILES WILL NOT RUN WITH THE NEW VERSION.
   OLD FILES MUST BE MODIFIED TO MATCH THE NEW INPUT FORMAT.

2. Output has been added to follow Memo to Designers 11-11 (Nov. 1986) Computation forms.
3. Units are shown for calculated values.
4. Minimum Prestressed Concrete Strength Default P/S f'c = 4000 psi.
5. Ec to be used for deflections is calculated from input P/S f'c or fcmax required ($Ec = 57000 \sqrt{f'c}$)
6. Deflections are all positive downward (Consistent with BDS).
7. Deflections are based on the Transformed Girder Properties.
8. Slab Concrete Strength can now be input if required. (f'c for slab defaults to 3250 psi)
9. The number of Live Load Lanes can be input, if required, to override the S-Over Distribution Factor used by the program.
10. Prestressed Cable Locations XCL and XND can now be input to the nearest 0.1 inch.

Mickey Horn

Mickey Horn
Structures Computer
Operations & Support Engineer

psgirdr

Chapter 6 - Prestressed Concrete

Section 6-1 - Prestressed Girder Analysis

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Included in this section are full-sized forms of panels in English and Metric units to be photocopied and used by the engineers.

A Prestressed Girder Analysis

B Superstructure Section

C Sections by Parts

D Section Dimensions - Symmetric Sections

E Section Dimensions - Unsymmetric Sections

Prestressed Girder Analysis Instructions for Users

Location

The prestressed Girder Program is listed on the main bridge menu as PSGIRDR.

Purpose

To analyze simple span concrete girder bridges using either pre-tensioned or post-tensioned systems.

Input Requirements

Data may be entered at the terminal on either pre-formatted input panels containing descriptive column headings or by creating or revising a file with XEDIT (called here "text file"). The text file created by the use of latest version of the program keeps the data in the free format form and the text file created by the use of oldest version of the program keeps the data in the fixed format form. All previous versions are executable by the latest version. If input panels are used, only one panel per card is currently available. If more input is required, XEDIT must be used. If more accuracy is required, XEDIT in free format must be used. The Prestressed Girder Analysis input forms that are used to code the data are as follows:

Input Form	Number	Card	Input Panel
Variables for Input/output options			Units
Girder Properties & Moments	DS-D-0028	1791	A
Superstructure Sections	DS-D-0127	7681	B
Section By Parts	DS-D-0128	7691	C
Section Dimensions	DS-D-0025	1793/1794	D, E

The forms are provided so that problems can be coded before going to the terminal. The column numbers shown on the forms are to assist with the fixed formatted old version data input when XEDIT is used. If the pre-formatted input panels are used, input format may vary slightly from the forms due to limitation of significant digits on the pre-formatted input panels.

The following pages contain detailed descriptions of each input form.

Input and Output Variables Sheet (Mandatory for the 2.00 or later Versions) - Panel Units

Input and Output Variables Sheet is used to define the variables for the input and output. These variables are mandatory for the 2.00 or later versions of the program. Otherwise, the program shall not be executed. Part 1 of Appendix 3 refers to change the text file created by the oldest version to the text file for the 2.00 or later versions in order to add these variables. Input consists of:

1. Variable for the Input Units
2. Variable for the Output Units
3. Variable for Free/Fixed format for an Input in English units

1. Variable for Input Units (VIU)
   (Mandatory for the latest version of the program)
   Enter m or M for the input in Metric units. Enter any other character (Usually E) for the input in English units.

2. Variable for Output Units (VOU)
   Enter m or M for the output in Metric units. Enter any other character (Usually E) for the output in English units. The default VOU is same as the VIU resulting in the input and output in the same units. VOU must be in the text file.

3. Variable for Free/Fixed format for an Input in English units (VFIE)
   Enter f or F for a free formatted input in English units. Enter any other character for a fixed formatted input in English units. The default VFIE for panels is F. VFIE must be in the text file.

