



Wyoming Department of Transportation

Bridge Pier Analysis System

BRASS - PIER™

Version 3.9

User Manual
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AASHTO Specification

The BRASS-PIER™ program is current with the AASHTO LFD Standard Specifications for Highway Bridges, 17th Edition, 2002.

How To Use This Manual

The first four sections of this manual are designed to act as a self help guide for the novice user and as a reference guide for the more experienced user.

To the Novice:

Recommended reading is Sections 1 and 2 (Introduction and General) followed by a brief look through Section 4, Typical Command Sets. Next, thirty minutes or more reviewing the rest of the manual section by section is recommended to get an idea of the types of commands available for defining a problem. There are sets of commands related to logical units of a bridge such as the deck, frame pier, solid shaft pier, etc.

One or two commands should be studied in detail noting the format of the command description and the structure of the command and following parameters. Each problem in BRASS-PIER is made up of a set of commands and associated parameters.

The next step recommended for the novice is to pick out a set of plans for a very simple bridge and code a set of BRASS-PIER commands. A structure should be chosen which closely matches one of the Typical Command Sets. The beginning of each chapter contains a description of the purpose of the commands to follow. Read this carefully. These descriptions are on the first pages of each tabbed section.

If the above procedure is followed, the novice should be able to assemble a proper input data set (command file). If the command set does not work, contact your BRASS Advisor.

To the User of Previous BRASS Versions:

BRASS-PIER input is based on commands followed by parameters. The parameters can be integer or floating point (contain a decimal) and need only be separated by a comma, column location does not matter so the input is “free format”. Each command has a three letter abbreviation. Several of the examples should be studied to get an idea of how the command structure language appears. We also suggest you read “To the Novice” preceding this and follow the procedure as necessary.

1. INTRODUCTION

TRANSVERSE ANALYSIS OF A BRIDGE SYSTEM

BRASS-PIER™ is a system of computer programs developed to assist in the analysis and design of reinforced concrete piers for bridges. The system analyzes a transverse (normal to the centerline of the roadway) cross-section of a bridge. Figure 1, Page 1.2 shows a general overview of the system.

BRASS-PIER presently consists of four components:

- Deck Analysis and Loading
- Pier Analysis and Loading
- Ultimate Strength Design/Analysis of Concrete Column Sections (PCA Column Design)
- Pier Support (Footing) Analysis and Design

The Deck Analysis and Loading Component will apply dead and live loads to a bridge deck section (one-foot-wide transverse strip) and distribute the loads as reactions to the girders.

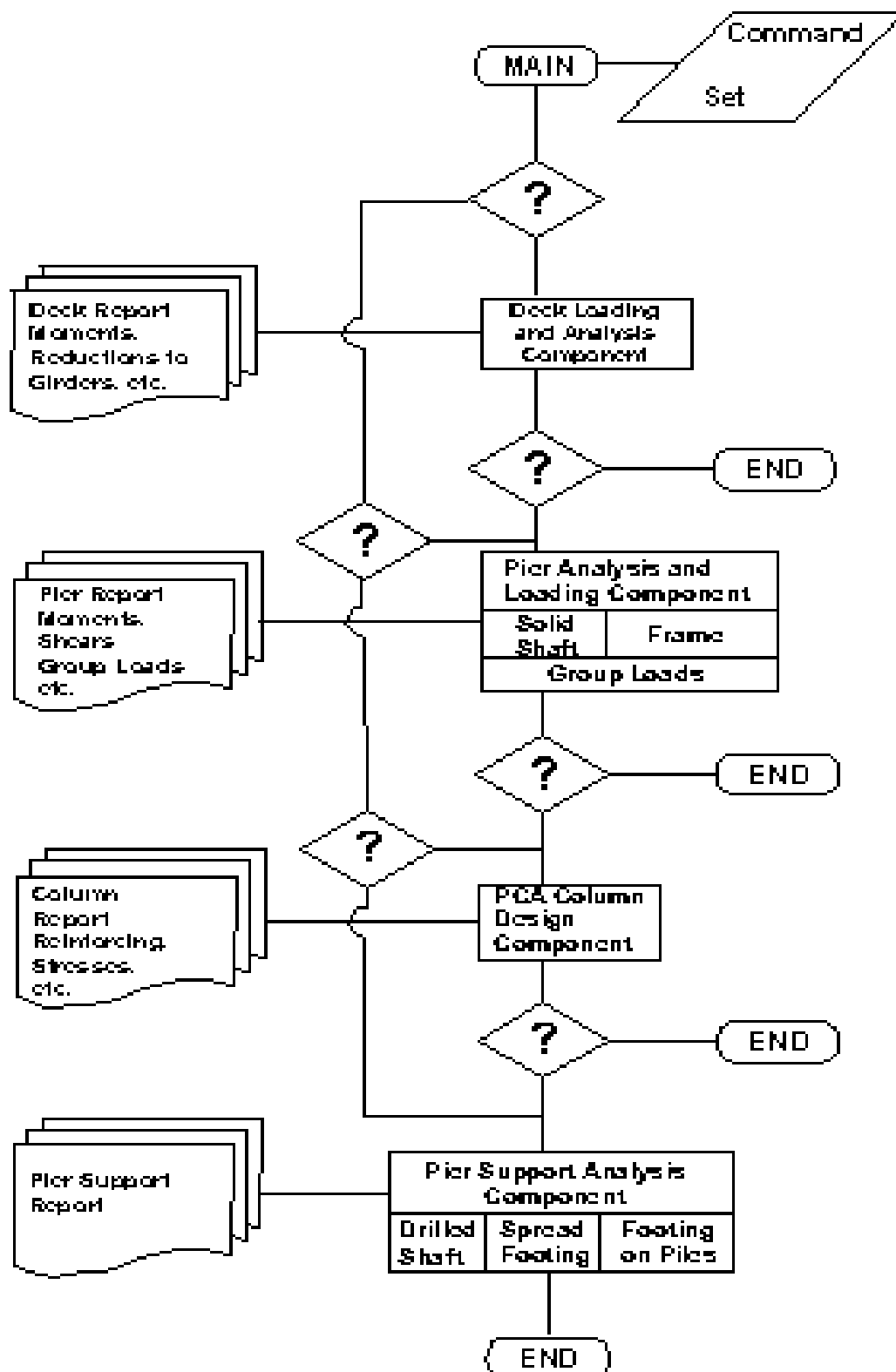
The reactions output from the Deck Analysis and Loading Component may be used as uniform load per foot for longitudinal girder analysis. The longitudinal girder reactions at the pier are then used by the Pier Analysis and Loading Component. A study of Figure 2, Page 1.3 should help explain the interrelationship between loads and reactions on transverse and longitudinal bridge members. An understanding of how BRASS-PIER™ and a longitudinal girder analysis system such as BRASS-GIRDER™ work together to determine loads to the pier is paramount to utilizing BRASS-PIER™ to its fullest extent.

The Pier Analysis and Loading Component, using the dimensions and loads input, will apply the resulting forces to the pier and determine the resultant actions in the pier (shear and moment in the cross beam, axial load and moment in the columns). The PCA Column Design Component when supplied the cross-section properties and applied loads will determine the required column reinforcement. If the actual column reinforcement is input, the program will determine the adequacy of the section to resist the applied loads. The Pier Support Component takes the forces at the bottom of the columns and performs one or more types of footing design.

The Deck Analysis and Loading Component can analyze bridge decks supported on two or more girders, up to a maximum of twenty. The Deck Loading Component has three purposes. The first is to assist the engineer in the analysis of the deck itself. See BRASS-GIRDER™ for complete information. The second is to assist in the analysis of the longitudinal girder system with the distribution of the dead load of the deck to the girders. The third is to assist in the analysis of a frame pier with the distribution of live load to the girder bearings and hence to the pier. The deck analysis/rating must be done in BRASS-GIRDER™ not BRASS-PIER™.

The dead load distribution section of the Deck Analysis and Loading Component will calculate and apply dead load to the deck using the dimensions of the deck, curbs, etc., and any superimposed loads input.

BRASS-PIER System Overview



TYPICAL BRASS-PIER USAGE WITH GIRDER ANALYSIS (BRASS-GIRDER)

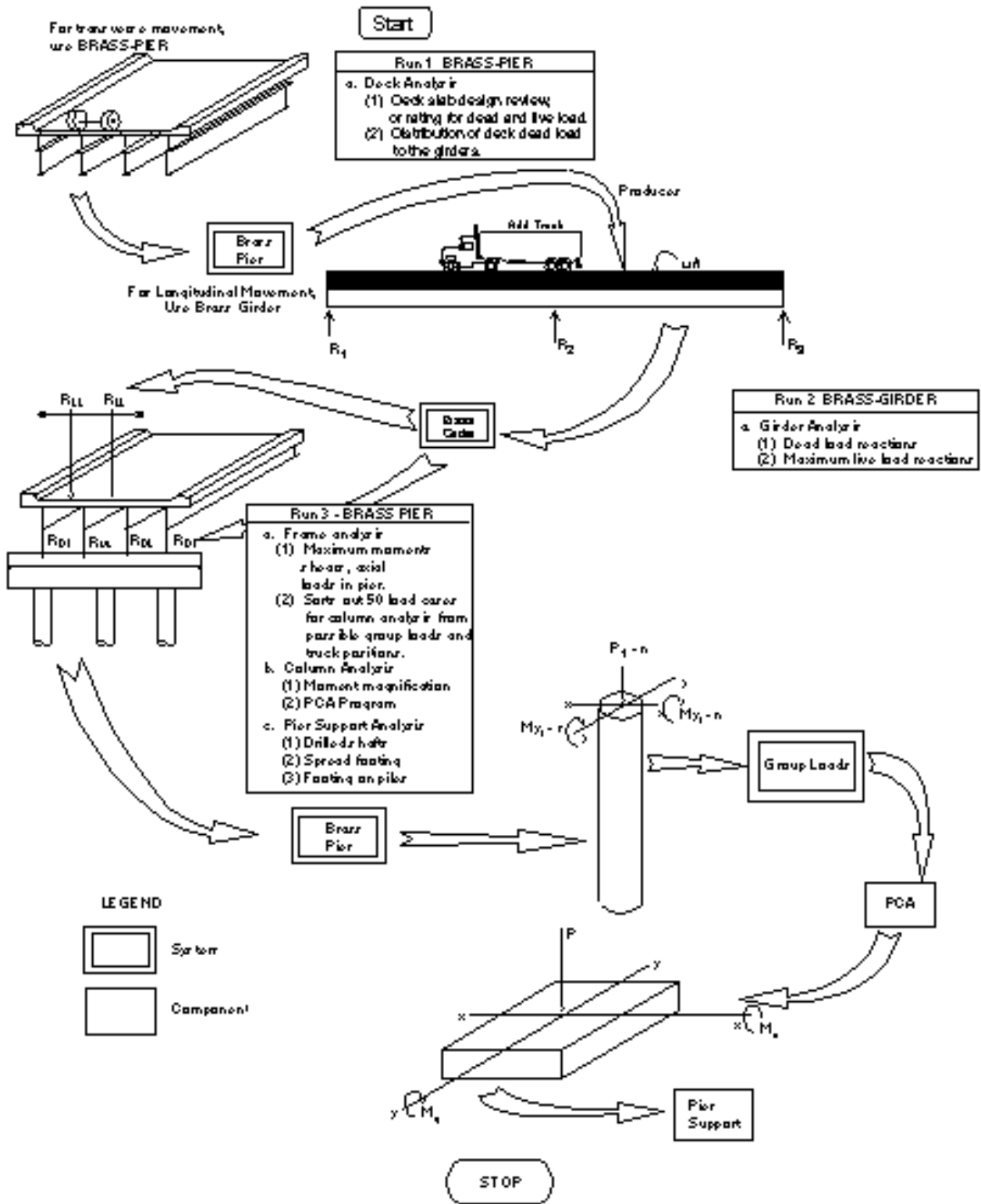


Figure 2

Up to 10 uniform and 10 concentrated loads may be applied to the deck. A wearing surface may also be applied. The limits of the wearing surface will be defined by the curbs and median, or the limits of the wearing surface may be input. The Deck Loading Component will allow stage loading of the deck. This feature is used in the analysis of a longitudinal girder system where the deck slab is composite with the girders. The construction of a typical composite girder bridge involves the placement of the fluid concrete on the girders, followed by the placement of the curbs, railings, etc., on the hardened concrete slab. In the analysis of the longitudinal girder system, this results in a two stage dead loading of the structure:

1. The load due to the weight of the fluid concrete being applied to the non-composite girder section.
2. The load due to the weight of the curbs, railing, etc., being applied to the composite slab-girder section.

The placement of the fluid concrete on the girders is analyzed by calculating the uniform load on the girders due to the weight of the slab and applying this uniform load to the girder in a structural analysis program, such as BRASS-GIRDER™. BRASS-PIER™ treats the deck as a continuous one foot wide beam over the girders. The reactions due to this one foot wide beam are calculated. The reactions at the girders for the one foot strip of deck then become the uniform loads (in kips per foot) to be applied to the individual non-composite girders in the structural analysis. The placement of the curbs, railing, etc., on the slab is analyzed by BRASS-PIER™ in the same method mentioned above to determine the uniform loads to apply to the individual composite girders in the structural analysis.

The input command set for the dead load distribution run may be saved, and with minor modifications, used for the live load distribution for frame pier analysis. The live load distribution section of the Deck Loading Component will position a specified live load (truck or lane) transversely on roadway at one foot intervals and calculate the live load reaction to each girder for each position. The resulting live load reactions are stored internally for use by the frame section of the Pier Analysis and Loading Component. The live load distribution section must be executed immediately prior to, and in the same run as, the frame section of the Pier Analysis and Loading Component so that the live load reactions will be available for use in applying the live load to the pier.

The Pier Analysis and Loading Component will analyze either solid shaft piers or frame piers with two to six columns. The loads which may be applied are: Dead, Live, Wind, Shrinkage, Temperature, Centrifugal Force, Longitudinal Force, Earthquake, Buoyancy, Stream Flow, and Ice Pressure. The vertical loads from the superstructure (Dead and Live load) may be applied by either input of the girder reactions or automatically through the Deck Analysis and Loading Component. The horizontal forces from the superstructure (Centrifugal and Longitudinal, or Braking, forces) and the forces from nature (Buoyancy, Stream Flow, and Ice Pressure) may be applied by either input of the force or by input of the data required to calculate the force. The forces on the pier which result from the application of the various loads are combined according to the AASHTO specifications for Combination of Loads, 3.22.

As there is a very large number of load cases to consider for the design of columns in a frame pier, it is impractical to analyze each case. The many possible positions of trucks on the bridge deck and number of group load combinations, create literally thousands (depending on deck width) of load cases of M_x , M_y and P . BRASS-PIER™ automatically eliminates all identical load cases, and then utilizes the following procedure to reduce the number of load cases to a maximum of 50.

Each load case, c , produces a vector, V_c

$$\text{where } V_c = \sqrt{(M_{x_c})^2 + (M_{y_c})^2 + (P_c)^2}$$

The direction of the load vector is determined by its horizontal angle about the P axis and its vertical angle above the plane containing the M_x and M_y axes. As P is always positive and a column symmetrical about both axes is assumed, only that portion of the biaxial bending interaction diagram where M_x , M_y , and P are positive is considered as shown below in Figure 3.

Any vector V_c which projects through the failure surface formed by the diagram indicates that the column is not adequate for load case c . Therefore, the column must be designed so that no vector passes through the failure surface. To accomplish this, BRASS-PIER™ divides the failure surface into 50 "windows", each 9° wide horizontally and 18° long vertically as shown in Figure 3. BRASS-PIER™ then finds the load case having the longest vector in each window. Generally there are less than 50 because some windows will have no vectors.

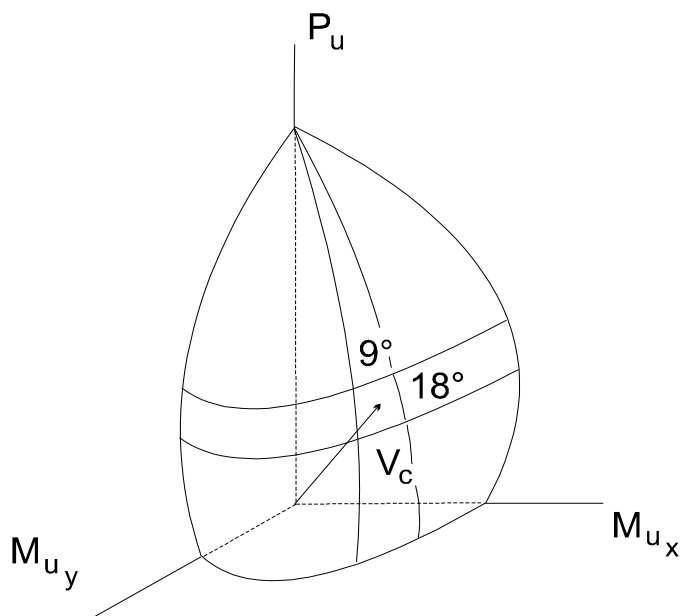


Figure 3

For each load case, c , the PCA Column Design Component will design the required reinforcement for a reinforced concrete compression member or will investigate the adequacy of a given cross section to resist a similar set of loadings. The method of solution is based on accepted ultimate strength theories for reinforced concrete design. It will also compute the moment magnifiers (AASHTO) to take into account slenderness effects.

The Pier Support Analysis Component consists of three sections. These sections are:

1. Spread Footing analysis
2. Footing on Piles analysis
3. Drilling Shaft Foundation analysis (Future)

The Pier Support Analysis Component may be run independently or be included in sequence in a complete pier analysis wherein the loads will be passed automatically to this component.

BRASS-PIER™ INPUT LANGUAGE allows the bridge engineer to communicate with the problem-solving capabilities of BRASS using terminology common to the bridge engineering profession. System input is free format consisting of commands grouped logically to define the bridge structure, loads to be applied and the output desired. Figure 4 shows the command groups.

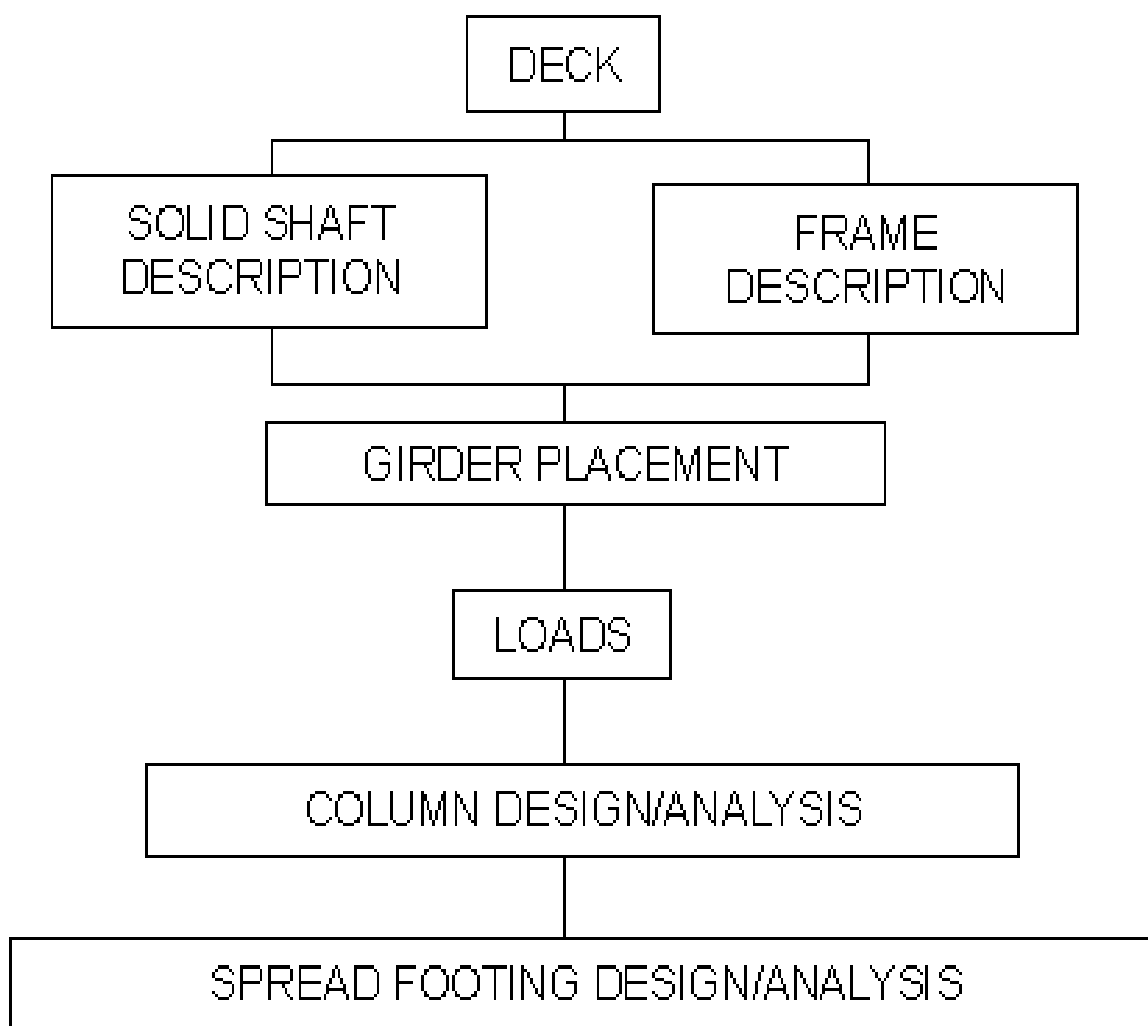


Figure 4 Command Groups

OUTPUT -- data is designed to be logically arranged and self-explanatory. The amount of detail is controlled by the user through the REPORT-LEVEL command.

SYSTEM AIDES -- each subroutine in BRASS-PIER™ is assigned a number and placed in a numbered component. Built in trace of intermediate values may be turned on by subroutine number or by component number through the SYSTEM commands. Each subroutine is internally documented with numerous comments.