The forms are provided so that problems can be coded before going to the terminal. The column numbers shown on the forms are to assist with the fixed formatted old version data input when XEDIT is used. If the pre-formatted input panels are used, input format may vary slightly from the forms due to limitation of significant digits on the pre-formatted input panels.

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1. Variable for the Input Units
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1. Variable for Input Units (VIU)
   (Mandatory for the latest version of the program)
   Enter m or M for the input in Metric units. Enter any other character (Usually E) for the input in English units.

2. Variable for Output Units (VOU)
   Enter m or M for the output in Metric units. Enter any other character (Usually E) for the output in English units. The default VOU is same as the VIU resulting in the input and output in the same units. VOU must be in the text file.

3. Variable for Free/Fixed format for an Input in English units (VFIE)
   Enter f or F for a free formatted input in English units. Enter any other character for a fixed formatted input in English units. The default VFIE for panels is F. VFIE must be in the text file.

1. Trial Number

(Mandatory for All Problems)

Enter a number from 01 to 99. Enter a different number for each line used.

2. Section Number

(Mandatory if Superstructure Sections (B) and/or Section by Parts Sheets (C) are used)

Enter the same number used to describe the section on the Superstructure Section or the Sections by Parts Sheets. If these sheets have not been used, this column must be left blank.

3. Structure Depth

Give the depth from the top of the deck to the bottom of the girder or the soffit.

4. Girder Depth

Give the depth from the top to the bottom of the girder, excluding the fillet. *For non-composite girder construction, Girder Depth should be the same as Structure Depth.*

5. Girder Spacing

Give the distance from center to center of girders.

6. P-S Concrete Strength - f'_c

Input the concrete strength of the prestressed girder. The default compressive strength of the girder concrete is 4.00 ksi in English units and 28 MPa in Metric units. If P-S Concrete Strength, f'_c, is input, $E_c = 57\sqrt{f'_c}$ in English units and $E_c = 5\sqrt{f'_c}$ in Metric units.

7. Span Length

Give the distance between the centerline of support bearings.

Panel A in English Units

CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS

A
English

INSTRUCTIONS:

NOTES:

Panel A in Metric Units

CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS

A
Metric

INSTRUCTIONS:

NOTES:

8. Composite Slab

For composite girder construction, give the slab thickness, effective width of the composite slab (see *Bridge Design Spec.*) or the center to center girder spacing, the cross-slope of the
plane slab in percent, and the compressive strength of the slab concrete. The default compressive strength of the slab concrete is 3.25 ksi in English units and 28 MPa in Metric units.

If the slab is not composite or if the bridge is fully described on the Section By Parts or Superstructure Sections Sheets, these column should be left blank.

9. Type

If a standard "I" girder is used, enter a 1. If not, leave this column blank. Refer to *Bridge Design Aids* 6-1.

10. Pretension

If the system is pretensioned, put a 1 in this column. If post-tensioned, leave this column blank.

11. f'_s

The ultimate strength of the prestressing steel. If left blank, 270 ksi in English units and 1860 MPa in Metric units will be used.

12. XCL (midspan), XND (end)

Give the dimension from the bottom of the girder to the center of gravity of the prestressing steel. XCL is assumed to be at midspan and XND is assumed to be at the end of the girder. XND is used to calculate the simple beam deflections. If these deflections do not apply, enter a 99.0 in the XND column.

13. Low Lax

If low lax prestressing steel is used, enter a 1 in this column and the factor is 0.75. Otherwise, leave the column blank, and the factor is 0.70.

14. Allowable Tension Factor (under DL + ADL + LL)

Give the concrete allowable tension as a fraction of in tenths. For example, in English units, $f'c$ of the girder is 4000 psi, the maximum allowable tension is 379 psi. If only 190 psi is desired, enter 0.5 (190/379 rounded to nearest 0.1). If left blank, 0 ksi (English units) or MPa (Metric units) will be used.