The BRASS™ Suite

BRASS™ is a suite of programs that assist the engineer in many aspects of bridge design and rating. These programs are described below:

Program	Description
BRASS-GIRDER™	Performs a design review and/or rating of highway bridges decks and girders using plane frame analysis and the AASHTO Standard Specifications. Load factor and working stress computations are performed.
BRASS-GIRDER(LRFD)™	A comprehensive system for the design and/or rating of highway bridges decks and girders using finite element theory of analysis and current AASHTO LRFD Specifications.
BRASS-CULVERT™	Designs, analyzes, and/or rates one, two, three, or four barrel reinforced concrete rigid or flexible box culverts, with or without bottom slab. End skews can also be defined. Wall and slab thickness may be specified or the program will set the thickness. AASHTO guidelines are followed and Service Load Design, Load Factor Design, or Load and Resistance Factor Design may be specified. Member capacities are designed based on applied truck load, soil fill, self weight and water pressure. Standard AASHTO and user defined truck loadings can be specified. Output generated by the program includes: culvert geometry; moments, shears, and axial forces at tenth points; stresses; required area of reinforcement; steel design table; splice length; weights and volumes of steel and concrete; and influence ordinates. Critical design moments, shears, and axial forces for each member are summarized.
BRASS-PIER(LRFD)™	Performs an analysis of a bridge transverse section at pier locations. Provides a comprehensive analysis of bridge decks, piers, and selected foundation types. All AASHTO (LRFD) loads and group loads are considered. Live load is automatically positioned for maximum actions.
BRASS-TRUSS™	Performs a comprehensive working stress analysis and rating of simple or continuous truss or girder floorbeam stringer type bridges.
BRASS-SPLICE™	Performs the design of field splices for rolled beam or welded plate steel girders. Design criteria are in compliance with the AASHTO Load Factor Design Standard Specifications and WYDOT design practice.
BRASS-POLE™	Performs a working stress analysis of cantilever sign, luminaire and signal support structures. Round or polygonal steel poles may be analyzed according to the AASHTO Standard Specifications.
BRASS-DIST™	Performs a finite-strip element analysis to determine the factor for wheel load distribution for any axle spacing or width and any tire configuration of a truck placed at any position on the bridge deck. Standard trucks may also be used. NOTE: AASHTO formulas are based on empirical data and are applicable to six-foot axle widths. BRASS-DIST™ will also give results for a simple beam “deck-to-girder” analysis for dead loads.
BRASS-PAD™	Performs analysis and design of steel or fabric reinforced elastomeric bearing pads according to the AASHTO Standard or LRFD Specifications.

Additional information may be obtained from:

Keith R. Fulton, P.E.
State Bridge Engineer
Wyoming Department of Transportation
5300 Bishop Boulevard
Cheyenne, Wyoming 82009-3340
Telephone: (307) 777-4427
Fax: (307) 777-4279
E-Mail: Keith.Fulton@dot.state.wy.us
Web Page: http://dot.state.wy.us/wydot/engineering_technical_programs/bridge/brass
FTP Site: <ftp://brass:password@wydot-ftp.dot.state.wy.us>

Technical Assistance:

Brian D. Olsen, P.E.
Bridge Engineer
Telephone: (307)777-4745
E-Mail: Brian.Olsen@dot.state.wy.us

When requesting technical assistance, please mail (or E-mail) your input data set and mail (or fax) a description of the problem, any error messages, any bridge drawings, and any hand computations which illustrates the concern. See page 2.10 for solutions to common errors. A Problem Log number will be assigned to track the progress of resolving the problem. You may check the status of the Problem Log by visiting <http://www.dot.state.wy.us/brass/BRASSProbLog.jsp>

2. GENERAL

BRASS-PIER™ is designed to assist a bridge engineer in the design or analysis of a pier or its components. To use BRASS-PIER™, the engineer inputs a series of "Commands" each followed by one or more parameters. Basically the engineer needs to describe: 1) the bridge deck, 2) the pier (either solid shaft or frame), 3) the placement of the girders on the pier, 4) the loads to be applied, 5) the properties of the columns, and 6) the properties of the footing(s).

"Typical Command Sets" are provided to help the engineer become acquainted with the system. These begin on page 4.1.

Numerous defaults are built into BRASS-PIER™. If a Command parameter has a default value listed, the parameter may be left blank and the default value will be used. Be sure to enter zero when it is a valid desired value.

Short descriptions of the Commands and their parameters are summarized in the BRASS-PIER™ Command Language Manual. If additional information is required, each short description of a command has the number reference for the full description contained in this manual.

Each input "Command Set" must begin with one or two TITLE commands. Optional COMMENT commands may be used as often as needed to document the input series of commands. The commands must be arranged in the order shown to describe the problem. However, not all of these groups of commands are required.

- 1) Bridge Deck
- 2) Solid Shaft or Frame Pier
- 3) Girder Location
- 4) Loads
 - Dead Load
 - Live Load
 - Wind Load
 - Centrifugal Force
 - Longitudinal Force
 - Shrinkage
 - Temperature
 - Earthquake
 - Buoyancy
 - Stream Flow
 - Ice Pressure
- 5) Column Design/Analysis
- 6) Footing Design/Analysis

An overview precedes each of the above groups of commands and is tabbed for quick reference.

Input Format

The commands guide the user in building an ASCII data file. This data file is developed in a command format. Each line begins with a command which describes data entries hereinafter referred to as parameters. A blank space following the command *is required*.

The data may be entered as a real (including a decimal), an exponential (i.e. 12.345e4), an integer (excluding a decimal point) or an alpha character. Zero is not the same as a blank. Alpha characters are NOT case sensitive. Default entries are given with most commands and are employed by a blank field or by omission of the command in those cases where all default values are desired. Each command has a three character abbreviation which may be used in lieu of the full command name. Commands and their abbreviations are also NOT case sensitive.

Commas are used to delineate parameters. The number of spaces between entries has no meaning, however, do not use tabs to separate entries. For example, if the third entry of a command is the only entry required, any of the following would be valid.

```
COMMAND-EXAMPLE      ,      ,      2.0,      ,      ,
COMMAND-EXAMPLE      ,      ,      2
CEX                   ,      ,      2.0
CEX                   ,      ,      2.0000
CEX                   ,      ,      2
```

Continuation Character: A maximum of 80 characters is allowed per line in the data file. Some commands have numerous parameters and all of them may not fit on one line. Therefore, a continuation character may be used to indicate that another line follows which should be appended to the command line. A slash (/) is used as the continuation character and must be the last character in the input line. There is no limit on the number of continuation lines, however, the total number of characters for one command is 420. An example continuation is illustrated.

```
COMMAND-EXAMPLE 123.4, 567.8, 901.2, 345.6, 789.0, 123.4, 567.8, /
                901.2, 345.6
```

It is not required to build an input data set and run BRASS from Windows™. The user may use any ASCII text editor to create an ASCII data file. BRASS-PIER™ may be executed at the DOS prompt by entering “C:\PIER\EXE> PIER filename.DAT filename.OUT”.

Output files may be viewed using most text editors. Unfortunately, DOS 5.0+ EDIT, used by Microsoft Windows™, does not utilize enough extended memory to load large output files. See page 2.9 for instructions to view output files.

There are several commands available to the user to control the amount and type of output. These commands are located in:

<u>Command #</u>	<u>Command</u>	<u>Page</u>
#30	SYSTEM-1 command	6.2
#40	SYSTEM-2 command	6.4
#50	SYSTEM-3 command	6.6

#55	REPORT-LEVEL command	6.8
#60	DECK-CON command, parameter 1	7.4
#550	GROUP-CONTROL command, parameter 2	10.2

Microsoft Windows™ Graphical User Interface

Introduction

A Microsoft Windows™ based Graphical User Interface has been developed to take advantage of many of the features within the Windows™ environment. These features include user friendly graphical input forms (also called ‘dialog boxes’), on-line help, ‘point-and-shoot’ text editors, and drop down menu commands. This section is designed to help you get started with using the BRASS-PIER™ Graphical User Interface (GUI).

Running the Graphical User Interface

To enter the GUI, double-click on the application icon ‘BRASS PIER’ in the BRASS Program Group.

Most of the BRASS dialog boxes have standard Windows™ functions. Dialog boxes created specifically for BRASS-PIER™ each have five additional buttons:

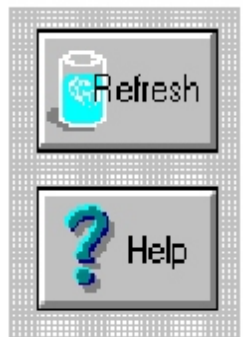


This button will write the data entered in the dialog box into the input data set. It will then close the dialog box and move on to the next command.

This button will cancel the entries into the dialog box and will close the box.



This button will write the data to the input data set and leaves the dialog box open. This function is useful when a particular command is to be repeated several times with minor changes to the data (i.e. several rows of reinforcing with minor changes in row location).



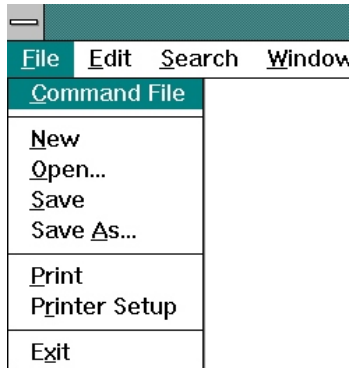
If another line of the same command is desired (i.e., TLE or CAP), this button will “Refresh” or clear the previous input and reset variables to their default values.

This button will access the *help* file for the displayed dialog box.

NOTE: If two or more of the same commands are desired, do not use *Write* button for the final entry. Use the *OK* button. If you use *Write* and then *OK*, it will duplicate the last set of

data. If you inadvertently click the *Write* button, you may double click the negative symbol in the upper left hand corner or the smallest window displayed to exit properly. This writes the values to the input file and exits the dialog box. In short *OK* performs *Write* and then *Cancel* in that order.

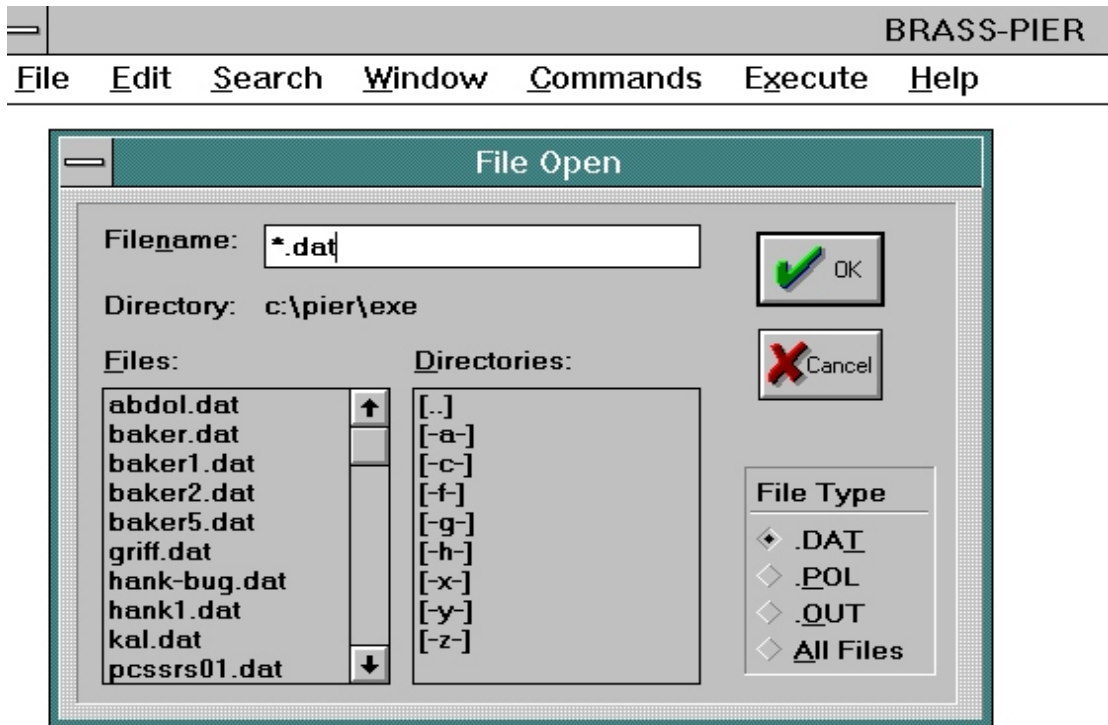
Description of the File Option



COMMAND FILE: This will open the last command file (input data set) you were working on in this session, or will open a blank input data set named 'input.pol'.

- New:** Open a new command file.
- Open:** Open a specific command file.
- Save:** Save the current command file.
- Save As:** Save current command file in the directory and name you specify.
- Print:** Print current command file.
- Printer Setup:** Open the windows printer setup to specify a printer.
- Exit:** Exit BRASS-PIER™.

The **Open** option will display a dialog box that is slightly different than the standard **Open** box found in most Windows™ applications.



You may select any of the 'filter' options by clicking any of the *File Type* check boxes in the lower right hand corner.

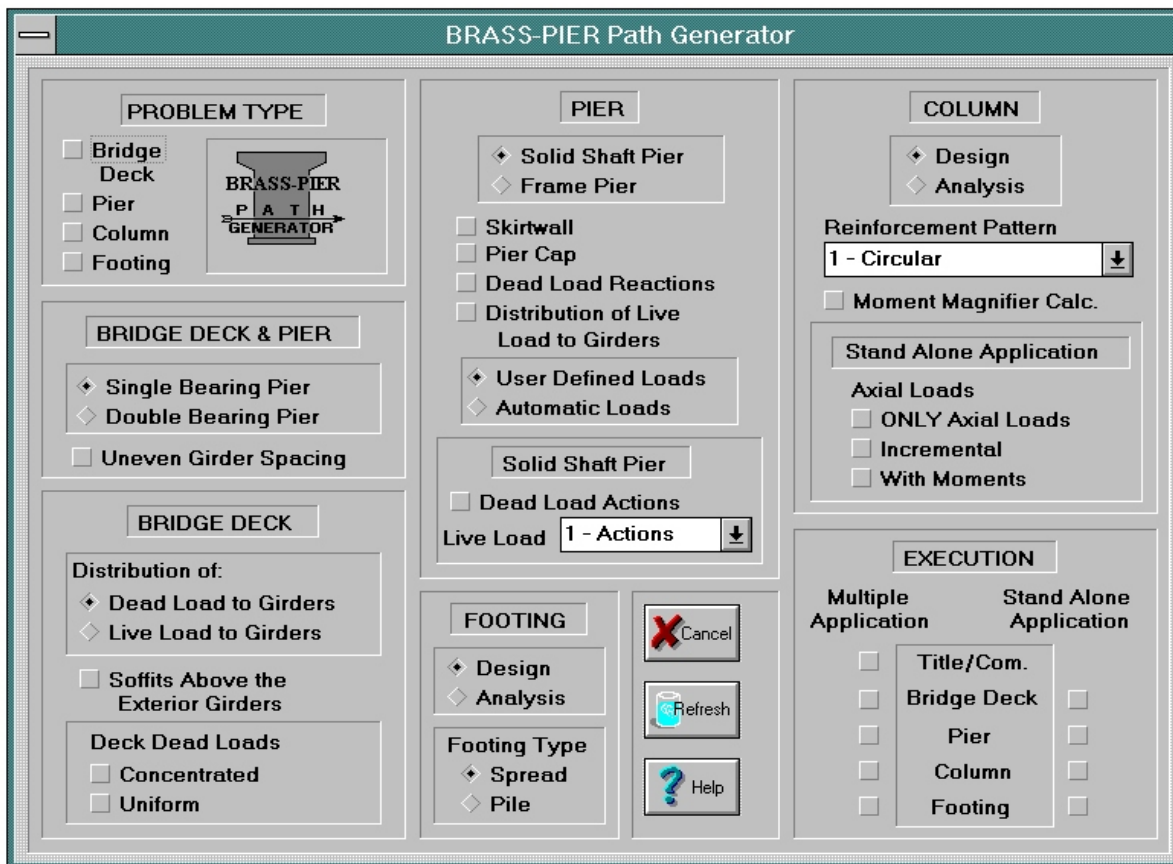
Creating a BRASS-PIER™ Command File (Input Data Set)

Remember, the Windows™ Graphical User Interface (GUI) is just a *tool* for creating an ASCII input

data set. On-line help and program execution are also available in the GUI, however, it is not required to use Windows™ to perform these functions.

In the GUI, the user may create an input data set using any combination of the following three methods: 1) By selecting **File**, then **New**, the user is placed in DOS 5.0+ EDIT. Commands may be typed following the same format and procedures as outlined in the BRASS-PIER™ manual; 2) While in EDIT, the user may select the **Commands** drop down menu then select any of the available dialog input forms to create commands; 3) The **Path Generator** (in the **Commands** drop down menu) may be used to automatically select dialog input forms. The last method is described below. **NOTE:** BRASS-PIER™ commands must be placed in the order they appear on this list and in the User Manual.

The Path Generator



The Path Generator is an optional tool which prompts the user to define the type of pier or pier component (deck, solid shaft pier, frame pier, column, and footing) to be analyzed. BRASS-PIER™ has the capability to design or analyze each of these components separately or combined with other components. If certain components require data input, this data can be “passed along” to the other component analysis routines. Repetition of data input for other components is not necessary. For example, girder spacing and reactions do not need to be input into the cap and pier commands since they are passed downward by the deck commands.

From this information, BRASS-PIER™ provides a series of dialog boxes required to describe the pier or pier component(s). Once the pier has been defined on the **Path Generator** dialog box, the user can generate the input file by checking each of the *EXECUTION* boxes in sequence, either as

a combination of components (*Multiple Application*) or as separate components (*Stand Alone Application*).

Remember, the Path Generator displays *only* those forms that are required for the pier structure or component(s) that have been defined. Additional data may be required for specific cases.

PROBLEM TYPE Select which pier component(s) are to be analyzed or designed. Up to four boxes may be checked.

BRIDGE DECK & PIER Indicate whether this is a single bearing or double bearing pier. Also indicate if the girder spacing varies across the pier cap.

BRIDGE DECK Indicate whether you want BRASS-PIER™ to compute the girder reactions due to the dead load of the deck, curbs, railing, etc. distributed to the girders -or- compute the girder reactions due to placement of live load(s) placed laterally on the bridge deck. Since BRASS-PIER™ can only perform one distribution of loads per run, it may be necessary to perform a bridge deck analysis twice. Usually a dead load distribution is run first, followed by a live load distribution and pier analysis/design. The dead load results from the first run are then input as girder reactions for the second run.

Next, indicate whether soffits exist above the exterior girder. Finally, indicate if concentrated loads and/or uniform loads are placed on the deck.

PIER Indicate whether this is a solid shaft pier or a frame pier. Next, indicate if dead loads due to a skirtwall exist. Indicate if pier cap dimensions are to be input. Remember, at this time BRASS-PIER™ does not perform a pier cap analysis or design. Only *actions* on the pier cap are produced.

Indicate if the dead load and/or live load actions are to be input by the user. For centrifugal, longitudinal, earthquake, temperature, etc. loadings, indicate if the user will be inputting these forces or if BRASS-PIER™ will compute these actions according to AASHTO Specifications.

For a Solid Shaft Pier, indicate if dead load actions will be input. Also, indicate if live load actions, forces or reactions will be input (if not previously computed in the deck component).

COLUMN Indicate whether this is a column design or analysis. Enter the pattern of longitudinal reinforcing used in the column (either circular, tied - equal number of bars in each axis, tied - unequal number of bars in each axis, or irregular - irregular reinforcement pattern).

Next, indicate if moment magnifiers are to be used.

If *only* a column design or analysis is desired (*Stand Alone Application*), indicate if only axial loads are to be applied to the column and will be input by the user.

Next, indicate if an initial axial load, a final axial load, and an increment value is to be applied to the column. Finally, indicate if moments about the x-x and y-y axes are to be applied to the column.

FOOTING

Indicate whether this is a footing design or analysis. Also, indicate if this is a spread footing or a footing cap on steel piles.

EXECUTION

As described above, check each box, in order, to display the required dialog boxes. Use the column *Multiple Application* if more than one pier component will be described. Use the column *Stand Alone Application* if only a single pier component will be described.

The *Refresh* button will reset the pier definition fields but will not affect the *EXECUTION* check boxes.

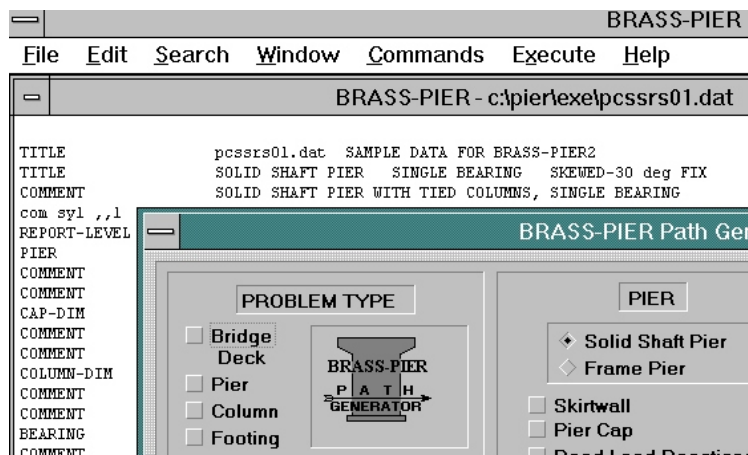
If a file is created using the Path Generator, the user must be sure to carefully review the commands created. A helpful hint is to always note the commands indicated at the top of each dialog box that is displayed by the Path Generator.

Effective Use of the Command File

Many GUI users prefer displaying the active Command File (or input data set) while entering data from the dialog boxes. This allows you to review the data *while* it is being added to the input data set.

You can view the input data set at any time by pulling down the **File** menu and selecting **Command File**. If you are working with the **Path Generator**, the input data set you are creating will be placed behind the **Path Generator** window.

To view the Command File, move the **Path Generator** window (or dialog box) to the side. This is done by clicking the mouse in the window title strip (at the top) and dragging the mouse (hold the left button down and move). Clicking anywhere in the **Command File** will bring the **Command File** to the front. Be sure to click anywhere in the **Path Generator** or dialog box to continue data input.



WARNING! As with most commands in BRASS, the commands may require placement in the file in a specific order (refer to the BRASS manuals). Using the **Commands** menu, as well as the **Path Generator**, will *place the command generated at the position of the cursor in the command file*. If you have just opened the file to edit, the cursor is automatically placed at the top of the input file. Before leaving the Command File to input data from a dialog box, ensure the cursor is placed at the **END** of the Command File or at the location you wish to enter data.

Individual commands may be inserted in a Command File at any time, in any place, from a dialog box. First, open the Command File and place the cursor at the location you wish to insert the command (usually before the first character of the following command). When the dialog box exits, the new command line will be inserted. **IMPORTANT:** Be sure to place the cursor in the first space below the last command before continuing to enter data from dialog boxes. As always, the Command File may be edited at any time using standard editor commands.

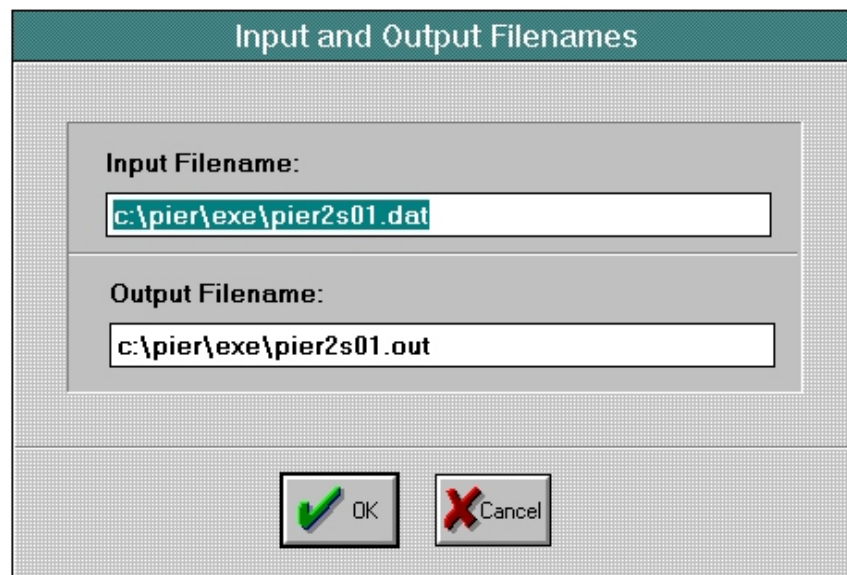
The Command File (input data set) must be saved and exited before executing BRASS-PIER™.

Executing BRASS-PIER™ from the Graphical User Interface

To execute BRASS-PIER™, you must first open the Command File and then close it. This ‘activates’ the Command File and prepares it for execution. If you do not ‘activate’ the Command File, BRASS-PIER™ will execute the last Command File work that was performed on during the current session or it will execute the default file ‘input.pol’.

Next, select **Execute** then **Run Command File**.

You will then be prompted for the input data set file name to run. The current ‘activated’ Command File will be placed in the *Input Filename* box and the *Output Filename* will be set to *filename.OUT*.



Selecting the *OK* button will begin executing BRASS-PIER™.

When BRASS-PIER™ begins execution, the screen will turn black for a short time. Upon completion of the analysis, the BRASS-PIER™ GUI will reappear. To retain messages on the screen

(in the case of input data set debugging), see section ‘Bugs, Gremlins and Other Problems’ on page 2.10.

Viewing BRASS Output Files

Output files may be viewed using most text editors or word processors. Unfortunately edit control, used by the GUI, does not utilize enough extended memory to load large output files. Therefore, you cannot view/edit large output files from inside the Graphical User Interface. An alternate editor is required. Smaller files, such as input data sets, may be viewed in the BRASS-PIER™ GUI.

To alleviate this problem, there is a sub-option in the **Execute** drop down menu called **My Editor**. This sub-option allows you to use any text based editor (Norton Deskedit, Lancaster University’s Programmer’s File Editor) or any word processing program (Microsoft Word, Corel Word Perfect).

To enable **My Editor** in Windows XP, select ‘Control Panel’ from the Start > Settings menu. In the ‘Control Panel’ window, select ‘System’ or ‘System Properties’. Then, select the ‘Advanced’ tab and click the ‘Environment Variables’ button. Next, enter a new User Variable and Value as BRASS_EDITOR and Drive:\Application Path\Application Name, respectively. Then select the OK button to save the Variable and Value. Finally, select the OK button to close the dialog. You will need to reboot the PC for the change to take effect.

A shareware text editor called Programmer’s File Editor, written by Alan Phillips, Lancaster University Computer Centre, United Kingdom, has been included with BRASS-PIER™. It must be noted that this program is a shareware program and is *not* an essential component of BRASS-PIER™. It is provided to the user, free of charge, as an optional text editor.

The output is formatted for portrait page orientation, with margin settings of 0.5" for the top, bottom, and left and 0.3" for the right. A monospaced font, such as 8pt. Courier New, is required for column alignment.

Accessing Help

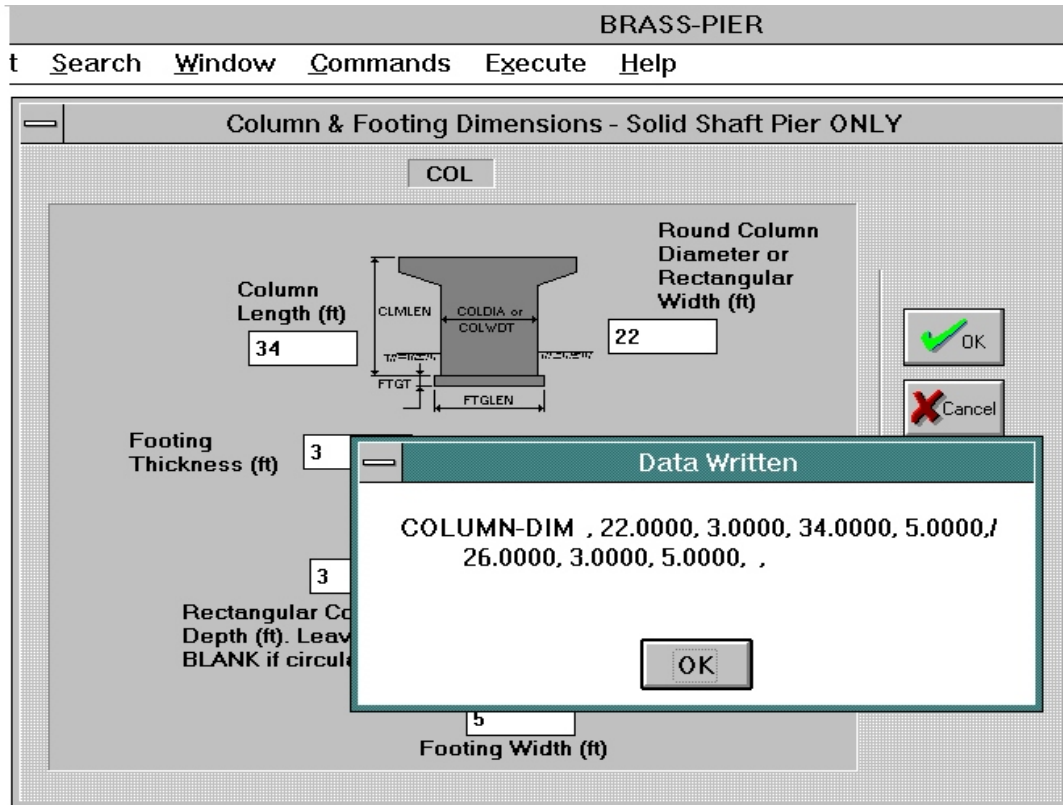
You can use the on-line Help system to view information about any BRASS-PIER™ command or dialog box. To access the complete Help file, choose the **Help** command from the Menu bar.

Clicking on any green text (hypertext) will place you in the Help section pertaining to that text. The Help file can also be accessed by pressing the *Help* button in any of the dialog boxes. Doing so will place you in the Help file pertaining to that particular command.

You can also obtain help for a particular command by placing the cursor on any line in the Command File and pressing the <Ctrl F1> keys simultaneously.

Refer to your Microsoft Windows™ documentation for directions using Help.

Some users requested immediate notification that data was being written to the Command File. The menu item **Help>Show Writes** will display a dialog box that shows the data that was written to the Command File when the *Write* button is selected:



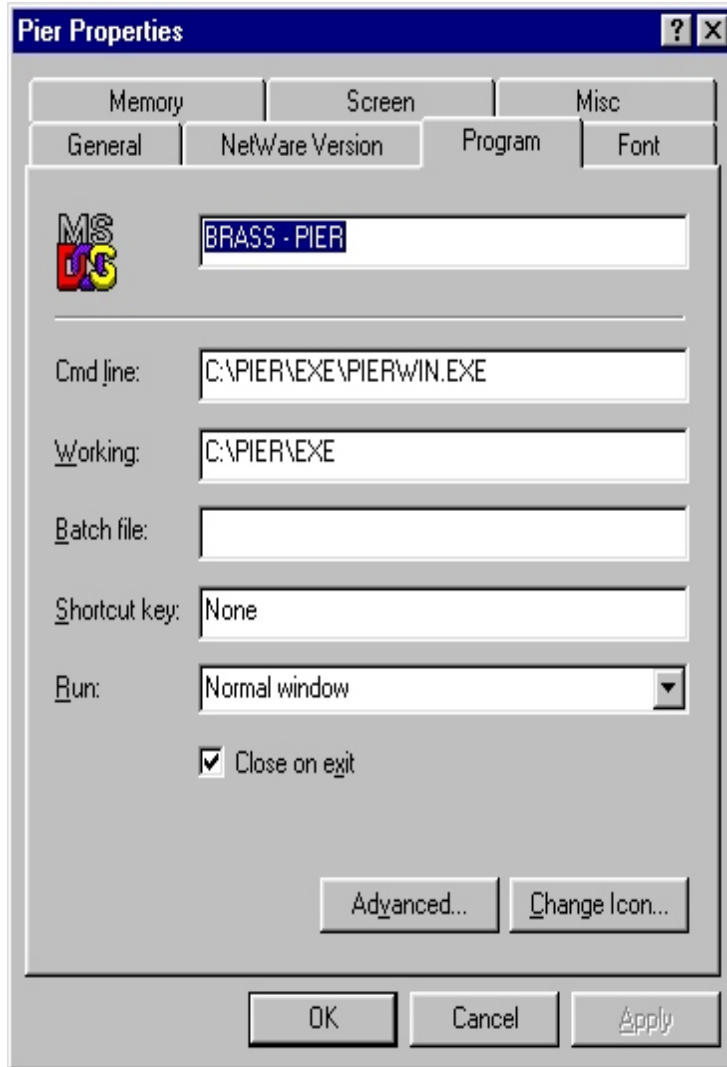
If you inadvertently activated the function, you can disable it by choosing **Help>Show Writes**. Disabling the function should remove the check mark in front of the words *Show Writes*.

Bugs, Gremlins and Other Problems

Inevitably, every user will have an input data set that will not run properly. Based on past experience, approximately 90% of all problem logs are user error. Naturally, this should be the first place to look when BRASS won't run. A lot of error and warning messages have been written into the source code to handle the most common errors. It is nearly impossible to anticipate every error which may occur. When searching for coding errors, check the output file and/or screen messages for clues to the problem.

Occasionally, error messages flash on screen too fast for reading. There are two methods to retain these messages on screen. First, run BRASS-PIER™ from the DOS prompt, as described on page 2.2.

Second, edit the PIER shortcut file. In Windows Explorer, locate the file C:\PIER\EXE\Pier. Explorer will display the MS-DOS icon with this file. Right click on the file and select the Program tab. To display all error messages, make sure the box saying **Close on exit**, in the lower portion of the dialog box, is not checked.



Other common error messages are *Math Error* or *Divide by Zero Error*. This message usually indicates that some required data was not input. Check your input data set for omissions.

If you cannot resolve the problem, you can request technical assistance using the procedures listed on page 1.8.

3. LIST OF COMMANDS FOR

JOB CONTROL:

TITLE	TLE	10	Problem Title.
COMMENT	COM	20	Input Comments.
SYSTEM-1	SY1	30	System Control No. 1.
SYSTEM-2	SY2	40	System Control No. 2.
SYSTEM-3	SY3	50	System Control No. 3. Primarily a debugging aide by subroutine no.
REPORT-LEVEL	RPT	55	Control levels of Output reporting.

DECK LOADING:

DECK-CON	DCN	60	Bridge Deck Control.
DECKC-DIM1	DD1	90	General Dimensions.
DECKC-DIM2	DD2	100	General Dimensions. Required for concrete curbs and/or median.
DECKC-DIM3	DD3	110	General Dimensions.
DECKC-DIM4	DD4	120	General Dimensions. Required for tapers.
DECKC-DIM5	DD5	130	General Dimensions. Required for tapers on non-identical cantilevers.
DECKC-GS	DGS	140	Variable girder spacing. Required if girder spacing varies.
DECKC-LODG	DLG	150	Deck dead loads. General information.
DECKC-LODC	DLC	160	Concentrated Dead Loads. Required for concentrated loads on deck. Repeat as needed.
DECKC-LODU	DLU	170	Uniform dead loads. Required for uniform loads on deck. Repeat as needed.

DECKC-LODP	DLP	180	Live loads to be distributed through deck to pier.
DECK-AHD1	DA1	190	Distribution of live load, double bearing pier - deck dimensions.
DECK-AHD2	DA2	200	Distribution of live load, double bearing pier - variable girder spacing.
DECK-AHD3	DA3	210	Distribution of live load, double bearing pier - live loads.

PIER ANALYSIS:

PIER	PIR	220	Control of pier analysis.
SKIRTWALL	SKW	230	Skirtwall dimensions.
CAP-DIM	CAP	240	Pier cap dimensions.
COLUMN-DIM	COL	250	Pier column dimensions.
BEARING	BRG	300	Location and orientation of girder bearings on pier.
BEARING-VS	BRV	320	Variable girder spacing.

PIER LOADING:

DEAD-LOAD	DLD	330	Dead and live load control.
DEAD-ACTION	DAC	340	Dead load actions for solid shaft pier.
DEAD-REACTION	DRC	350	Input dead load girder reactions.
LIVE-ACTION	LAC	380	Live load actions for solid shaft pier.
LIVE-SOLID1	LS1	390	Data for calculation of live load forces on solid shaft pier.
LIVE-SOLID2	LS2	400	Data for calculation of live load forces on solid shaft pier.
LIVE-REACTION	LRC	410	Live load girder reactions.
LIVE-COMBINE	LLC	430	Define truck positions.
WIND-LOAD	WND	440	Wind load control.

SUPERSTRUCTURE	SPR	450	Data for calculation of wind loads.
WIND-REACTIONL	WRL	460	Girder reactions due to unit uplift at windward quarter- point of deck, wind from left.
WIND-REACTIONR	WRR	470	Girder reactions due to unit uplift at windward quarterpoint of deck, wind from right.
CENTRIFUGAL	CTF	480	Centrifugal force.
LONGITUDINAL	LTF	490	Longitudinal force.
SHRINKAGE	SHR	500	Shrinkage force.
TEMPERATURE	TMP	510	Temperature force.
EARTHQUAKE	ETQ	515	Earthquake force.
BUOYANCY	BUY	520	Buoyancy force.
STREAM-FLOW	STF	530	Stream flow force.
ICE-PRESSURE	ICE	540	Ice pressure force.

COMBINATION OF LOADS:

GROUP-CONTROL	GRP	550	Combination of loads control.
GROUP-A	GRA	560	Input of factors and loads.
GROUP-B	GRB	570	Input of loads.
GROUP-C	GRC	580	Input of loads.

COLUMN DESIGN/ANALYSIS:

COLUMN-DESIGN	PCA	590	Column design/analysis control.
FACTORS	FCT	600	Constant factors for design or investigation.
PROPERTIES	PRP	610	Material properties for design or investigation.
REINFORCEMENT-A	RNA	620	Circular or spiral pattern or equal number of bars in each face.

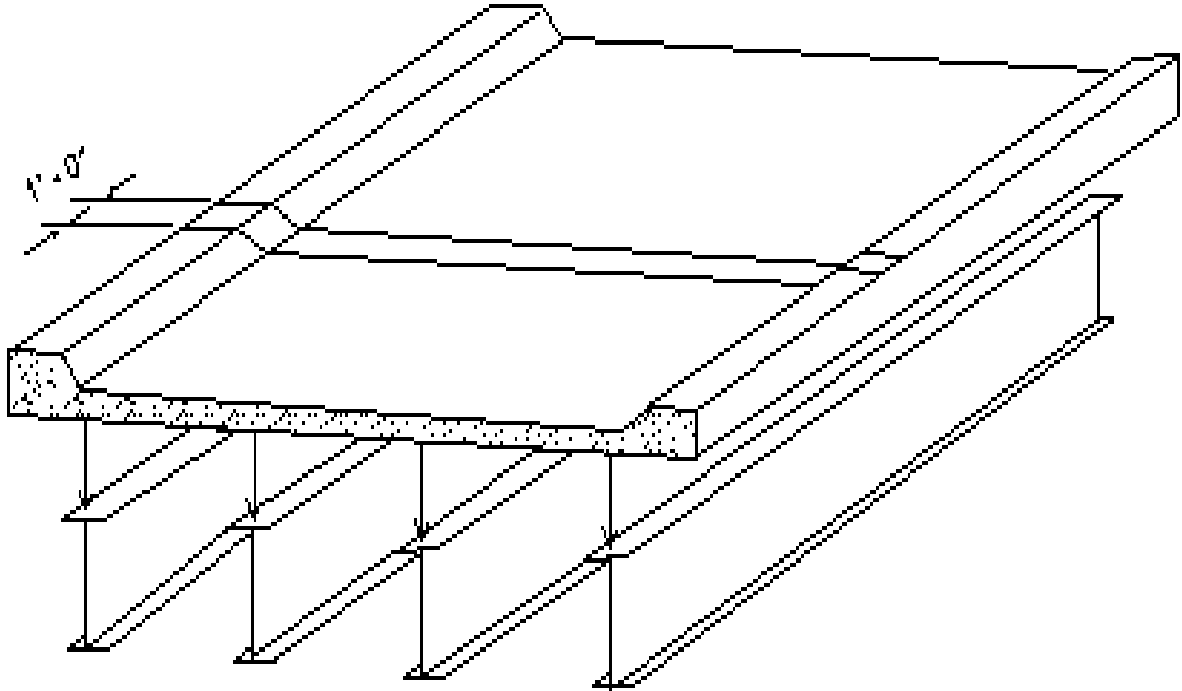
REINFORCEMENT-B	RNB	630	Tied member, number of bars in each face not equal.
REINFORCEMENT-C	RNC	640	Irregular reinforcement pattern.
LOAD-AXIAL	AXL	660	Axial loads.
LOAD-INCREMENT	INC	670	Axial loads: beginning, ending, increment.
LOAD-COMBINED	CMB	680	Axial loads combined with uniaxial or biaxial moments.
SLENDERNESS-A	SLA	690	Moment magnifier control.
SLENDERNESS-B	SLB	700	Moment magnifiers - beta factors and end moments.

FOOTING DESIGN/ANALYSIS:

FOOTING	FTG	710	Footing analysis/design control.
SPREAD	SPF	720	Spread footing dimensions.
SPREAD-DESIGN	SPD	730	Spread footing data for design.
PILE	PIL	740	Pile footing dimensions.
PILE-DESIGN	PLD	750	Pile footing data for design.
COLUMN-DATA	CDM	760	Column dimensions.
MATERIALS	MTR	770	Properties of footing materials.
REINFORCEMENT	RNF	780	Footing reinforcement data.
FOOTING-SERVICE	FSV	790	Service loads.
FOOTING-ULTIM	FUL	800	Ultimate loads.

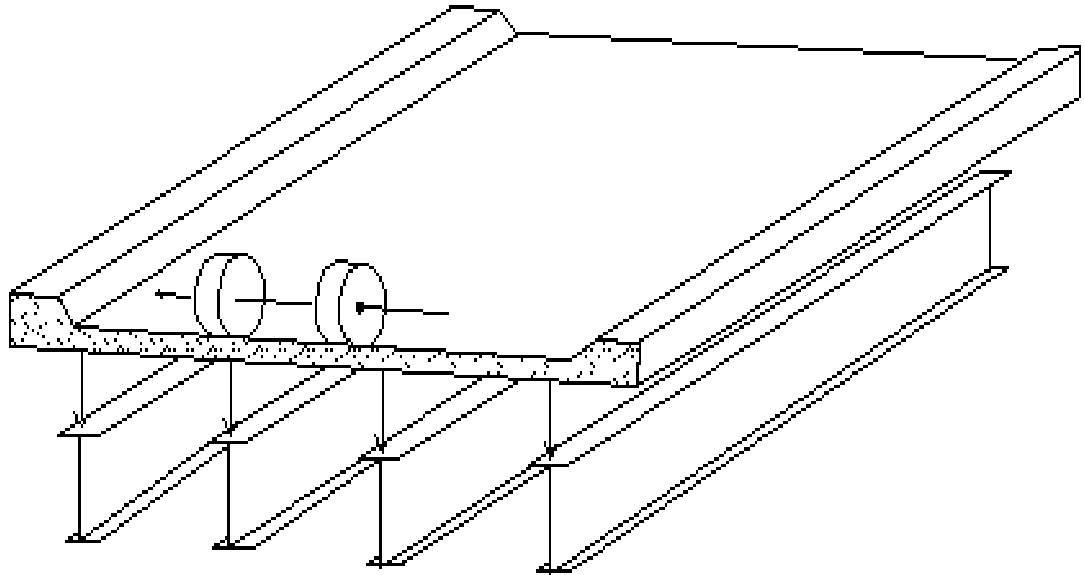
4. TYPICAL COMMAND SETS

1. Bridge Deck - Distribution of Dead Loads to Girders



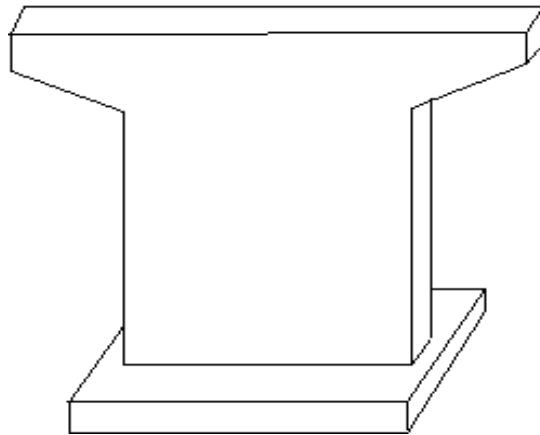
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TITLE	TLE	10	Required
COMMENT	COM	20	Optional
DECK-CON	DCN	60	Required
DECKC-DIM1	DD1	90	Required
DECKC-DIM2	DD2	100	Optional
DECKC-DIM3	DD3	110	Required
DECKC-DIM4	DD4	120	Optional
DECKC-DIM5	DD5	130	Optional
DECKC-GS	DGS	140	Optional
DECKC-LODG	DLG	150	Optional
DECKC-LODC	DLC	160	Optional
DECKC-LODU	DLU	170	Optional

2. Bridge Deck - Distribution of Live Load to Girders



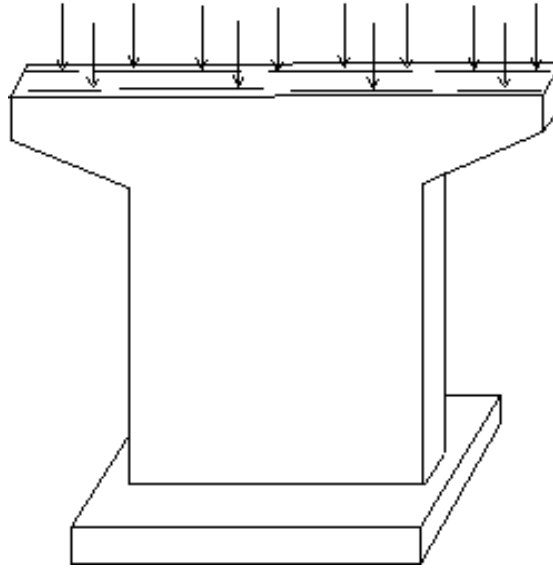
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
DECK-CON	DCN	60	Required
DECKC-DIM1	DD1	90	Required
DECKC-DIM2	DD2	100	Optional
DECKC-GS	DGS	140	Optional
DECKC-LODG	DLG	150	Optional
DECKC-LODP	DLP	180	Required