15. Final Prestress Force

If a specified prestress force is to be used, instead of calculating one, enter it here. If the prestress force is to be calculated, leave the column blank.

16. Live Load Lanes

Give the number of live load lanes if it is necessary to override the S-over distribution factor. The default distribution factor is S/5.5, and can be changed to other standard values on the other input cards.

17. Moments

Calculated moments are simple beam moments at centerline of span. Dead load moments are based on concrete weight of 150 pcf.

a) Note A - This is the *dead load moment applied to the section at the time of initial prestressing of the girder*. If this moment is due to loads caused by the girder section described, this column may be left blank. For any other condition show the DLM applied to the initial girder section. A moment shown here will replace the computer calculated DLM.

b) Note B - This is the *dead load moment applied to the transformed section at the time of initial prestressing of the girder*. If this moment is due only to the composite slab and its fillets, if any, leave this column blank. For any other condition, show the dead load moment. Do not include the dead load moment shown under Note A. A moment shown here will replace the computer calculated DLM due to the dead load of composite slab and its fillets. The moment calculated uses the girder spacing for the slab width. If the girder spacing is left blank, the effective composite slab is used.

c) Note C - This is the *additional dead load moments applied to the final section*. There are no computer calculated additional dead load moments. Examples of loads causing these moments would be rail loads, curb loads, utility loads, and AC surfacing.

d) Note D - This is *the live load plus impact moment (LL+I) moment applied to the final section*. If left blank, a default (LL+I) moment is calculated that is equal to the maximum HS20 (LL+I) moment for the described span length, girder spacing (max. 14 ft in English units or 4.27 in Metric units). For any other condition, show the (LL+I) moment. Any other moment shown will replace the computer calculated moment.

If the HS20 (LL+I) moment is calculated (Note D), then the P-truck (LL+I) moment will be calculated. The larger of the factored HS20 (LL+I) moment or P-truck (LL+I) moment is used to calculate the ultimate applied moment. If the (LL+I) moment is input, the ultimate applied moment is $1.3(DLM_{girder} + DLM_{int} + \text{added DLM}) + 2.17(LL+I)$ moment.

Superstructure Sections Sheet - Panel B

The Superstructure Sections Sheet (Form DS-D-0127) is used to input section dimensions when the entire superstructure is being described. Input consists of:

1. Section Number
2. Live Load Distribution (S)
3. Superstructure (S.S.) Data
4. Slab Data
5. Interior Girders
6. Exterior Girders
7. Overhangs

1. Section No.

   This is the Section No. that is referred to on the girder Girder Properties Sheet. The entry must be numeric. A maximum of nine referenced sections per problem may be used.

2. Live Load Distribution (S)

   This column is used to specify the live load distribution. An entry of 0,1, or 2 for S specifies S/5.5, S/6.0, or S/7.0, respectively. If left blank, S/5.5 will be assumed.

3. Cross Section Location, Recall, Reference Point Coordinate

   Leave these columns blank.

4. Superstructure (S.S.) Data

   The superstructure width and depth must be given. The width is measured from edge of deck to edge of deck and the depth from top of deck to the soffit.

5. Slab Data

   The thickness of the top slab must be given. If there is no bottom slab, the bottom thickness column should be left blank.

6. Interior Girders

   Give the total number of girders and web thickness for the interior girders. If the section consists of only exterior girders, omit both entries.

Panel B in English Units

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CALTRANS DESIGN SYSTEM

PRESTRESSED GIRDER ANALYSIS - SUPERSTRUCTURE SECTION

B

English

			Ref. Pt. Cord.		S. S. Data		Slab Data		Interior Girders		Exterior Girders						Overhangs					
											Left			Right			Left			Right		
Section No.	Group Section Location	Precast	X	Y	Width	Depth	Top Thickness	Bottom Thickness	No.	Web Thick.	Web Thick.	Factor		Web Thick.	Factor		Length	Top Thick.	Bot. Thick.	Length	Top Thick.	Bot. Thick.
	(ft)		(ft)	(ft)	(in)	(in)	(in)	(in)		(in)	(in)			(in)			(in)	(in)	(in)	(in)	(in)	(in)

UC 7261 Note: The shaded area above is for future application and is not used currently in the analysis.