3. Solid Shaft Pier



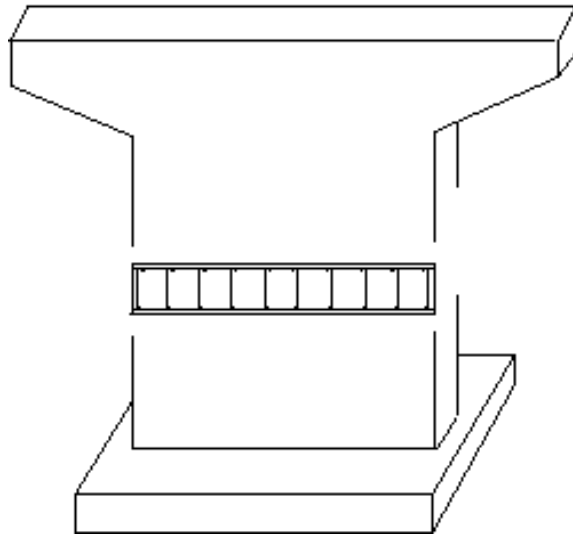
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Optional
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-ACTION	DAC	340	Optional
DEAD-REACTION	DRC	350	Optional
LIVE-ACTION	LAC	380	Optional
LIVE-SOLID1	LS1	390	Optional
LIVE-SOLID2	LS2	400	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional

4. Solid Shaft Pier - Double Bearing



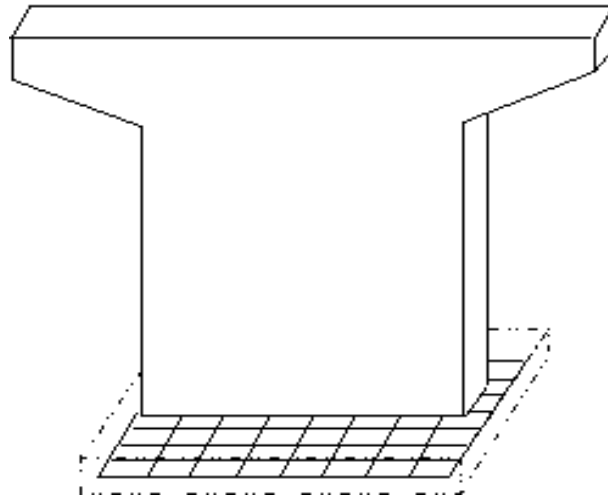
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Optional
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-ACTION	DAC	340	Optional
DEAD-REACTION	DRC	350	Optional
LIVE-ACTION	LAC	380	Optional
LIVE-SOLID1	LS1	390	Optional
LIVE-SOLID2	LS2	400	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional

5. Solid Shaft Pier with Column Design Analysis



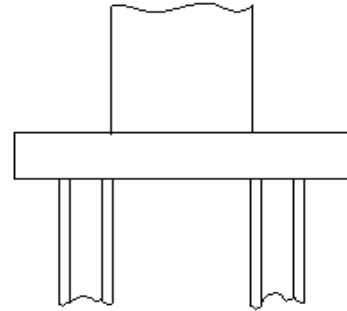
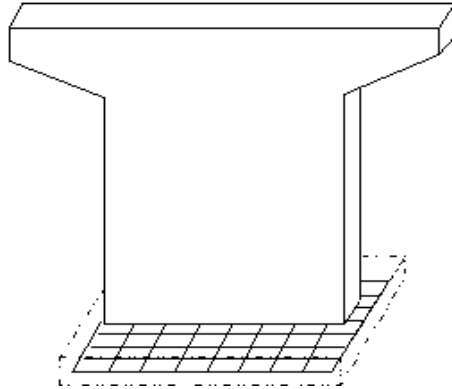
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Optional
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-ACTION	DAC	340	Optional
DEAD-REACTION	DRC	350	Optional
LIVE-ACTION	LAC	380	Optional
LIVE-SOLID1	LS1	390	Optional
LIVE-SOLID2	LS2	400	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
COLUMN-DESIGN	PCA	590	Required
FACTORS	FCT	600	Optional
PROPERTIES	PRP	610	Optional
REINFORCEMENT-A	RNA	620	Optional
REINFORCEMENT-B	RNB	630	Optional
REINFORCEMENT-C	RNC	640	Optional
SLENDERNESS-A	SLA	690	Optional

6. Solid Shaft Pier with Spread Footing Design/Analysis



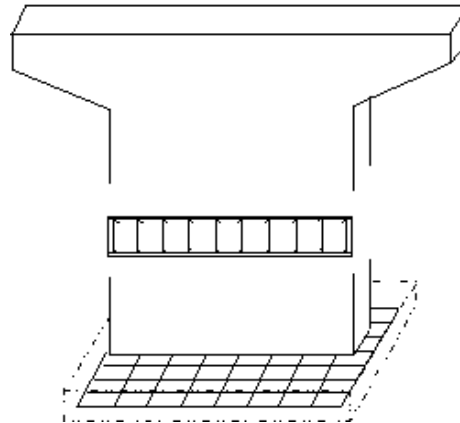
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TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Optional
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-ACTION	DAC	340	Optional
DEAD-REACTION	DRC	350	Optional
LIVE-ACTION	LAC	380	Optional
LIVE-SOLID1	LS1	390	Optional
LIVE-SOLID2	LS2	400	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
FOOTING	FTG	710	Required
SPREAD	SPF	720	Optional
SPREAD DESIGN	SPD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

7. Solid Shaft Pier with Pile Footing Design/Analysis



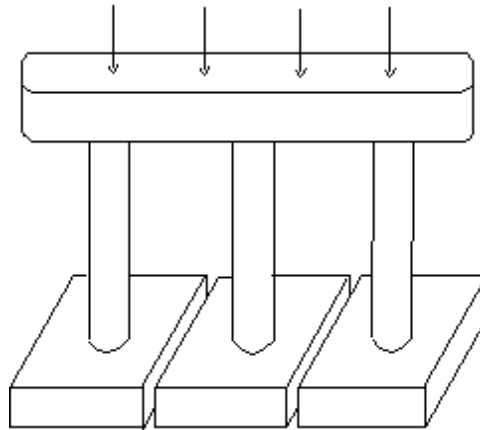
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Optional
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
FOOTING	FTG	710	Required
PILE	PIL	720	Optional
PILE-DESIGN	PLD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

8. Solid Shaft Pier with Column Design/ Analysis & Spread Footing Design/Analysis



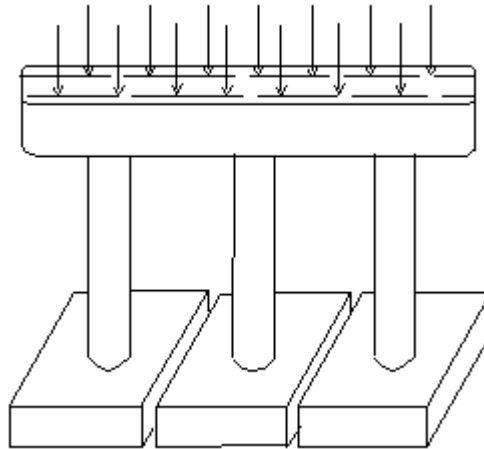
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Optional
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-ACTION	DAC	340	Optional
DEAD-REACTION	DRC	350	Optional
LIVE-ACTION	LAC	380	Optional
LIVE SOLID1	LS1	390	Optional
LIVE SOLID2	LS2	400	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
COLUMN-DESIGN	PCA	590	Required
FACTORS	FCT	600	Optional
PROPERTIES	PRP	610	Optional
REINFORCEMENT-A	RNA	620	Optional
REINFORCEMENT-B	RNB	630	Optional
REINFORCEMENT-C	RNC	640	Optional
SLENDERNESS-A	SLA	690	Optional
FOOTING	FTG	710	Required
SPREAD	SPF	720	Optional
SPREAD	SPD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

9. Frame-Pier



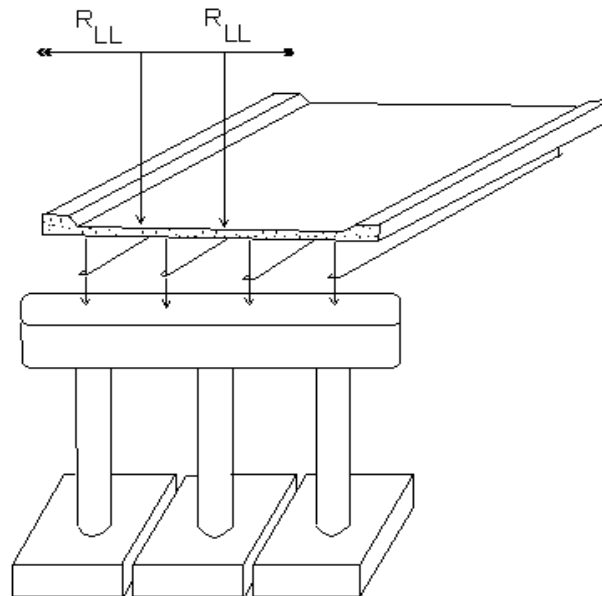
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TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-ACTION	LAC	380	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional

10. Frame Pier - Double Bearing



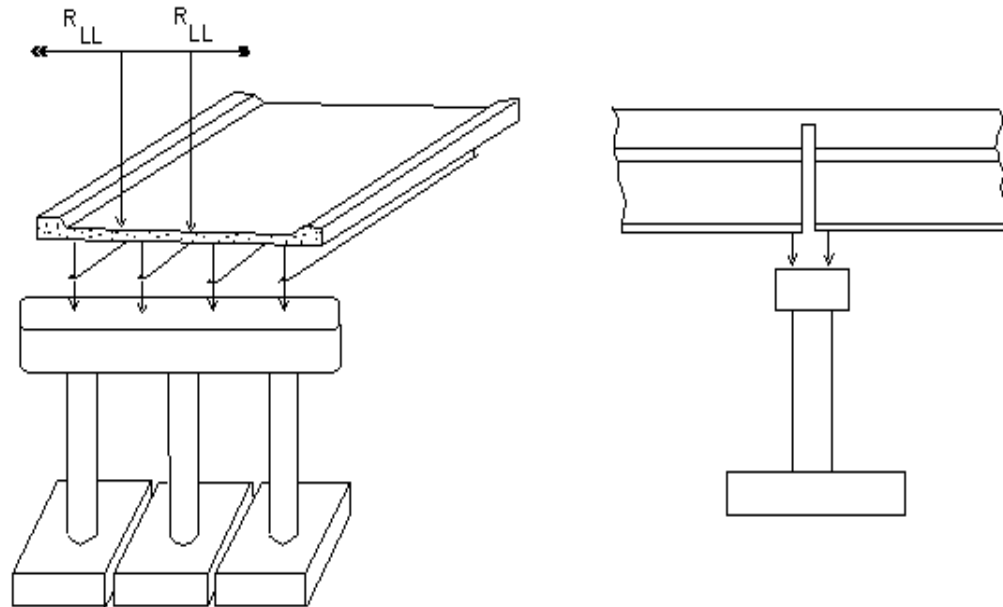
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional

11. Frame-Pier with Distribution of Live Load to Girders



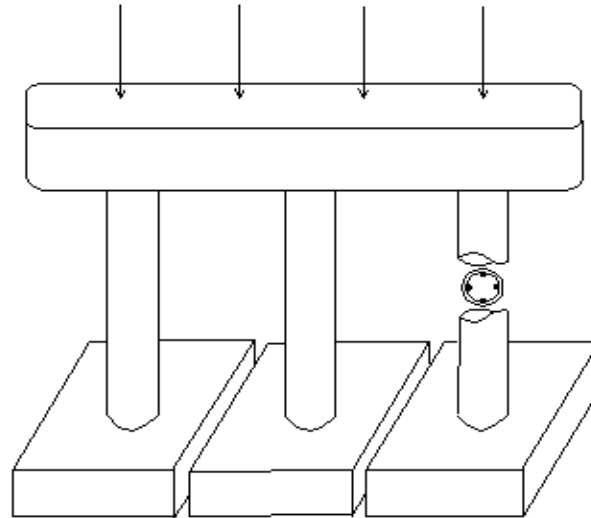
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
DECK-CON	DCN	60	Required
DECKC-DIM1	DD1	90	Required
DECKC-DIM2	DD2	100	Optional
DECKC-GS	DGS	140	Optional
DECKC-LODG	DLG	150	Optional
DECKC-LODP	DLP	180	Required
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-COMBINE	LLC	430	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional

12. Frame Pier - Double Bearing with Distribution of Live Load to Girders



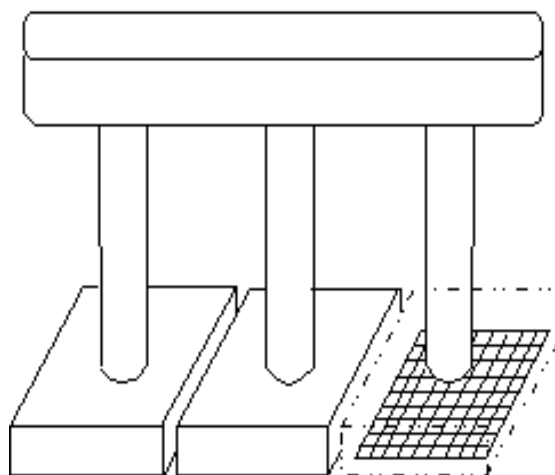
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
DECK-CON	DCN	60	Required
DECKC-DIM1	DD1	90	Required
DECKC-DIM2	DD2	100	Optional
DECKC-GS	DGS	140	Optional
DECKC-LODG	DLG	150	Optional
DECKC-LODP	DLP	180	Required
DECK-AHDI	DA1	190	Required
DECK-AHD2	DA2	200	Optional
DECK-AHD3	DA3	210	Required
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-COMBINE	LLC	430	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional

13. Frame Pier with Column Design/Analysis



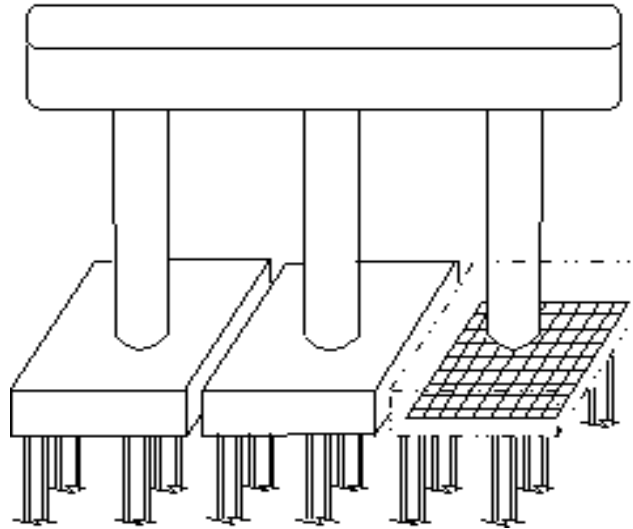
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
COLUMN-DESIGN	PCA	590	Required
FACTORS	FCT	600	Optional
PROPERTIES	PRP	610	Optional
REINFORCEMENT-A	RNA	620	Optional
REINFORCEMENT-B	RNB	630	Optional
REINFORCEMENT-C	RNC	640	Optional
SLENDERNESS-A	SLA	690	Optional

14. Frame-Pier with Spread Footing Analysis/Design



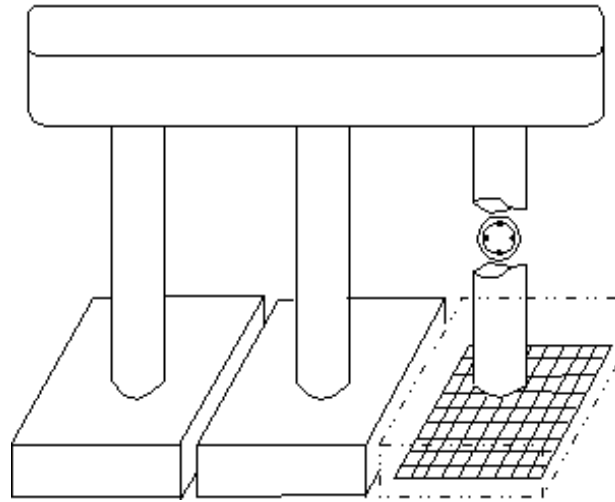
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
FOOTING	FTG	710	Required
SPREAD	SPF	720	Optional
SPREAD-DESIGN	SPD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

15. Frame Pier with Pile Footing Design/Analysis



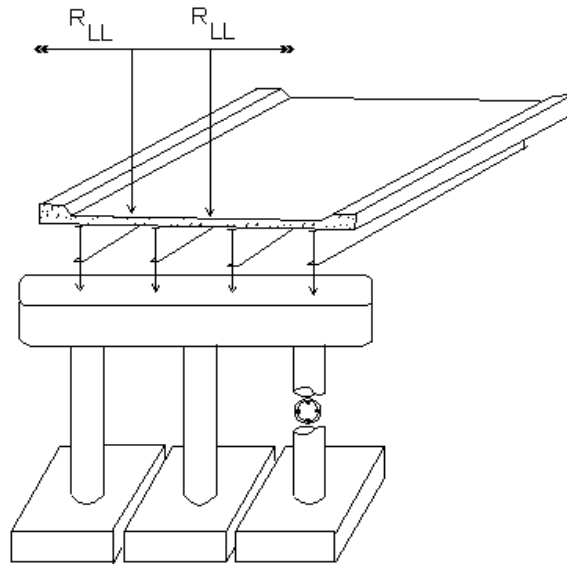
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Optional
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
FOOTING	FTG	710	Required
PILE	PIL	720	Optional
PILE-DESIGN	PLD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

16. Frame-Pier with Column Analysis/Design and Spread Footing Analysis/Design



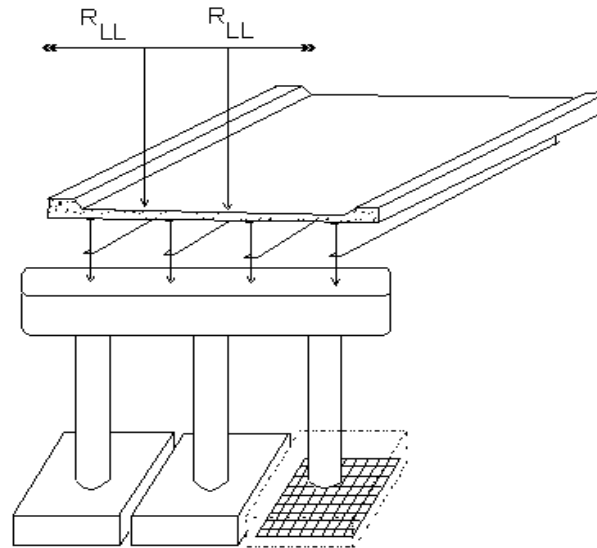
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-REACTION	LRC	410	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
COLUMN-DESIGN	PCA	590	Required
FACTORS	FCT	600	Optional
PROPERTIES	PRP	610	Optional
REINFORCEMENT-A	RNA	620	Optional
REINFORCEMENT-B	RNB	630	Optional
REINFORCEMENT-C	RNC	640	Optional
SLENDERNESS-A	SLA	690	Optional
FOOTING	FTG	710	Required
SPREAD	SPF	720	Optional
SPREAD-DESIGN	SPD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

17. Frame-Pier with Distribution of Live Load to Girders and Column Analysis/Design



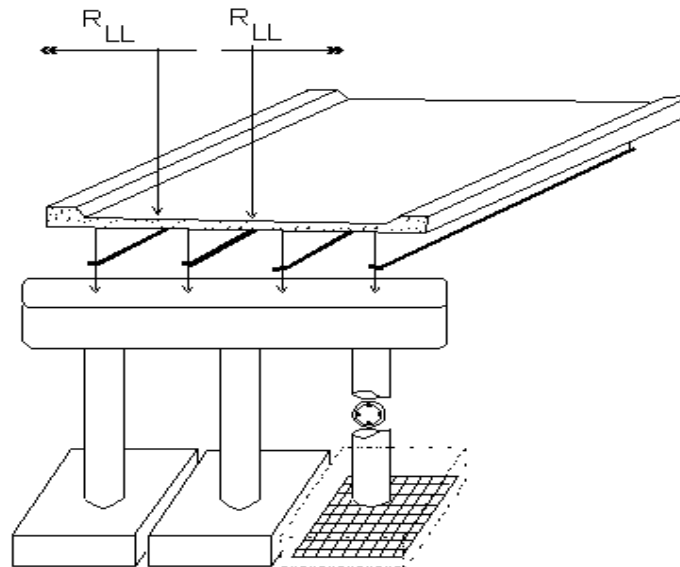
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
DECK-CON	DCN	60	Required
DECKC-DIM1	DD1	90	Required
DECKC-DIM2	DD2	100	Optional
DECKC-GS	DGS	140	Optional
DECKC-LODG	DLG	150	Optional
DECKC-LODP	DLP	180	Required
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-COMBINE	LLC	430	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
COLUMN-DESIGN	PCA	590	Required
FACTORS	FCT	600	Optional
PROPERTIES	PRP	610	Optional
REINFORCEMENT-A	RNA	620	Optional
REINFORCEMENT-B	RNB	630	Optional
REINFORCEMENT-C	RNC	640	Optional
SLENDERNESS-A	SLA	690	Optional

18. Frame-Pier with Distribution of Live Load to Girders and Spread Footing Analysis/Design



<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
DECK-CON	DCN	60	Required
DECKC-DIM1	DD1	90	Required
DECKC-DIM2	DD2	100	Optional
DECKC-GS	DGS	140	Optional
DECKC-LODG	DLG	150	Optional
DECKC-LODP	DLP	180	Required
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-COMBINE	LLC	430	Optional
WIND-LOAD	WND	440	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
FOOTING	FTG	710	Required
SPREAD	SPF	720	Optional
SPREAD-DESIGN	SPD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

19. Frame-Pier with Distribution of Live Load to Girders, Column Analysis/Design and Spread Footing Analysis/Design

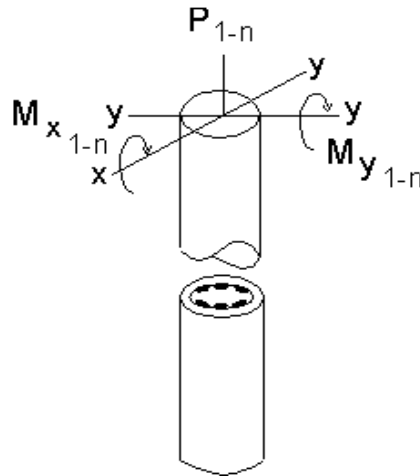


<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
DECK-CON	DCN	60	Required
DECKC-DIM1	DD1	90	Required
DECKC-DIM2	DD2	100	Optional
DECKC-GS	DGS	140	Optional
DECKC-LODG	DLG	150	Optional
DECKC-LODP	DLP	180	Required
PIER	PIR	220	Required
SKIRTWALL	SKW	230	Optional
CAP-DIM	CAP	240	Required
COLUMN-DIM	COL	250	Required
BEARING	BRG	300	Required
BEARING-VS	BRV	320	Optional
DEAD-LOAD	DLD	330	Required
DEAD-REACTION	DRC	350	Optional
LIVE-COMBINE	LLC	430	Optional
SUPERSTRUCTURE	SPR	450	Optional
WIND-REACTIONL	WRL	460	Optional
WIND-REACTIONR	WRR	470	Optional
CENTRIFUGAL	CTF	480	Optional
LONGITUDINAL	LTF	490	Optional
SHRINKAGE	SHR	500	Optional
TEMPERATURE	TMP	510	Optional
EARTHQUAKE	ETQ	515	Optional

(Continued)

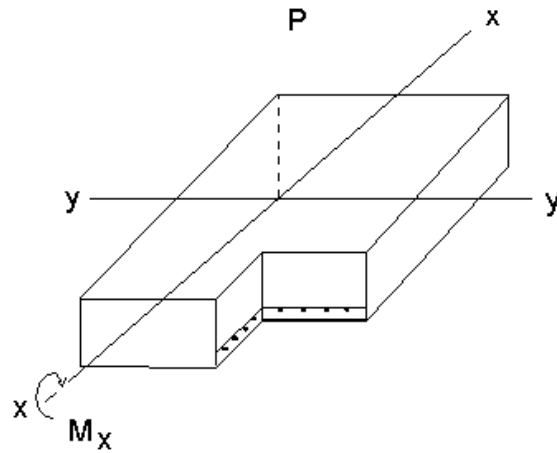
<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
BUOYANCY	BUY	520	Optional
STREAM-FLOW	STF	530	Optional
ICE-PRESSURE	ICE	540	Optional
COLUMN-DESIGN	PCA	590	Required
FACTORS	FCT	600	Optional
PROPERTIES	PRP	610	Optional
REINFORCEMENT-A	RNA	620	Optional
REINFORCEMENT-B	RNB	630	Optional
REINFORCEMENT-C	RNC	640	Optional
SLENDERNESS-A	SLA	690	Optional
FOOTING	FTG	710	Required
SPREAD	SPF	720	Optional
SPREAD-DESIGN	SPD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required

20. Column Design/Analysis



<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
COLUMN-DESIGN	PCA	590	Required
FACTORS	FCT	600	Optional
PROPERTIES	PRP	610	Optional
REINFORCEMENT-A	RNA	620	Optional
REINFORCEMENT-B	RNB	630	Optional
REINFORCEMENT-C	RNC	640	Optional
LOAD AXIAL	AXL	660	Optional
LOAD-INCREMENT	INC	670	Optional
LOAD-COMBINED	CMB	680	Optional
SLENDERNESS-A	SLA	690	Optional
SLENDERNESS-B	SLB	700	Optional

21. Spread Footing Analysis/Design



<u>COMMAND</u>	<u>ABBREVIATION</u>	<u>COMMAND NUMBER</u>	<u>USAGE</u>
TITLE	TLE	10	Required
COMMENT	COM	20	Optional
REPORT-LEVEL	RPT	55	Optional
FOOTING	FTG	710	Required
SPREAD	SPF	720	Required
SPREAD-DESIGN	SPD	730	Required-Design
COLUMN-DATA	CDM	760	Required
MATERIALS	MTR	770	Optional
REINFORCEMENT	RNF	780	Required-Analysis (Optional-Design)
FOOTING-SERVICE	FSV	790	Required
FOOTING-ULTM	FUL	800	Required

5. TITLE AND COMMENTS

The commands in this section define a title to be used on each page of output and optional comments used in the command set to help the user document his input.

10	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME		TITLE	TLE
PURPOSE		The data entered by this command is used to identify the output to the user. Agency name, page number, and date are also included as page heading. This command is required.	
1 COMMAND PARAMETER			
		One or two TITLE commands may be used and each can have up to 60 characters of information. TITLE commands must be the first in the sequence of input commands.	

EXAMPLE

TITLE BRIDGE OVER CROW CREEK
TITLE STA 124+11 THREE COLUMN BENT

FIGURES

NOTES

20	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	COMMENT		COM
PURPOSE	<p>The COMMENT command may be used to document the string of input commands. They may be inserted in any number in any location in the input after the TITLE commands.</p>		
1 COMMAND PARAMETER			
	<p>One or more may be inserted as needed and each may contain up to 60 characters of descriptive data.</p>		

EXAMPLE

COMMENT INPUT DECK DIMENSIONS

COMMENT SOLID SHAFT PIER INCLUDE CANTILEVERS
COMMENT AND SKIRTWALLS

FIGURES

NOTES

6. SYSTEM AIDES

The following three commands are basically for assisting the Systems Analyst assigned to BRASS-PIER™. However, they are available to the Engineer who desires to further comprehend the internal logic, equations and flow paths utilized in BRASS PIER. For further information see Section VI of the BRASS-PIER™ Systems Manual.

30	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	SYSTEM-1		SY1
<p align="center">PURPOSE</p>	<p>This command is used to obtain additional information from a run of BRASS-PIER™. If used, the SYSTEM-1 should follow the TITLE command.</p> <p>This command is optional</p>		
3 COMMAND PARAMETERS			
Additional User Output	<p>This parameter controls the level of possible additional output that may be useful to the user. Three levels of additional output are available with level 3 producing the most output. Each level contains all of the output of the lower levels. The areas of the program for which the output is desired may be defined by use of the SYSTEM-2 command. Enter 1, 2 or 3.</p>		
Debug Output	<p>This parameter controls the level of possible debug output. Three levels of additional output are available with level 3 producing the most output. Each level contains all of the output of the lower levels. The subroutines for which the output is desired may be defined by use of either the SYSTEM-2 or SYSTEM-3 commands. Enter 1, 2 or 3.</p>		
Program Path	<p>If this parameter is coded 1, the name of each subroutine called during the execution of the program will be printed on the right side of the output when the subroutine is called. The subroutine number and the component number in which it resides will also be printed.</p> <p>If this parameter is coded 2, only the subroutine names of those subroutines called out in the SYSTEM-2 and SYSTEM-3 commands are listed.</p>		

EXAMPLE

For output that calls for level two additional output of interest to the user, no debug output, and turns on the trace of all subroutines called, code:

```
SYSTEM-1      2,      ,      1
```

FIGURES**NOTES**

40	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	SYSTEM-2	
PURPOSE	<p>This command turns on traces of intermediate values from one or more BRASS-PIER™ components. The command may be repeated if more than 6 components are to be traced.</p> <p>This command is optional.</p>	
6 COMMAND PARAMETERS		
First Component Number	Enter the number of the BRASS-PIER™ Component to be traced. See notes and the Systems Manual for a description of the Components.	
Second Component Number	Enter the number of the BRASS-PIER™ Component to be traced. See notes and the Systems Manual for a description of the Components.	
Third Component Number	Enter the number of the BRASS-PIER™ Component to be traced. See notes and the Systems Manual for a description of the Components.	
Fourth Component Number	Enter the number of the BRASS-PIER™ Component to be traced. See notes and the Systems Manual for a description of the Components.	
Fifth Component Number	Enter the number of the BRASS-PIER™ Component to be traced. See notes and the Systems Manual for a description of the Components.	
Sixth Component Number	Enter the number of the BRASS-PIER™ Component to be traced. See notes and the Systems Manual for a description of the Components.	

EXAMPLE

SYSTEM-2 3, 5

The above will turn on a trace of components #3 and #5.

FIGURES**NOTES**

Component No.

1. Administrative
2. Deck Loading
3. Pier Analysis - Solid Shaft
4. Pier Analysis - Frame
5. Pier Analysis - Load Generation
6. Pier Analysis - Combination of Loads
7. Group Loads
8. Column Design
9. Pier Support Analysis

50	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	SYSTEM-3		SY3
PURPOSE	<p>This command turns on traces of intermediate values from one or more subroutine numbers. The command may be repeated if more than 6 subroutines are to be traced.</p> <p>This command is optional.</p>		
6 COMMAND PARAMETER			
First Subroutine	Enter the number of the BRASS-PIER™ subroutine to be traced.		
Second Subroutine	Enter the number of the BRASS-PIER™ subroutine to be traced.		
Third Subroutine	Enter the number of the BRASS-PIER™ subroutine to be traced.		
Fourth Subroutine	Enter the number of the BRASS-PIER™ subroutine to be traced.		
Fifth Subroutine	Enter the number of the BRASS-PIER™ subroutine to be traced.		
Sixth Subroutine	<p>Enter the number of the BRASS-PIER™ subroutine to be traced.</p> <p>NOTE: Refer to Section VI of the BRASS-PIER™ Systems Manual.</p>		

EXAMPLE

SYSTEM-3 5, 33, 34

The above will turn on a trace of subroutines COMP, GLINPU, and GLOA.

FIGURES**NOTES**

55	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	REPORT-LEVEL	RPT
PURPOSE	<p>This command is used to specify the level of output reporting desired. Enter zero if the particular report is not desired.</p> <p>This command is optional.</p>	
10 COMMAND PARAMETERS		
Deck	(Future) Leave blank.	
Frame Properties Default = 1	Frame Pier only. Level 1: Basic report of pier dimensions. Level 2: Level 1 plus frame properties for moment distribution, i.e., distribution factors, carry-over factors, fixed end and simple beam moments due to dead load of pier. Also the results from a moment distribution for sidesway are printed.	
Girder Placement Default = 1	Frame Pier only. Level 1: Report of Girder Locations on pier. Level 2: Level 1 plus simple beam moments and shears due to unit girder load.	
Dead Load Default = 1	Solid Shaft Pier only. Level 1: Report of Dead Load actions, Axial Loads, Longitudinal and Transverse Moments. Level 2: Level 1 plus intermediate results of dead load computations.	
Live Load Default = 1 (Continued)	Solid Shaft Pier Level 1: Report of Live Load actions. Level 2: Level 1 plus intermediate results of live load computations. Frame Pier Level 1: Report of Live Load actions. Level 2: Level 1 plus truck positions producing maximum actions. Level 3: Level 2 plus Live Load influence values.	

COMMAND PARAMETERS (Cont.)

<p>Wind Load Forces Default = 0</p>	<p>Level 0: No report.</p> <p>Level 1: Report of wind load computations.</p>
<p>Wind Load Actions Default = 1</p>	<p>Frame Pier only.</p> <p>Level 1: Maximum crossbeam actions and all column actions printed.</p> <p>Level 2: All crossbeam and column actions printed.</p> <p>Level 3: Only column actions printed.</p> <p>Level 4: Only crossbeam actions printed.</p>
<p>Other Loads Default = 0</p>	<p>Level 0: No Report</p> <p>Level 1: Actions and other information due to centrifugal, longitudinal, shrinkage, temperature, earthquake, buoyancy, stream flow and ice pressure.</p>
<p>Footing</p>	<p>Level 1: Intermediate output for footing analysis/design.</p>
<p>Column Default = 0</p>	<p>Level 1: Moment magnification and minimum eccentricity report. Note that the SLENDERNESS-A command is required for moment magnification calculations.</p> <p>Level 2: Intermediate output for calculation of column 'k' value. Note that the SLENDERNESS-A command is required for moment magnification calculations.</p>

EXAMPLE

For an output with frame pier dimensions and girder locations printed, (blank), report of truck positions producing live load actions, and default of 0, (no report of wind load computations), code:

REPORT-LEVEL , 1, 1, , 2, , 3, 1

FIGURES**NOTES**

7. BRIDGE DECK LOADING

This component will apply dead and live loads to the deck and calculate the reactions to the girders. The deck may be supported by up to 20 girders.

The dead load of the deck is applied to the girders based on the dimensions of the deck, the unit weight of the deck material, and the loads which are input by the user. A wearing surface may also be applied with the limits of the wearing surface defined by dimensions of the curbs and median, the user having the option to override these limits by input of the desired limits.

The user may specify the sequence in which the loads are to be applied to the deck by coding the stage in which each load is to be applied.

Frame Piers

The live loads are applied to the deck by moving a truck or lane load across the roadway, from left to right, and calculating the reaction to each girder for each position. The limits of the roadway are defined by the curb and median dimensions with the user having the option of overriding these limits. To obtain the value of the truck load to be applied to the deck, assume that one line of wheels is placed directly on the longitudinal girder section, see Figure 7.1. Then position the wheels to produce maximum reaction at the pier and calculate the reaction due to that placement. When a longitudinal girder analysis program (such as BRASS-GIRDER™) is used, the reaction may be obtained by dividing the maximum live load reaction due to the truck load by the wheel fraction.

The truck load is applied as two point loads equal to the reactions input, spaced 6 feet apart, centered in a 10 foot load lane, see Figure 7.2. The value of the lane load to be applied to the deck is obtained by assuming that a one-foot strip of the lane load is placed directly on the longitudinal girder section, see Figure 7.3. The concentrated load is considered to be distributed over the 10 foot lane width, a one foot wide section of that load then being placed directly on the girder section. The uniform load and the concentrated load are then placed to produce maximum reaction at the pier and the reaction calculated. When a longitudinal girder analysis program (such as BRASS-GIRDER™) is used, the reaction may be obtained by dividing the maximum live load reaction due to the lane load by the lane fraction (one-half the wheel fraction) times the lane width (10 feet). The load lane is applied as a uniform load distributed over the 10 foot lane width. The value of the reaction input is the per foot value of the uniform load. When the live load girder reactions are to be available for use in applying the live load to a frame pier, the DECK LOADING component must be executed immediately prior to, and in the same run as the Pier Analysis component.

Solid Shaft Piers

Live load placement is controlled by the LIVE-SOLID1 and LIVE-SOLID2 commands.

Impact

Both truck and lane load values should be entered with impact. BRASS-PIER™ will divide out the impact for foundation analysis. The amount of impact must be entered on the DEAD-LOAD command unless the default value is acceptable.

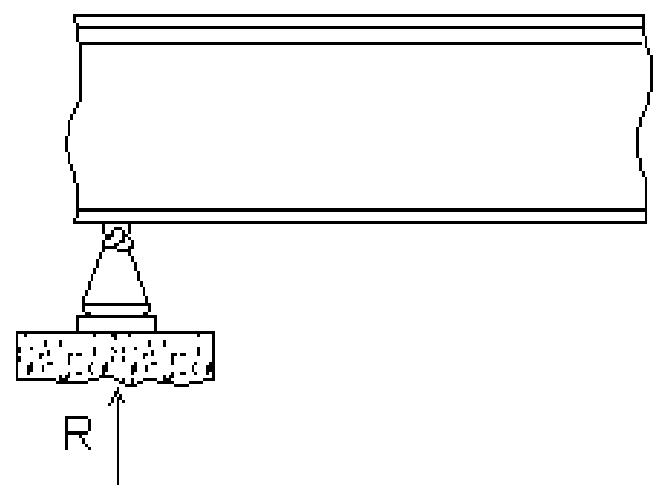
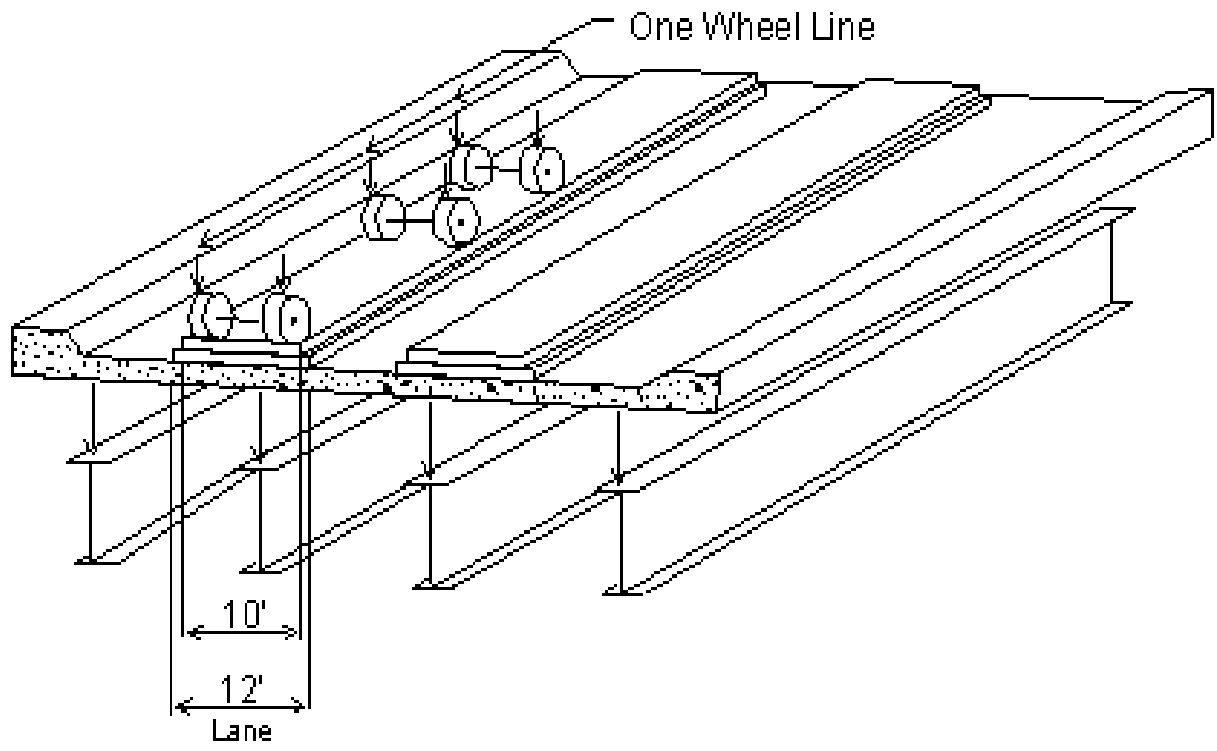


Figure 7.1
Placement of Truck on Girder

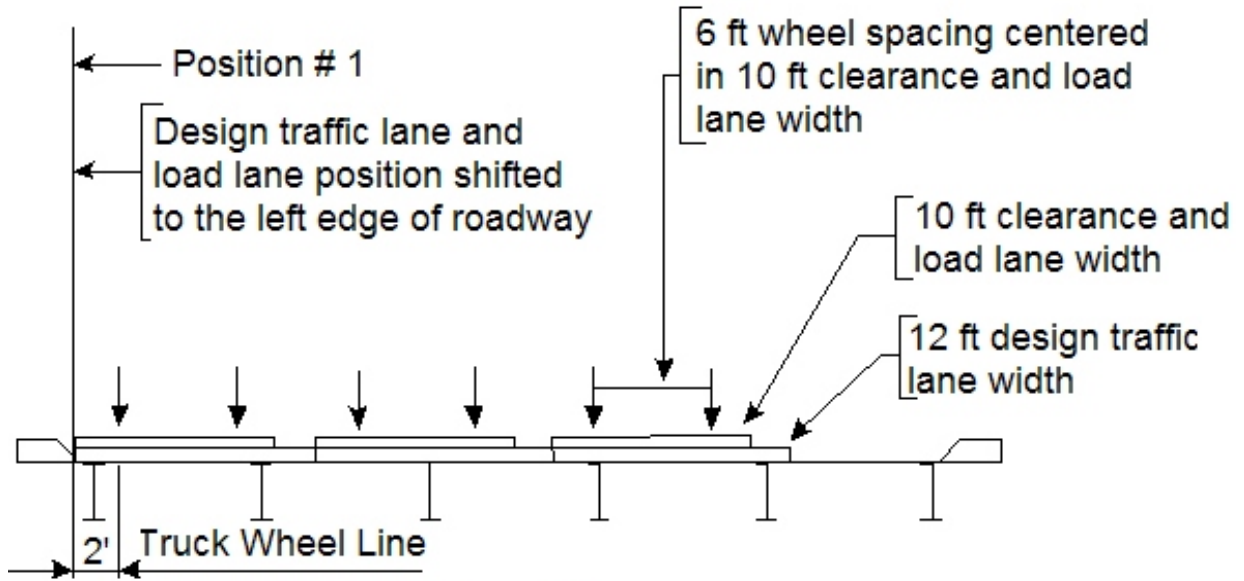


Figure 7.2
Placement of Truck on Deck

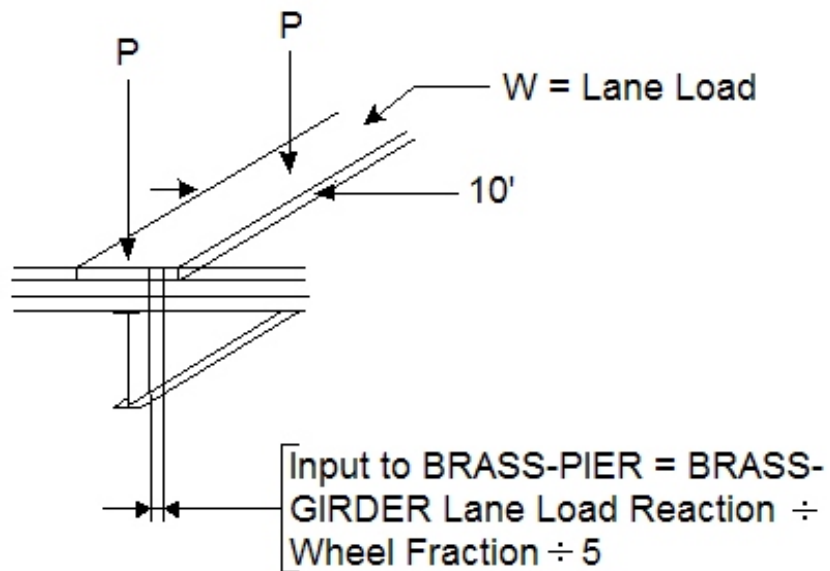


Figure 7.3
Placement of Lane Load on Girder

60	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	DECK-CON		DCN
PURPOSE	DECK-CON is the control command for the load distribution on a bridge. It is required whenever the user desires dead and live loads to be distributed to the girders.		
6 COMMAND PARAMETERS			
Run control	Code 3: Distribution of the dead load of the deck and its appurtenances to the supporting girders is desired. Code 4: Distribution of the live load to the supporting girders is desired. This option is only valid for frame piers.		
Continuity Default = 2	If the concrete deck is continuous over 3 or more girders, code 2. If simple span supported by two girders, code 1. *Note: Omit the following 4 parameters when distribution of the live load to the girders is desired.		
Slab Stage Default = 1	Code the construction stage in which the uniform load per foot due to the weight of the deck is to be applied to the analysis girder. Code 0 if that load does not exist.		
Curb Stage Default = 1	Code the construction stage in which the uniform load per foot due to the weight of the curbs is to be applied to the girders. Code 0 if that load does not exist.		
Median Stage Default = 1	Code the construction stage in which the uniform load per foot due to the weight of the median is to be applied to the girders. Code 0 if that load does not exist.		
Wearing Surface Stage Default = 1	Code the construction stage in which the uniform load per foot due to the weight of the wearing surface is to be applied to the girders. Code 0 if that load does not exist.		

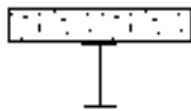
EXAMPLE

The following example is for distribution of dead load to the girders on a composite steel and concrete bridge where the deck is poured in stage 1 (non-composite section supports the load) and the curbs and wearing surface are placed in the second stage (after the deck concrete has hardened and the girder acts compositely.) The deck is continuous over 3 or more girders.

The 1st blank space will default to 2, and the 2nd blank space will default to 1.