Basic Section

Exterior Girders

Type 0 Type 1 Type 2 Type 3

Panel B in Metric Units

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CALTRANS DESIGN SYSTEM

PRESTRESSED GIRDER ANALYSIS - SUPERSTRUCTURE SECTION

DS-0-203 (REV. 11/96)

B

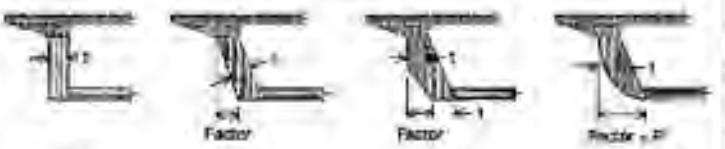
Metric

				S. S. Data		Slab Data		Interior Girders		Exterior Girders				Overhangs					
										Left		Right		Left			Right		
Section No.	Group Section Location	Precast		Width	Depth	Top Thickness	Bottom Thickness	No.	Web Thick.	Web Thick.	Factor	Web Thick.	Factor	Length	Top Thick.	Bot. Thick.	Length	Top Thick.	Bot. Thick.
	(km)			(m)	(m)	(mm)	(mm)		(mm)	(mm)		(mm)		(m)	(mm)	(mm)	(m)	(mm)	(mm)

SUC 7261 Note: The shaded area above is for future application and is not used currently in the analysis.

Basic Section

Exterior Girders



Type 0 Type 1 Type 2 Type 3

7. Exterior Girders

Give the type, web thickness, and factor for both the left and right exterior girders. Exterior girder types are shown at the bottom of the input sheet. Enter the appropriate type. Type 0 is assumed if no type is given. The web thickness and factors are measured as shown on the sketches of the various types.

Give the length, exterior thickness and interior thickness for the left and right overhangs. If omitted, the exterior thickness is assumed to be 7 inches (or 178 mms) and the interior thickness is assumed to be 11 inches (or 280 mms).

Section by Parts Sheet – Panel C

The Section by Parts sheet (Form DS-D-0128) is used to describe the structure part by part or to modify the section described on the Superstructure Section Sheet. Input consists of:

1. Section Number
2. Live Load Distribution (S)
3. Sign
4. Part Code
5. Part Dimensions
6. Reference Point Coordinates

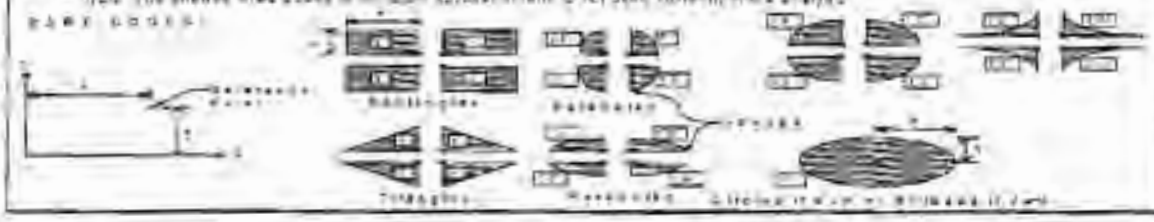
Panel C in English Units

CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS - SECTION BY PARTS

C
English

						Part Dimensions		Bar Pt Coord		Area Shape			
	S	Cross Section Location (ft)	Shape	Part Code	Part Name	Vertical or Depth D (in)	Horizontal B (in)	X (in)	Y (in)	Area (in²)	I_x (in⁴)	I_y (in⁴)	Note

PART CODES:



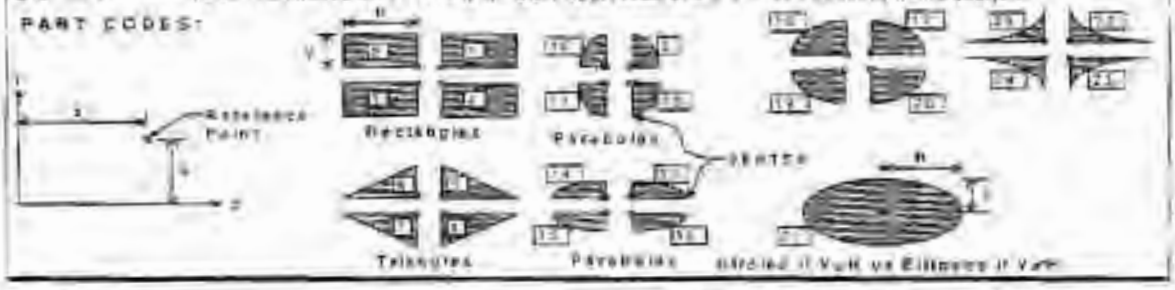
Panel C in Metric Units

CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS - SECTION BY PARTS

C
Metric

						Part Dimensions		Bar Pt Coord		Area Shape			
	S	Cross Section Location (m)	Shape	Part Code	Part Name	Vertical or Depth D (m)	Horizontal B (m)	X (m)	Y (m)	Area (m²)	I_x (m⁴)	I_y (m⁴)	Note

PART CODES:



1. Section No.

This is the Section No. that I referred to on the Girder Properties Sheet. The entry must be numeric. A maximum of nine sections per problem may be used. If this sheet is being used to modify a previously described superstructure section, the number must agree with the Superstructure Section Sheet.

2. S

This column is used to specify the live load distribution. An entry of 0, 1, or 2 for S specifies S/5.5, S/6.0, or S/7.0, respectively. If left blank S/5.5 will be assumed.

3. Cross Section Location, Recall

Not applicable. Leave these columns blank.

4. Sign

If this part is to be subtracted, enter a minus (-) sign in this column. If left blank, the part will be added to the section.

5. Part Code

Part Codes are described at the bottom of the input sheet. Determine the appropriate code number for the part being described and enter it in this column.

6. Part Dimensions

Enter the vertical and horizontal dimensions of the part being described.

7. Reference Point Coordinate

From the chosen coordinate system X axis and Y axis, enter the horizontal distance (X) and the vertical distance (Y) respectively to the reference point of the part being described. Keep X and Y coordinates positive and the reference point consistent for all parts.

8. Any Shape, Store #

Not applicable. Leave these columns blank.

Section Dimensions Sheet - Panel D, E

The Section Dimensions Sheet (Form DS-D-0025) is to be used to describe symmetrical or unsymmetrical "I" or "T" sections only when the standard "I" Girder shape is not applicable. Input consists of:

1. Trial No.
2. Section Dimensions
3. Live Load Distribution

Note: Use Panel C, Sections by Parts card for rectangular section.

1. Trial No.

   Enter a number equal to the Trial Number shown on the Girder Properties Sheet.

2. Section Dimensions

   The figure shown on the input form indicates rectangular and triangular elements available. Their respective vertical orientations must be maintained. Select the elements necessary to describe the section, enter the dimensions of those elements in the appropriate columns and leave all other columns blank. If the section is symmetrical, use only the upper (Symmetric Sections) group of dimensions to describe the section. If the section is unsymmetrical, use the upper group of dimensions to describe the left side and the stem of the girder, and the lower group of dimensions (Unsymmetrical Sections) to describe the dimensions of the right side of the girder.

3. Live Load Distribution (S)

   This column is used to specify the live load distribution (S). An entry of 0, 1, or 2 for S specifies S/5.5, S/6.0, or S/7.0, respectively. If left blank, S/5.5 will be assumed.