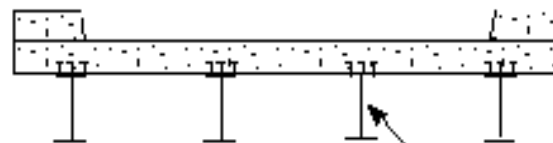
DECK-CON 3, , , 2, 0, 2

FIGURES



Stage 1

Non-hardened concrete deck supported by non-composite beam section



Stage 2

Analysis girder

The distributed load to the analysis girder due to the curbs and wearing surface is supported by the composite STEEL AND HARDENED CONCRETE BEAM SECTION

NOTES

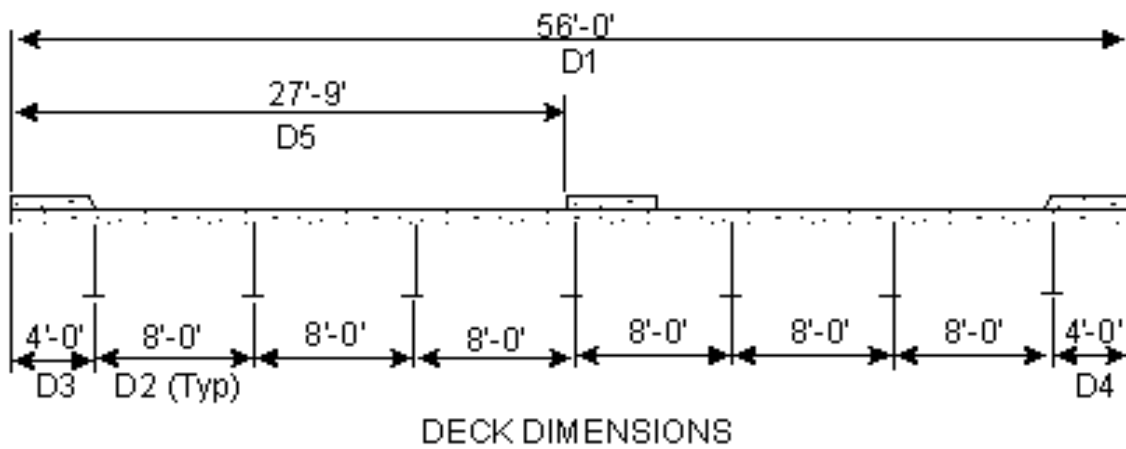
90	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-DIM1	
PURPOSE	DD1	
	<p>This is the first in a series of commands used to describe the dimensions of a cross-section of a bridge deck. It is always required for a load distribution.</p>	
5 COMMAND PARAMETERS		
NG	<p>Enter the number of girders supporting the deck. See Figure.</p> <p>A maximum of 20 girders may be entered.</p>	
D2	<p>If the girder spacing is constant enter the center to center distance (normal to the girders) between girders in feet. If the spacing varies, enter 1 and use the DECKC-GS command to describe the spacing. See Figure.</p>	
D3	<p>Enter the length of the left cantilever in feet. See Figure.</p>	
D4 Default = D3	<p>Enter the length of the right cantilever in feet. See Figure.</p>	
D5	<p>Enter the distance from the left edge of the deck to the left edge of the median. If no median, leave blank. Only one median is allowed.</p>	

EXAMPLE

For the deck shown in the Figure below:

DECKC-DIM1 7, 8, 4, , 27.75

FIGURES



NOTES

The overall deck width (D1) is calculated internally.

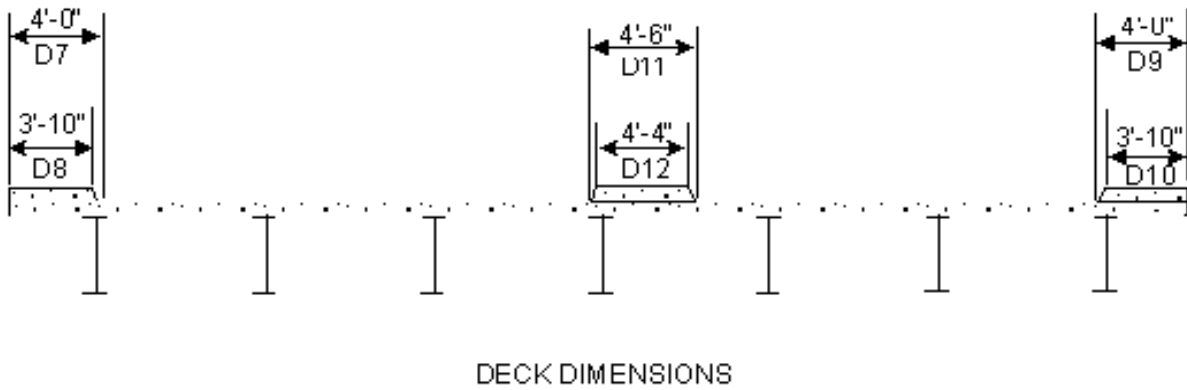
100	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-DIM2	
PURPOSE	<p>This is the second in a series of commands describing the dimensions of a cross-section of a bridge deck.</p> <p>It is required if the deck has curbs or a median.</p>	
6 COMMAND PARAMETERS		
D7	Enter the width of the bottom of the left curb in feet. See Figure.	
D8	Enter the width of the top of the left curb in feet. See Figure.	
D9 Default = D7	Enter the width of the bottom of the right curb in feet. See Figure.	
D10 Default = D8	Enter the width of the top of the right curb in feet. See Figure.	
D11	Enter the width of the bottom of the median in feet. See Figure. Only one median is allowed.	
D12	Enter the width of the top of the median in feet. See Figure. Only one median is allowed.	

EXAMPLE

For the deck shown in the Figure below:

DECKC-DIM2 4, 3.8333, , , 4.5, 4.333

FIGURES



NOTES

The width of the top of the curb or median must be less than the bottom of the curb or median.

110	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-DIM3	
PURPOSE	<p>This is the third in a series of commands describing the dimensions of a cross-section of a bridge deck.</p> <p>It is required only for distribution of dead load to the girders.</p>	
6 COMMAND PARAMETERS		
D13	Enter the thickness of the slab in inches.	
Blank	Leave blank.	
D15	If there is a supporting soffit at interior girders, enter the distance in feet from the centerline of the girder to the beginning of the taper or if there is no taper enter the distance to the edge of the soffit. See Figure.	
D16 Default=D15	If there is a supporting soffit at interior girders, enter the distance in feet from the centerline of the girder to the end of the taper or if there is no taper enter the distance to the edge of the soffit. See Figure.	
D17	If there is a supporting soffit, enter the thickness of the soffit in inches. See Figure.	
D6	If there are curbs or median, enter the thickness of the curbs and median in inches. See Figure.	

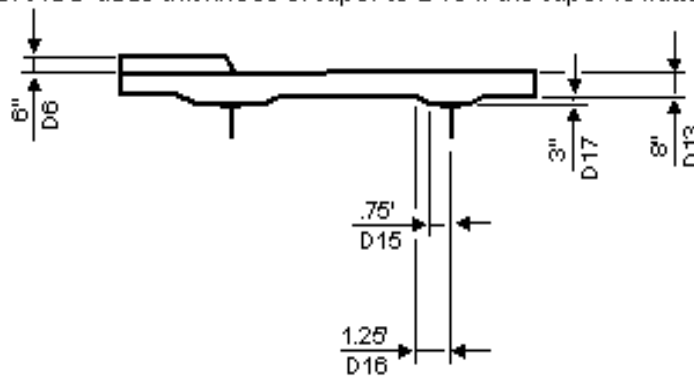
EXAMPLE

For the deck shown in the Figure below.

DECKC-DIM3 8, , 0.75, 1.25, 3, 6

FIGURES

NOTE: BRASS adds thickness of taper to D13 if the taper is flatter than 45°.



DECK DIMENSIONS

NOTES

Soffits on interior girders are assumed to be symmetrical about the vertical centerline of the girder.

The dimensions described may also be used to describe fillets on concrete girders.

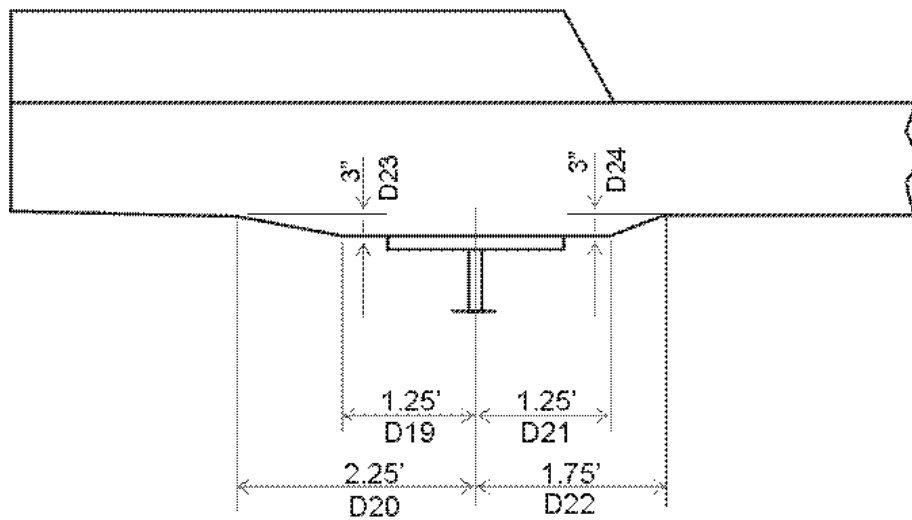
120	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-DIM4	
PURPOSE	<p>This is the fourth in a series of commands describing the dimensions of a cross-section of a bridge deck.</p> <p>It is required on a dead load distribution to girders run if there are the soffits above the exterior girders.</p>	
6 COMMAND PARAMETERS		
D19	Enter the distance from the centerline of the left exterior girder in feet to the beginning of the left taper or if there is no taper enter the distance to the left edge of the soffit. See Figure.	
D20	Enter the distance from the centerline of the left exterior girder in feet to the end of the left taper or if there is no taper enter the distance to the left edge of the soffit. See Figure.	
D23	Enter the thickness of the left soffit in inches.	
D21 Default=D19	If the soffit is not symmetrical about the centerline of the left exterior girder, enter the distance from the centerline of the left exterior girder to the beginning of the right taper or if there is no taper the distance in feet to the right edge of the soffit. See Figure.	
D22 Default=D20	If the soffit is not symmetrical about the centerline of the left exterior girder, enter the distance from the centerline of the left exterior girder to the end of the right taper or if there is no taper the distance in feet to the right edge of the soffit. See Figure.	
D24 Default=D23	Enter the thickness of the right soffit in inches.	

EXAMPLE

For the deck shown in the Figure below:

DECKC-DIM4 1.25, 2.25, 3, , 1.75

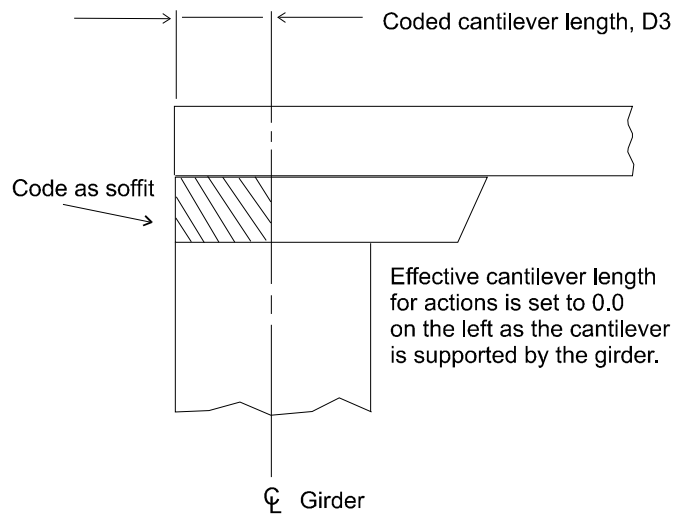
FIGURES



DECK DIMENSIONS

NOTES

If there is a soffit on one side of a girder, there must be one on the opposite side.



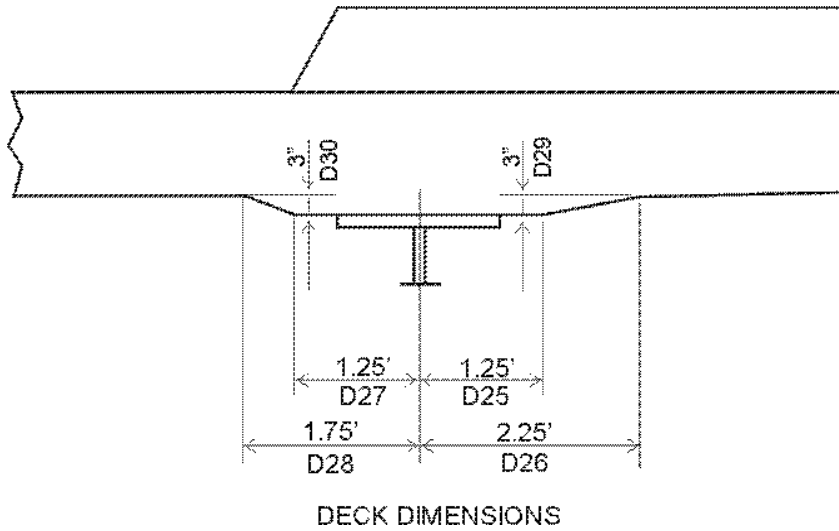
130	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-DIM5	
DD5		
PURPOSE	<p>This is the fifth in a series of commands describing the dimensions of a cross section of a bridge deck.</p> <p>It is required on a dead load distribution to girders run if there are tapers on the soffit above the right exterior girder and they are not equal to those above the left exterior girder.</p>	
6 COMMAND PARAMETERS		
D27	Enter the distance from the centerline of the right exterior girder in feet to the beginning of the left taper or if there is no taper enter the distance to the left edge of the soffit. See Figure.	
D28	Enter the distance from the centerline of the right exterior girder in feet to the end of the left taper or if there is no taper enter the distance to the left edge of the soffit. See Figure.	
D30	Enter the thickness of the left soffit in inches.	
D25 Default = D27	If the soffit is not symmetrical about the centerline of the right exterior girder, enter the distance from the centerline of the right exterior girder to the beginning of the right taper or if there is no taper the distance in feet to the right edge of the soffit. See Figure.	
D26 Default = D28	If the soffit is not symmetrical about the centerline of the right exterior girder, enter the distance from the centerline of the right exterior girder to the end of the right taper or if there is no taper the distance in feet to the right edge of the soffit. See Figure.	
D29 Default = D30	Enter the thickness of the right soffit in inches.	

EXAMPLE

For the deck shown in the Figure below:

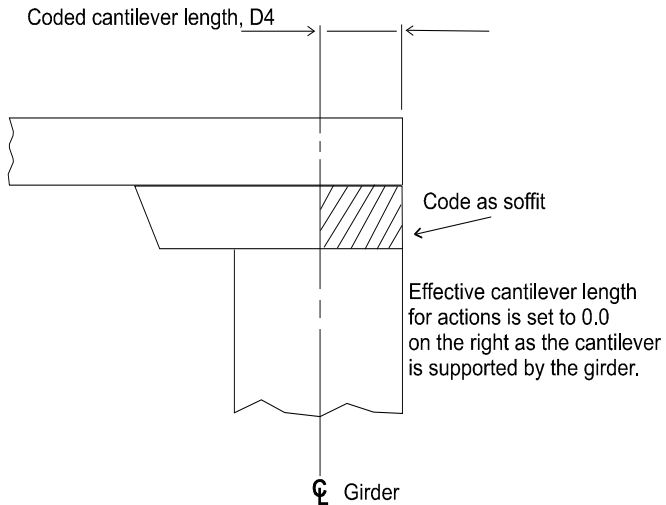
DECKC-DIM5 1.25, 1.75 3, , 2.25

FIGURES



NOTES

If there is a soffit on one side of a girder, there must be one on the opposite side.



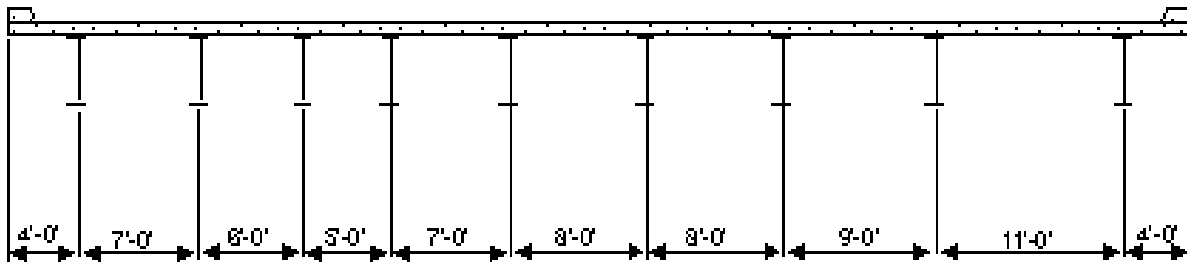
140	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-GS	
	DGS	
PURPOSE	<p>This command defines the spacing of the girders when the girders are not evenly spaced. This command must be used when the girder spacing (second parameter on DECKC-DIM1) is coded as 1.</p> <p>BRASS will analyze a deck supported on as many as 20 girders (19 spaces).</p>	
19 COMMAND PARAMETERS		
Space 1	Numbering the supporting girders from left to right, enter the space (normal to the girders), in feet, between girders #1 and #2.	
Space 2	Numbering the supporting girders from left to right, enter the space (normal to the girders), in feet, between girders #2 and #3.	
Space 3	Numbering the supporting girders from left to right, enter the space (normal to the girders), in feet, between girders #3 and #4.	
Space 4	Numbering the supporting girders from left to right, enter the space (normal to the girders), in feet, between girders #4 and #5.	
Space 5	Numbering the supporting girders from left to right, enter the space (normal to the girders), in feet, between girders #5 and #6.	
Space 6	Numbering the supporting girders from left to right, enter the space (normal to the girders), in feet, between girders #6 and #7.	
" "	" " " " " " " Etc.	
Space 19	Numbering the supporting girders from left to right, enter the space (normal to the girders), in feet, between girders #19 and #20.	

EXAMPLE

For the Figure shown below:

DECKC-GS7, 6, 5, 7, 8, 8, 9, 11

FIGURES



NOTES

See page 2.2 for information on command continuation lines.

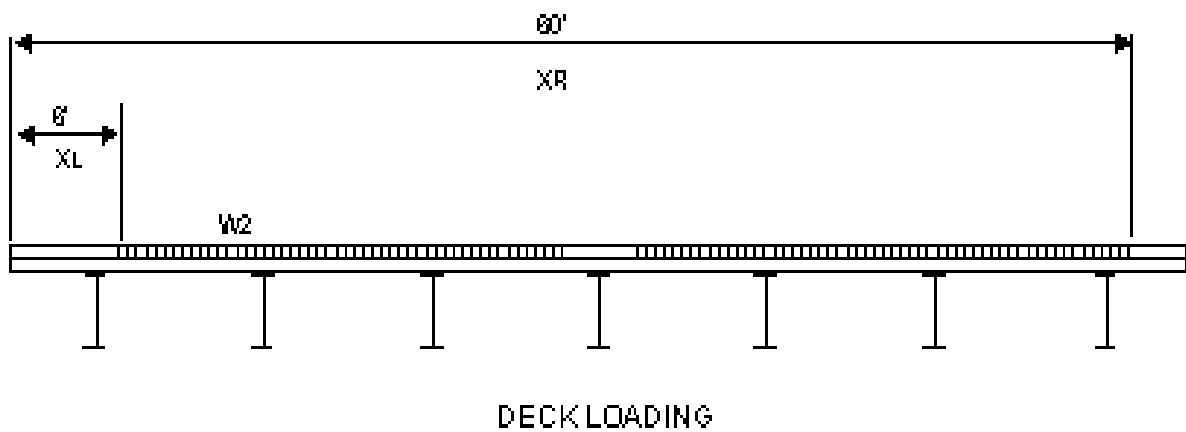
150	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-LODG	
PURPOSE	DLG	
<p>PURPOSE</p>	<p>This command defines several of the material parameters and dimensions needed for the program to calculate the dead load of the deck, curbs, median and wearing surface and placement of wheel loads. This command is required for the loading of concrete decks unless all defaults are used.</p>	
4 COMMAND PARAMETERS		
<p>W1 Default = 0.150</p>	<p>Enter the density of the concrete used in the deck, curbs, and median in kips per cubic foot.</p>	
<p>W2 Default = 0.018</p>	<p>Enter the weight of one square foot of the wearing surface in kips.</p>	
<p>XL Default, left curb defines left edge of travelway</p>	<p>Enter the distance in feet from the left edge of the deck to the left edge of the travelway. This distance controls placement of the wheel loads for cantilever actions and the limits of wearing surface if it exists.</p>	
<p>XR Default, right curb defines right edge of travelway</p>	<p>Enter the distance in feet from the left edge of the deck to the right edge of the travelway. This distance controls placement of the wheel loads for cantilever actions and the limits of wearing surface if it exists.</p>	

EXAMPLE

For the Figure shown below:

DECKC-LODG , 0.018

FIGURES



NOTES

BRASS-PIER™ will deduct the base area of the median from the area subjected to W2, wearing surface load.

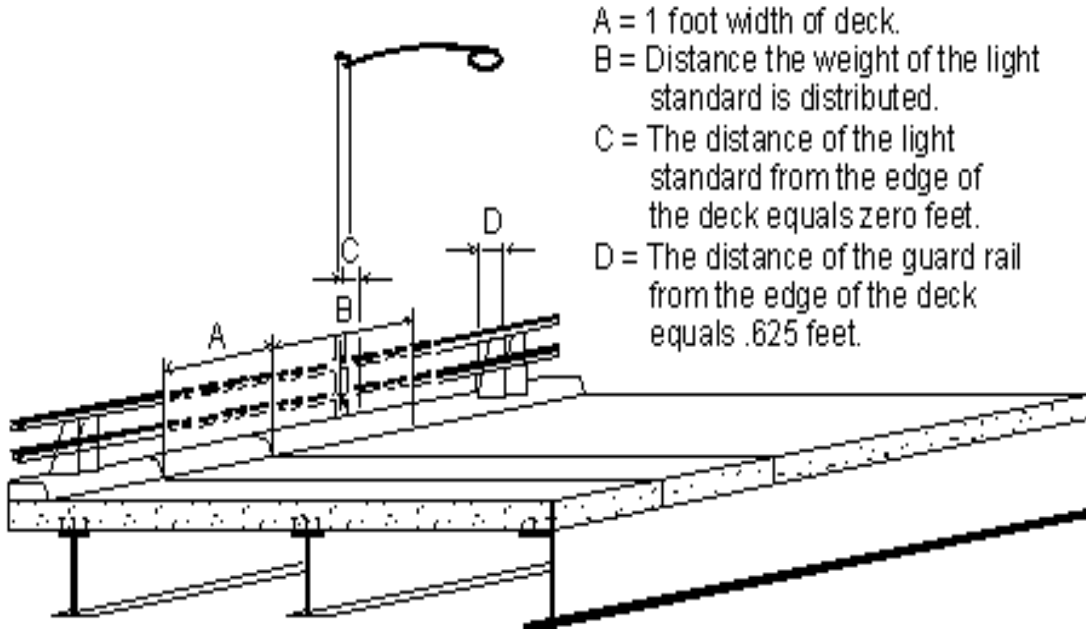
160	BRASS-PIER™	COMMAND DESCRIPTION													
COMMAND NAME	DECKC-LODC		DLC												
PURPOSE	<p>This command allows the user to apply concentrated loads to the bridge deck.</p> <p>This command is optional. It may be repeated as needed to describe up to a maximum of 9 point loads.</p>														
4 COMMAND PARAMETERS															
Load Description Code	<p>This parameter causes the effects due to this point load to be labeled in the output with one of the following names. Enter the number opposite the label desired.</p> <table border="0" data-bbox="574 863 950 1083"> <tr><td>Traffic Barrier</td><td style="text-align: right;">1</td></tr> <tr><td>Traffic Railing</td><td style="text-align: right;">2</td></tr> <tr><td>Pedestrian Railing</td><td style="text-align: right;">3</td></tr> <tr><td>Light Standard</td><td style="text-align: right;">4</td></tr> <tr><td>Utilities</td><td style="text-align: right;">5</td></tr> <tr><td>Miscellaneous</td><td style="text-align: right;">6</td></tr> </table>			Traffic Barrier	1	Traffic Railing	2	Pedestrian Railing	3	Light Standard	4	Utilities	5	Miscellaneous	6
Traffic Barrier	1														
Traffic Railing	2														
Pedestrian Railing	3														
Light Standard	4														
Utilities	5														
Miscellaneous	6														
P	Enter the amount of the point load in kips/ft. (parallel to girder). See Figure.														
XP	Enter the distance in feet from the left edge of the bridge deck to the point of application of the point load. See Figure.														
Stage Default = 1	Enter the construction stage in which this point load is to be applied so that it becomes effective on the analysis girder.														

EXAMPLE

For the figure shown below:

DECKC-LODC	4,	0.040, 0.0,	2
DECKC-LODC	2,	0.035, 0.625,	2

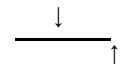
FIGURES



NOTES

1. The bridge is a composite steel and concrete structure. The light standard and traffic railing is placed after the concrete has hardened and the deck and girder act compositely so the stage of construction is entered as 2.
2. The light standard weighs 1.2 kips and the weight is considered to act over 30 feet. Therefore, the weight per foot equals $(1.2/30 = 0.040 \text{ kips/ft})$.
3. The guardrail weighs 0.035 kips/ft and the weight is considered to act over the entire span of 60 feet.
4. The loads used in these examples can be entered using other commands, they are just cited here as examples.

Note: The moment due to a rail impact or wind action at the base of a light standard could be entered as a couple of forces at a small distance apart



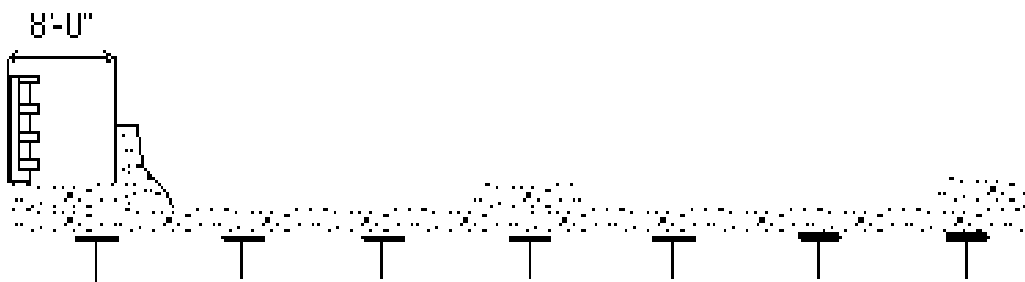
170	BRASS-PIER™	COMMAND DESCRIPTION								
COMMAND NAME	DECKC-LODU									
PURPOSE	DLU									
	<p>This command allows the user to apply uniform loads to the bridge deck. The wearing surface, the weight of the deck itself, curbs and median are calculated internally.</p> <p>This command is optional. It may be repeated as needed to describe up to a maximum of 9 different uniform loads.</p>									
5 COMMAND PARAMETERS										
Load Description Code	<p>The parameter causes the effects due to this uniform load to be labeled in the output with one of the following names. Enter the number corresponding to the label desired.</p> <table border="0" style="width: 100%;"> <tr> <td>Concrete topping (non-wearing surface)</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Asphalt topping (non-wearing surface)</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Sidewalk (not defined by curb dimensions)</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Miscellaneous</td> <td style="text-align: right;">4</td> </tr> </table>		Concrete topping (non-wearing surface)	1	Asphalt topping (non-wearing surface)	2	Sidewalk (not defined by curb dimensions)	3	Miscellaneous	4
Concrete topping (non-wearing surface)	1									
Asphalt topping (non-wearing surface)	2									
Sidewalk (not defined by curb dimensions)	3									
Miscellaneous	4									
W	Enter the uniform load in kips/sq. ft.									
XW	Enter the distance in feet from the left edge of the deck to the beginning of the uniform load.									
XWI	Enter the width in feet of the uniform load.									
Stage Default = 1	Enter the construction stage in which this uniform load is to be applied so that it becomes effective on the analysis girder.									

EXAMPLE

For the Figure shown below, consider the left sidewalk as a uniform load.

DECKC-LODU 3, 0.05, 0, 8.0, 1

FIGURES



NOTES

180	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECKC-LODP	
	DLP	
<p>PURPOSE</p>	<p>This command defines the live loads to be applied to the deck for distribution to the girders. For a double bearing pier, the live loads entered on this command will be those to be applied to the <u>back-on-line</u> bearings. The live loads to be applied to the ahead-on-line bearings will be entered on the DECK-AHD3 command.</p> <p>This command is used for Frame Piers Only.</p>	
<p>4 COMMAND PARAMETERS</p>		
<p>Pmax</p>	<p>Enter the reaction due to the longitudinal placement of one wheel line directly over the girder, for maximum reaction at the pier, in kips. See Figure 1^(a).</p>	
<p>Wmax</p>	<p>Enter the reaction due to the longitudinal placement of a one-foot longitudinal strip of the lane load directly over the girder, for maximum reaction at the pier, in kips per foot. See Figure 2^(b).</p>	
<p>Pmin</p>	<p>The following parameters apply only for a double bearing pier. Enter the reaction due to the longitudinal placement of one wheel line directly over the girder, for minimum positive or maximum negative reaction at the pier, in kips. For example cases of Pmax and Pmin, see Figure 3.</p>	
<p>Wmin</p>	<p>Enter the reaction due to the longitudinal placement of a one-foot longitudinal strip of the lane load directly over the girder, for minimum positive or maximum negative reaction at the pier, in kips per foot.</p>	

EXAMPLE

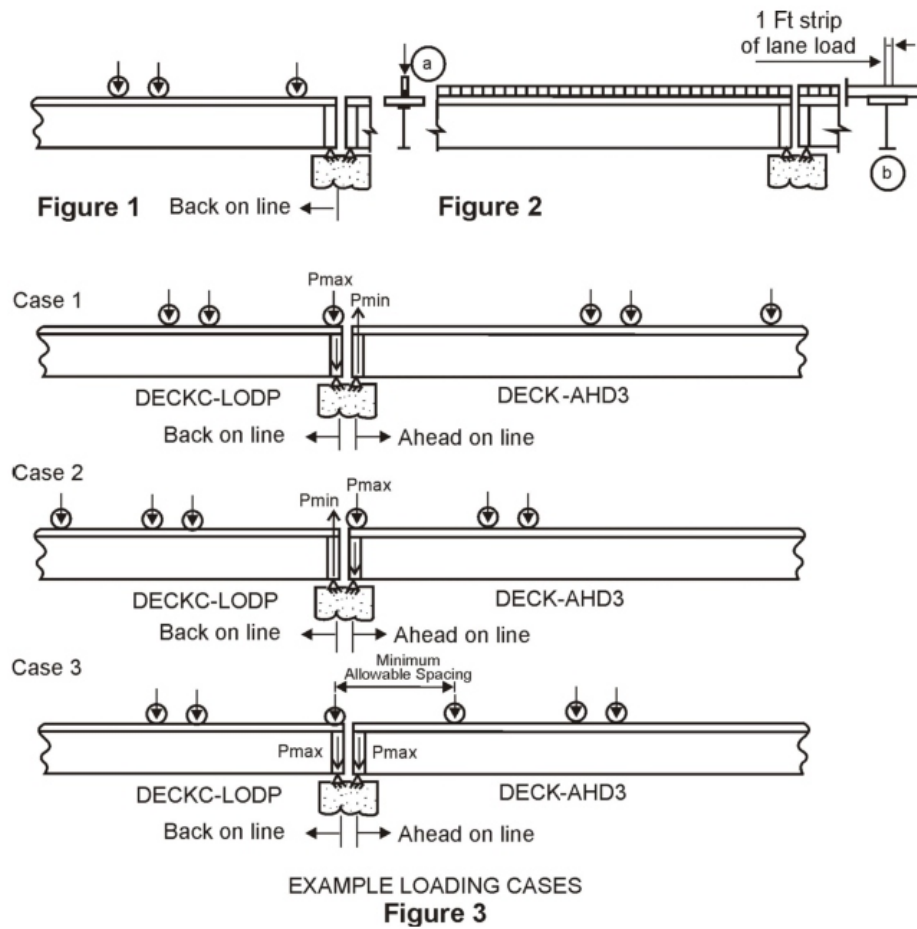
Single Bearing Pier

DECKC-LODP 43.802, 8.688

Double Bearing Pier

DECKC-LODP 32.02, 6.404, -4.477, -.894

FIGURES



NOTES

Enter the wheel and lane loads with impact. The DEAD-LOAD command must also be used if a pier analysis is to be performed, unless the impact default values of 1.3 are acceptable. BRASS-PIER™ will divide out the impact for foundation analysis.

For double bearing piers, the engineer is responsible for determining reasonable values for Pmax and Pmin for both back on line and ahead on line.

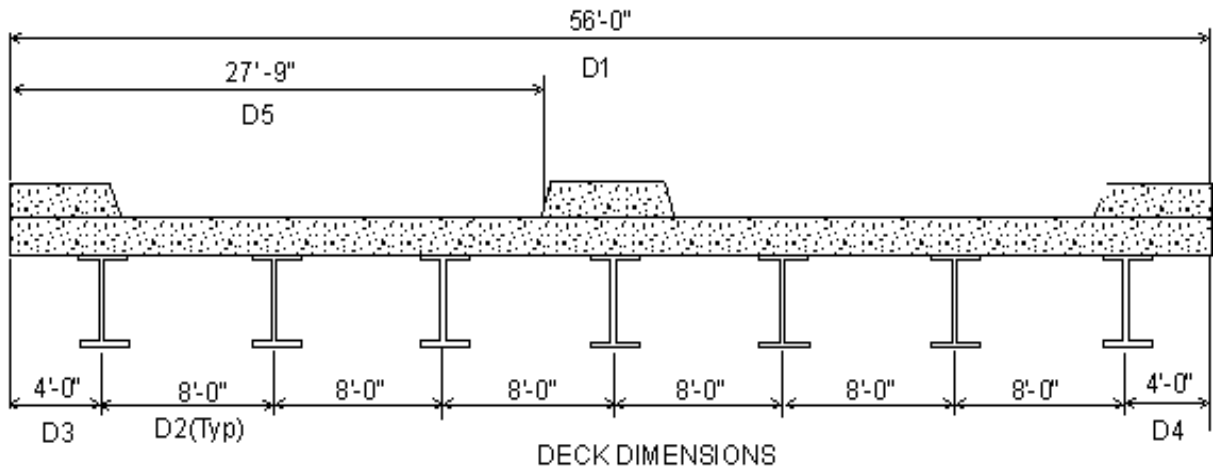
190	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECK-AHD1	
PURPOSE	<p>This command defines the dimensions of a cross-section of a bridge deck, necessary for the computation of the reactions due to the placement of the live load on the deck for the superstructure located ahead-on-line on a double bearing pier. This command is required for a double bearing pier.</p> <p>This command is used for Frame Piers Only.</p>	
4 COMMAND PARAMETERS		
NG	Enter the number of girders supporting the deck.	
D2	If the girder spacing is constant, enter the center to center distance between girders, in feet. If the spacing varies, enter 1 and use the DECK-AHD2 command to describe the spacing. See Figure.	
D3	Enter the length of the left cantilever, in feet. See Figure.	
D4 Default = D3	Enter the length of the right cantilever, in feet. See Figure.	

EXAMPLE

DECK-AHD1 7, 8, 4,

Will default to 4.

FIGURES



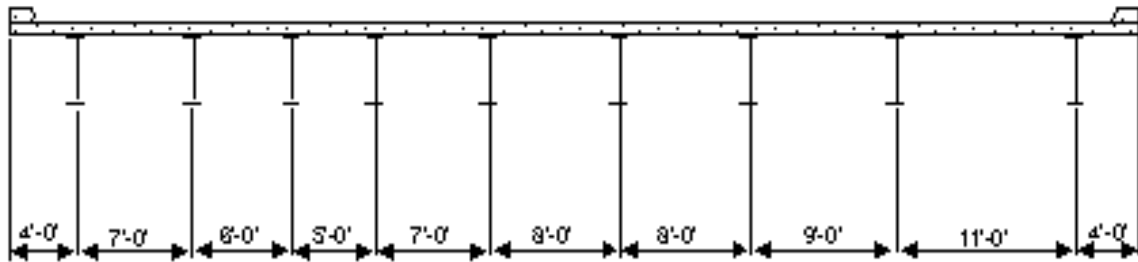
NOTES

200	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	DECK-AHD2		DA2
PURPOSE	<p>This command defines the spacing of the girders when the girders are not evenly spaced. This command must be used when the girder spacing (second parameter of the DECK-AHD1) has been left blank.</p> <p>This command is used for Frame Piers Only.</p>		
19 COMMAND PARAMETERS			
Space 1	Numbering the supporting girders from left to right, enter the space, in feet, between girders #1 and #2.		
Space 2	Numbering the supporting girders from left to right, enter the space, in feet, between girders #2 and #3.		
Space 3	Numbering the supporting girders from left to right, enter the space, in feet, between girders #3 and #4.		
Space 4	Numbering the supporting girders from left to right, enter the space, in feet, between girders #4 and #5.		
Space 5	Numbering the supporting girders from left to right, enter the space, in feet, between girders #5 and #6.		
Space 6	Numbering the supporting girders from left to right, enter the space, in feet, between girders #6 and #7.		
"	" " " " Etc.		
Space 19	Numbering the supporting girders from left to right, enter the space, in feet, between girders #19 and #20.		

EXAMPLE

DECK-AHD2 7, 6, 5, 7, 8, 8, 9, 11

FIGURES



NOTES

See page 2.2 for information on continuation lines.

210	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DECK-AHD3	
PURPOSE	<p>This command defines the live loads to be applied to the deck for distribution to the girders for the superstructure located ahead-on-line on a double bearing pier.</p> <p>This command is used for Frame Piers Only.</p>	
4 COMMAND PARAMETERS		
P_{MAX}	Enter the reaction due to the longitudinal placement of one wheel line directly over the girder, for maximum reaction at the pier, in kips. See Figure 1 (a).	
W_{MAX}	Enter the reaction due to the longitudinal placement of a one-foot longitudinal strip of the lane load directly over the girder, for maximum reaction at the pier, in kips per foot. See Figure 2 (b).	
P_{MIN}	Enter the reaction due to the longitudinal placement of one wheel line directly over the girder, for minimum positive or maximum negative reaction at the pier in kips.	
W_{MIN}	Enter the reaction due to the longitudinal placement of a one-foot longitudinal strip of the lane load directly over the girder, for minimum positive or maximum negative reaction at the pier, in kips per foot.	

EXAMPLE

DECK-AHD3 38.98, 7.796, -6.345, -1.269

FIGURES

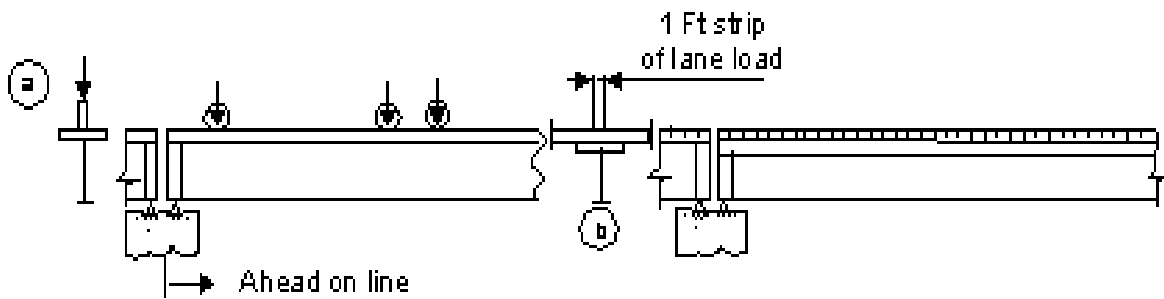


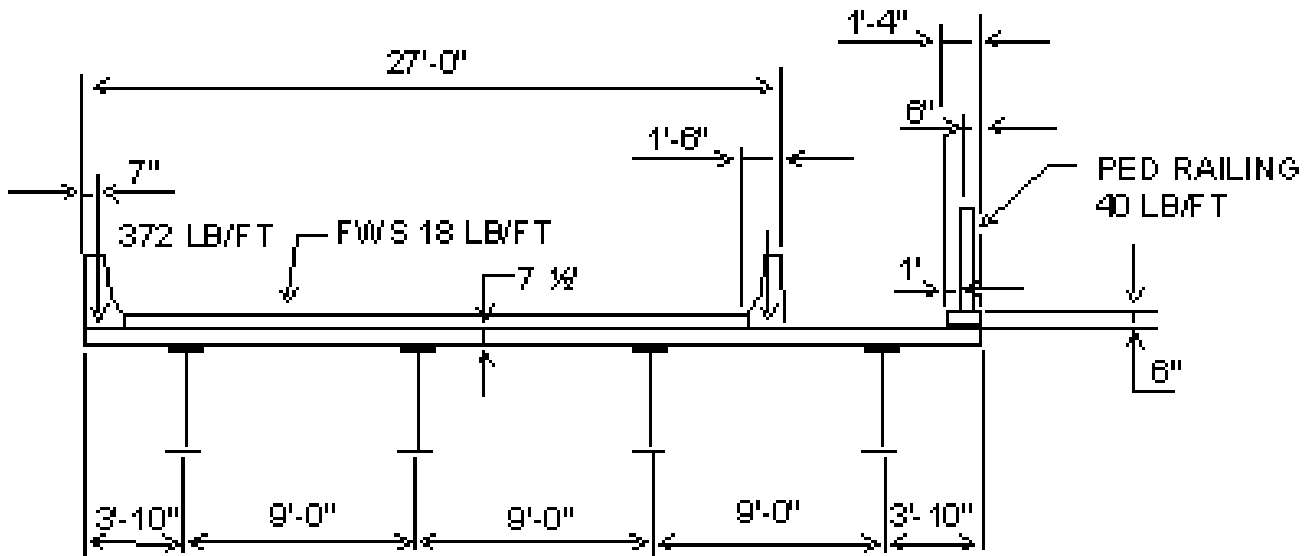
Figure 1

Figure 2

NOTES

Pages 7.32 through 7.34 show partial command sets to illustrate in DECK-LOADING section:

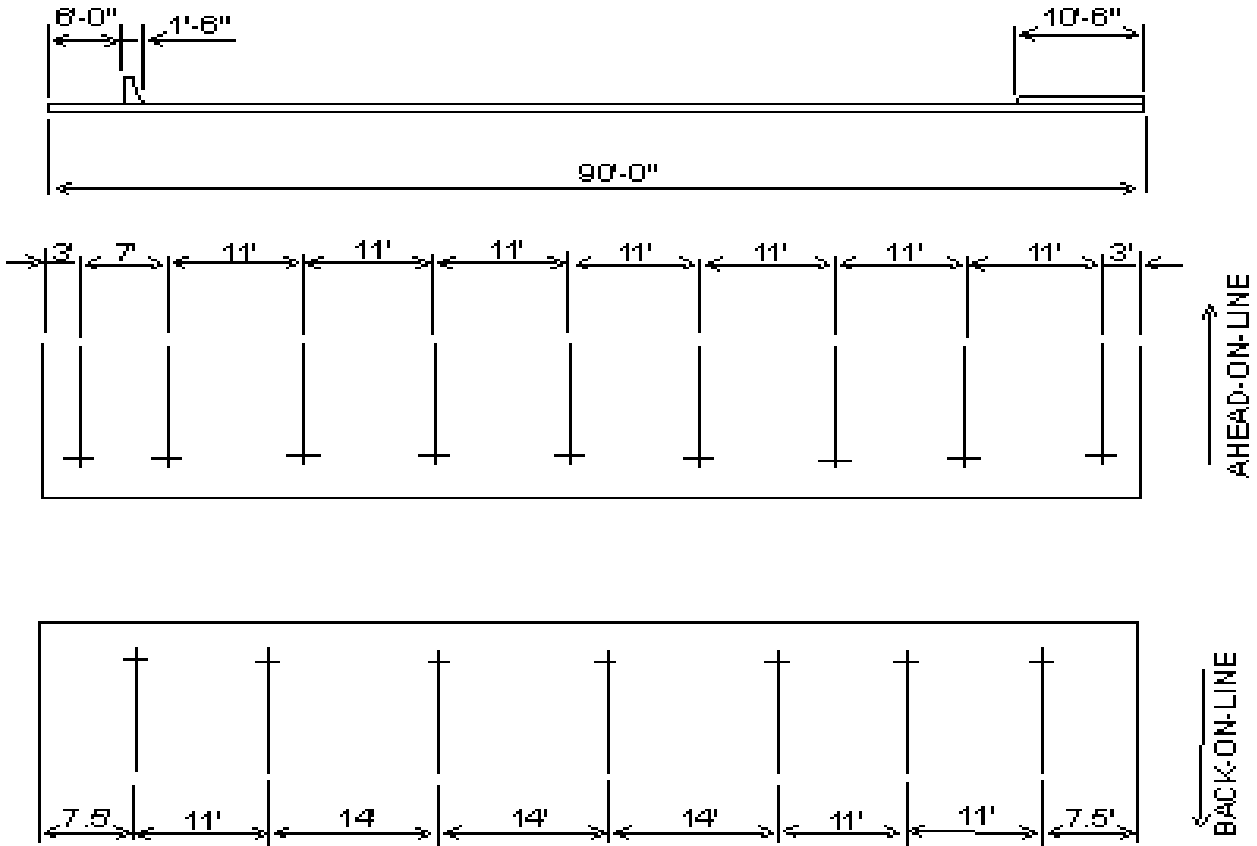
DEAD LOADING - DEAD LOAD TO GIRDERS



```

COM   REQUEST DEAD LOAD TO GIRDERS.
DCN   3,    2,    1,    2,    ,    2
COM   STEEL COMPOSITE - CURB, RAIL, FWS PLACED IN
COM   STAGE II
COM   INPUT GIRDER SPACING, ETC.
DD1   4,    9,    3.833,    3.833
COM   ENTER CURB DIMENSIONS
DD2   ,    ,    1.333,    1.25
DD3   7.5,    ,    ,    ,    ,    6
COM   ENTER LOAD PARAMETERS
DLG   .150,    .018,    1.5,    25.5
DLC   1,    .372,    .583,    2
DLC   1,    .372,    26.417,    2
DLC   3,    .040,    34.167,    2
    
```