Panel D in English Units

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CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS - SECTION DIMENSIONS
Symmetrical Sections

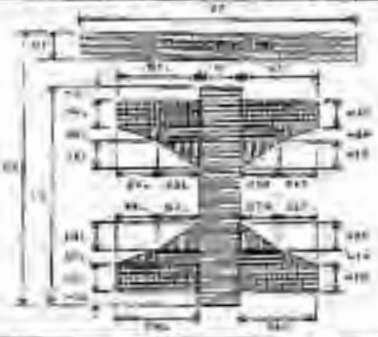
D
English

Trial No.	HX7 (in)	HX8 (in)	H4L (in)	H5L (in)	H6L (in)	H7L (in)	H8L (in)	H9L (in)	B3L (in)	W (in)	B4L (in)	B5L (in)	B6L (in)	B7L (in)	B8L (in)	S
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Notes:
"S" indicates the five load distribution factor.

S	L.L. Dist.
0	[illegible]
1	[illegible]
2	[illegible]

All dimensions in



Panel D in Metric Units

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CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS - SECTION DIMENSIONS
Symmetrical Sections

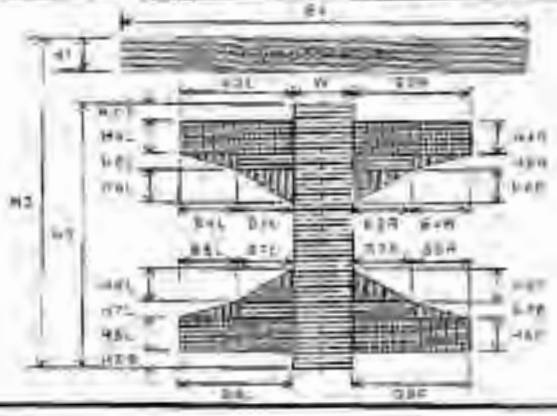
D
Metric

Trial No.	HX1 (mm)	HX8 (mm)	H4L (mm)	H5L (mm)	H6L (mm)	H7L (mm)	H8L (mm)	H9L (mm)	B3L (mm)	W (mm)	B4L (mm)	B5L (mm)	B6L (mm)	B7L (mm)	B8L (mm)	S
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Notes:
"S" indicates the five load distribution factor.

S	L.L. Dist.
0	[illegible]
1	[illegible]
2	[illegible]

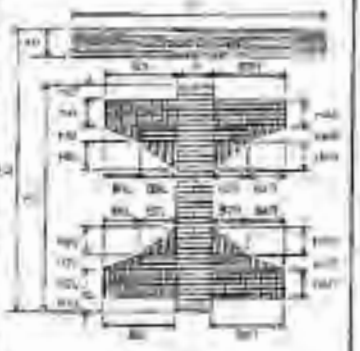
All dimensions in



Panel E in English units

CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS SECTION DIMENSIONS

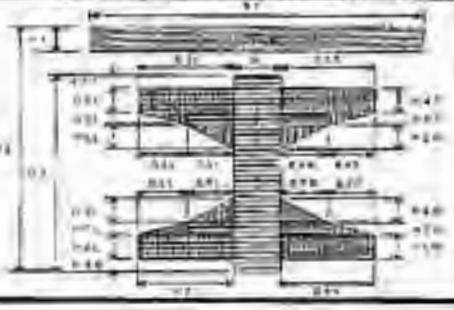
E
English



Panel E in Metric Units

CALTRANS DESIGN SYSTEM
PRESTRESSED GIRDER ANALYSIS - SECTION DIMENSIONS

E
Metric



Description of Output

The two forms of results for this program are described in the following sections:

Final Prestressing Force calculated, and Final Prestressing Force Given.

The output for this program consists of three parts:

(1) A display of the input

(2) The analysis

(3) The output of the results

The analysis output roughly follows the hand computation form (*Memo to Designers* 11-11, November, 1986).

A first approximation is based on the gross properties of the section and is shown on the first page of the analysis output. From the solution of this approximation up to four iterations will be made to determine the final solution using the final transformed section properties.