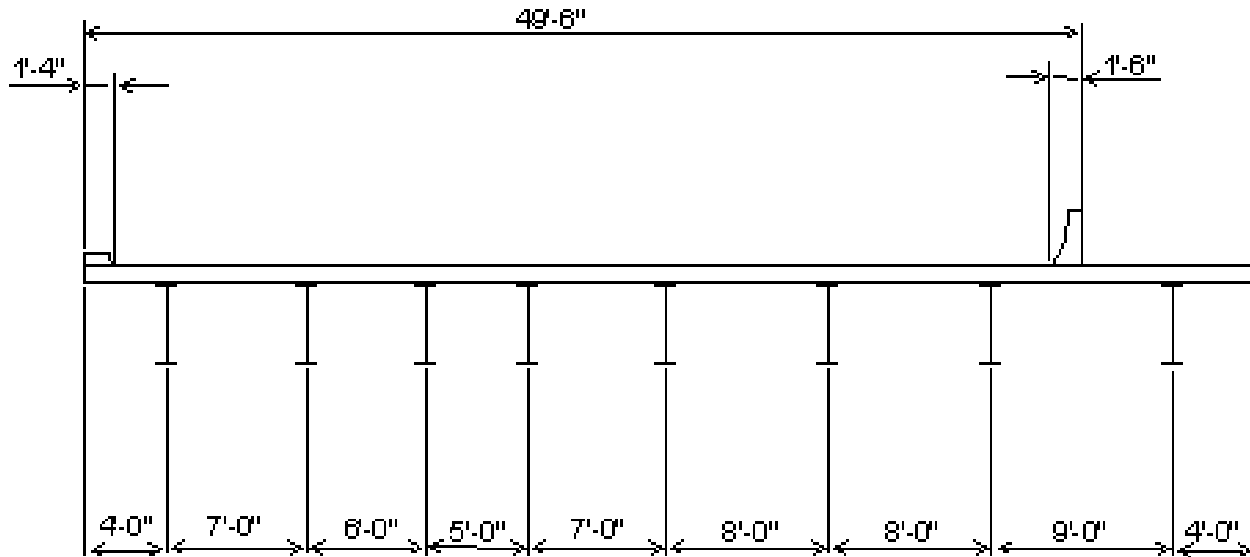
DECK LOADING - LIVE LOAD TO GIRDERS
DOUBLE BEARING PIER



```

COM      REQUEST OUTPUT OF LIVE LOAD TO GIRDERS
DCN      4,      2
COM      INPUT DECK DIMENSIONS
DD1      7,      1,      7.5
DD2      ,      ,      10.5
COM      INPUT GIRDER SPACING BACK ON LINE
DGS      11,    14,    14,      14,    11,    11
COM      INPUT MATERIALS FACTORS AND EDGES OF TRAVELWAY
DLG      ,      ,      7.5
COM      INPUT LIVE LOAD PARAMETERS FOR DOUBLE BEARING PIER
DLP      42.682, 9.027, -5.223, -1.117
COM      INPUT DATA FOR GIRDERS AHEAD ON LINE
DA1      9,      1,      3
DA2      7,      11,    11,      11,    11,    11,      11,    11
DA3      45.621, 10.047, -2.111, -0.423
    
```

DECK LOADING - LIVE LOAD TO GIRDERS
VARIABLE GIRDER SPACING



EXAMPLE:

From BRASS-GIRDER™, for a wheel fraction value of 1.5417, the maximum reactions due to HS20T are 67.529 and 66.975 kips respectively, were obtained. The reaction due to one wheel line, therefore, is:

$$\frac{67.529}{1.5417} = 43.802 \text{ kips}$$

and the reaction due to a 1-foot strip of lane load is:

$$66.975 * \frac{2}{1.5417} * \frac{1}{10} = 8.688 \text{ kips/ft.}$$

```

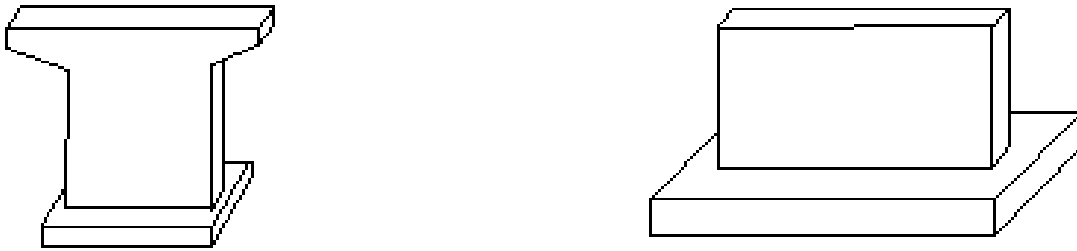
COM  REQUEST LIVE LOAD DISTRIBUTION TO GIRDERS
DCN  4, 2
COM  INPUT NO. OF GIRDERS
DD1  8, 1, 4, 4
COM  INPUT WIDTH OF CURB TO DEFINE WIDTH OF ROADWAY
DD2  1.333
COM  INPUT GIRDER SPACING PERPENDICULAR TO GIRDERS
DGS  7, 6, 5, 7, 8, 8, 9
COM  INPUT RIGHT CURB (BARRIER) TO DEFINE WIDTH OF ROADWAY
DLG  , , , 48
COM  INPUT LIVE LOAD REACTIONS
DLP  43.802, 8.688
    
```

8. PIER ANALYSIS

This component will analyze a solid shaft or a frame pier for all AASHTO Loadings, i.e., it converts the loadings to the pier into axial loads, shears (crossbeam of a frame pier only), and moments at various locations on the pier.

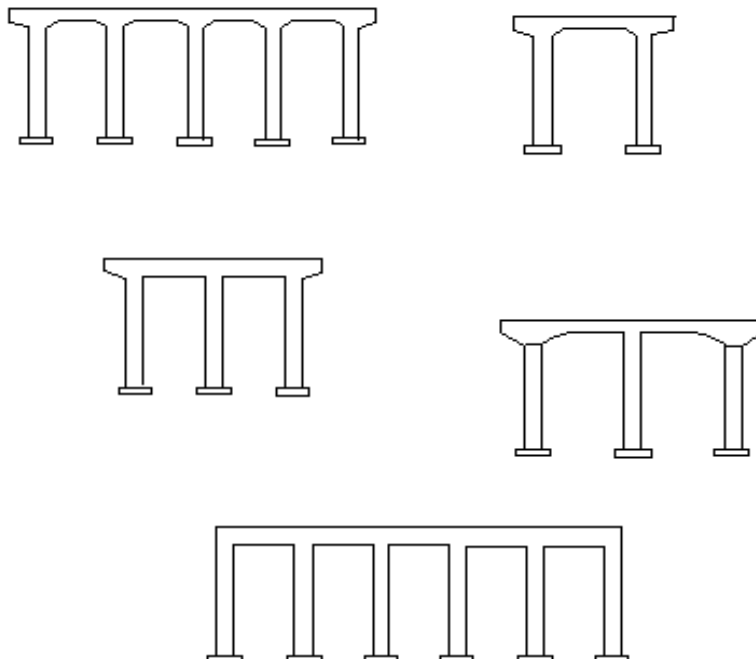
The actions (axial loads, shears, and moments) due to the various loadings are combined according to AASHTO 3.22 (Combinations of Loads), Load Factor Design.

The Solid Shaft Pier section will analyze a pier with a single column.



The Frame Pier section will analyze any single-story, open frame bent with a minimum of two and a maximum of six columns. Cantilevers are permissible on one or both ends of the bent. Columns may be either round or rectangular in cross section and each one may have a different length. Crossbeam spans between columns may be of different length and size, and haunches may be straight or parabolic.

The method of analysis is moment distribution with or without sidesway correction. Fixity of the columns at the footing may vary from a pin connection to a rigid connection and is left as an option to the designer.



220	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	PIER	PIR
PURPOSE	This command controls pier analysis. It is required whenever a solid shaft pier or a frame bent is to be analyzed.	
7 COMMAND PARAMETERS		
Pier Type	Two types of piers are possible: Code 1 for solid shaft pier or Code 2 for a frame bent. See Figure 1.	
Column Type Default = 2 for a solid shaft pier 1 for a frame pier	Columns may be divided into two classifications based on the type of lateral reinforcement in the column, either: Code 1 for spiral reinforcement - a continuous bar or wire, evenly spaced, or Code 2 for Ties - non-continuous bars.	
Bearing Default = 1	A pier may have either one or two rows of bearings depending on the continuity of the girders over the pier. If the girders are continuous over the pier, there will be one row of bearings and the pier will be referred to as a single bearing pier. If the girders are not continuous over the pier, there will be two rows of bearings and the pier will be referred to as a double bearing pier. See Figure 2. Code 1 for a single bearing pier or Code 2 for a double bearing pier.	
Step Height	If the pier is a double bearing pier, there is a possibility that the girders in one span are of a different height than the girders in the adjacent span. This will result in a step in the pier cap under the shallower girders (see Figure 2). Code the height of the step, in feet.	
Step Location	The step of a double bearing pier may be described as being located either back-on-line or ahead-on-line. The step shown in Figure 2 is located back-on-line. Code 1 if the step is located back-on-line or 2 if the step is located ahead-on-line.	
(Continued)		

COMMAND PARAMETERS (Cont.)

Sidesway
Default = 1

The following parameter applies only to a frame pier. Enter a code to specify the type of moment distribution to be performed

<u>Code</u>	<u>Type</u>
1	Moment distribution with sidesway correction (sidesway permitted)
2	Moment distribution without sidesway correction (sidesway prevented)

EC
Default = 3285 ksi

Enter the modulus of elasticity of the pier concrete, in kips per square inch.

EXAMPLE

Solid Shaft Pier, single bearing

PIER 1, 2, 1

Frame Pier, single bearing

PIER 2, 1, 1, , , 1

FIGURES

NOTES

EXAMPLE

Solid Shaft Pier, double bearing, step height = 4", back-on-line

PIER 1, 2, 2, .333, 1

Frame Pier - Single Bearing, moment distribution without sideway correction, $E_c = 3300$ ksi

PIER 2, 1, 1, , , 2, 3300

FIGURES

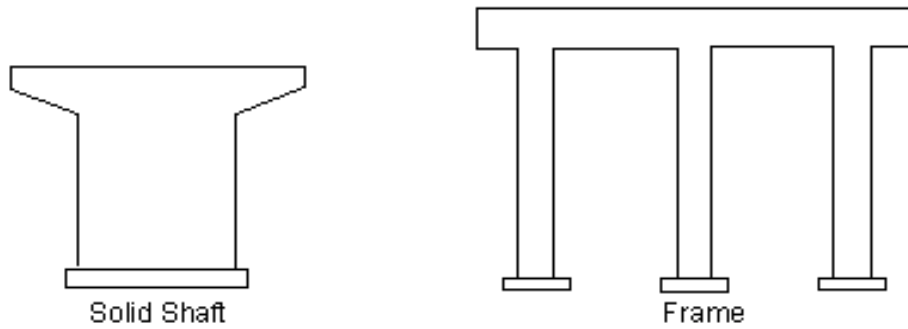


Figure 1 - PIER TYPES

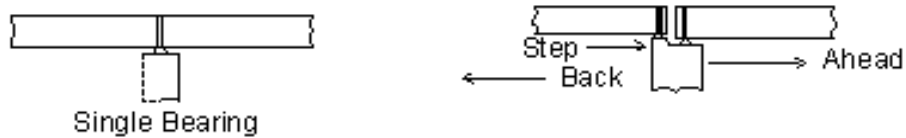


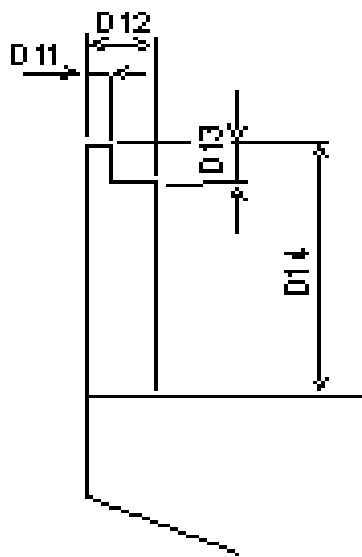
Figure 2 - BEARING TYPES

NOTES

230	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	SKIRTWALL		SKW
PURPOSE	This command defines the dimensions of a skirtwall which may be added to each end of the pier cap for aesthetic purposes. This command is optional.		
4 COMMAND PARAMETERS			
D14	Enter the height of the skirtwall, in feet. See D14 in Figure.		
D12	Enter the thickness of the skirtwall, in inches. See D12 in Figure.		
D13	Enter the height of the skirtwall step, in inches. See D13 in Figure.		
D11	Enter the thickness of the skirtwall step, in inches. See D11 in Figure.		

EXAMPLE

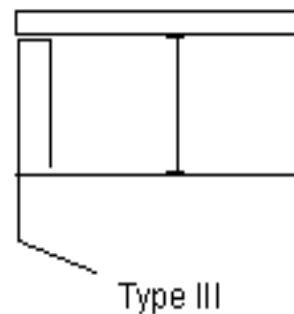
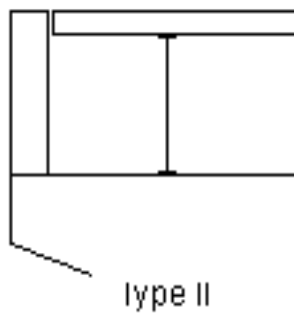
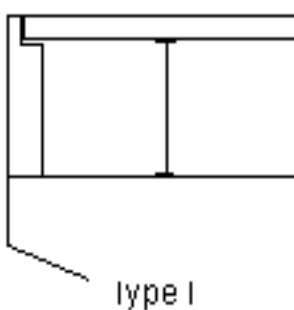
SKW 14.333, 10, 9, 4

FIGURES

Skirtwall Dimensions

NOTES

Three types of skirtwall are possible. Type I extends to the top of the deck with part of the skirtwall underneath the deck. Type II extends to the top of the deck but is outside the edge of the deck. Type III extends to near the bottom surface of the deck. Only Type I has a step. For Types II and III, the dimensions for the step would be 0.



240	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	CAP-DIM	
PURPOSE	CAP	
	<p>This command defines the dimensions of the pier cap.</p> <p>Repeat as needed to define all spans.</p>	
10 COMMAND PARAMETERS		
Span	<p>Enter the letter or a number to identify the span to be defined as follows:</p> <p>L refers to the left cantilever R refers to the right cantilever 1 refers to Span No. 1 2 refers to Span No. 2 3 refers to Span No. 3 4 refers to Span No. 4 5 refers to Span No. 5</p>	
Span Length	<p>For an interior span of a frame pier, enter the length of the span between the centerline of the columns, in feet.</p> <p>For the cantilevers of a solid shaft pier, enter the length of the cantilever, from the face of the column to the end of the cantilever, in feet.</p> <p>For the cantilevers of a frame pier, enter the length of the cantilever, from the centerline of the column to the end of the cantilever, in feet.</p> <p>See SPNLEN in Figures 1 and 2.</p>	
Cap Width Default = CBW	<p>Enter the width of the cap, in feet. For a solid shaft pier, the cap width must equal the depth of the shaft. See CBW in Figures 1 and 2.</p>	
Nominal Depth Default = CBND for a cantilever	<p>For the interior spans of a frame pier without haunches, enter the depth of the cap, in feet. For the interior spans of a frame pier with haunches, enter the depth of the cap that does not include the haunches, in feet.</p> <p style="text-align: center;">- or -</p> <p>For a cantilever, enter the depth of the cap at the end of the cantilever, in feet. See CBND in Figures 1 and 2.</p>	
(Continued)		

EXAMPLE

For a pier cap with a left cantilever, cantilever length = 5.25 ft., width = 3 ft., and nominal depth = 4 ft., code:

CAP L, 5.25, 3, 4, 1, 2, , , , 1

For a frame pier with a span between columns (span No. 1), span length = 12 ft., cap width = 3 ft., and nominal depth = 4 ft., code:

CAP 1, 12, 3, 4, 2, 2, 4, 2, 4, 3

FIGURES

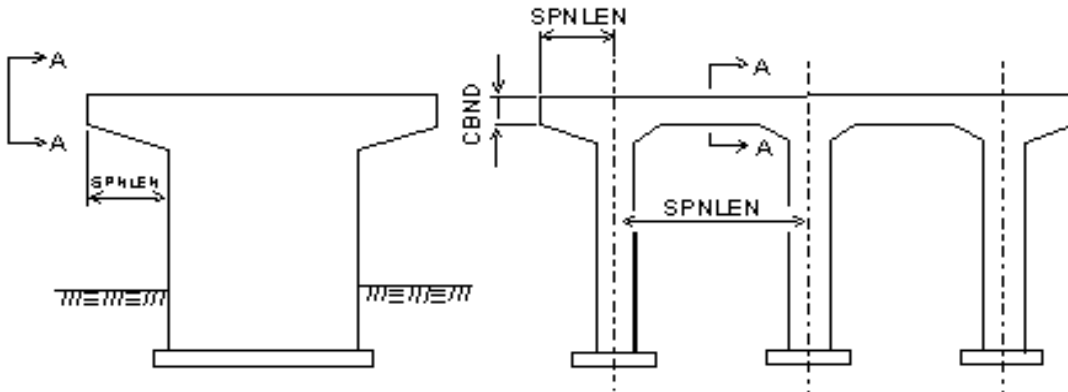
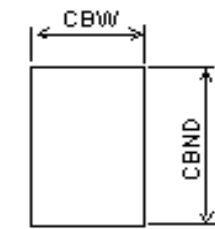


Figure 1 - Solid Shaft Pier

Figure 2 - Frame Pier



SECTION A-A

COMMAND PARAMETERS (Cont.)							
Type	<p>The next 5 parameters apply only to a span with a haunched crossbeam.</p> <p>Enter a code to specify the type of haunch being defined.</p> <table style="width: 100%; border: none;"> <tr> <td style="text-align: center; width: 50%;"><u>Code</u></td> <td style="text-align: center; width: 50%;"><u>Haunch Type</u></td> </tr> <tr> <td style="text-align: center;">1 Straight Taper</td> <td></td> </tr> <tr> <td style="text-align: center;">2 Parabolic Taper</td> <td></td> </tr> </table>	<u>Code</u>	<u>Haunch Type</u>	1 Straight Taper		2 Parabolic Taper	
<u>Code</u>	<u>Haunch Type</u>						
1 Straight Taper							
2 Parabolic Taper							
Haunch Depth	<p>The haunch depth is the difference between the depth of the cap at the face of the column and the nominal depth of the cap.</p> <p>For an interior span, enter the depth of the left haunch, in feet. See HDL in Figures 1 and 2.</p> <p>For a left OR right cantilever, enter the depth of the haunch, in feet. See DEPTH in Figures 1 and 2.</p>						
HLL	<p>The next 3 parameters apply <u>only</u> to interior spans.</p> <p>Enter the length of the left haunch, in feet. The haunch length is measured from the <u>face</u> of the column to the point where the haunch no longer exists. See HLL in Figure 2.</p>						
HDR	Enter the depth of the right haunch, in feet. See HDR in Figure 2.						
HLR	Enter the length of the right haunch, in feet. See HLR in Figure 2.						
IDENTICAL	Enter the number of spans identical to this span. See Notes.						

EXAMPLE

For a pier cap with a straight tapered haunch, haunch depth = 2 ft., and right cantilever identical to left Cantilever, code:

CAP L, 5, 25, 3, 4, 1, 2, , , , 1

For a pier cap with parabolic tapered haunches, left haunch depth = 2 ft., left haunch length = 4 ft., right haunch depth = 2 ft., right haunch length = 4 ft., and spans 2, 3 and 4 are identical to span No. 1, code:

CAP 1, 12, 3, 4, 2, 2, 4, 2, 4, 3

FIGURES

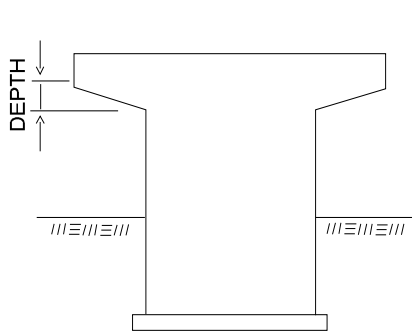


Figure 1 - Solid Shaft Pier

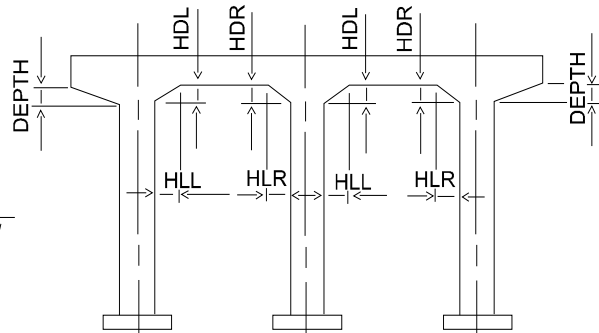


Figure 2 - Frame Pier

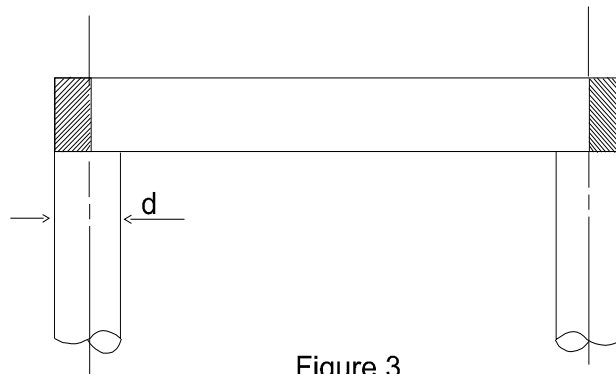


Figure 3

For the situation shown in Figure 3, shaded area may be coded as a cantilever. If not coded, weight of the shaded portion will not be included. If coded as a cantilever, the weight will be included and cantilever actions generated. Also, see Note on Command 250 - COLUMN-DIM.

NOTES

Notes for parameter No. 10 (identical spans):

Cantilevers

Entering a 1 will make the right cantilever identical to the left cantilever.

Interior Spans

The value entered in this parameter will be the number of spans (adjacent and to the right of) identical to the span defined, i.e., if parameter No. 1 is 2 and parameter No. 10 is 3 then spans 3, 4, and 5 will be identical to span No. 2.

250	BRASS-PIER	COMMAND DESCRIPTION
COMMAND NAME	COLUMN-DIM	
PURPOSE	COL	
	<p>This command defines the dimensions of column and footing for a pier.</p> <p>Repeat as needed to define all columns.</p>	
10 COMMAND PARAMETERS		
Column Number	<p>Enter the column number (left to right) being defined. A maximum of 6 columns are allowed for a frame pier. Leave blank for a solid shaft pier.</p>	
COLDIA or COLWDT	<p>Enter the diameter of a round column or the width of a rectangular column, in feet. See COLDIA or COLWDT in Figures 1 and 2.</p>	
COLDPT	<p>For a rectangular column, enter the depth of the column, in feet. For a solid shaft pier, the cap width must equal the depth of the shaft. See COLDPT in Figures 1 and 2. For a round column, this parameter must be left blank.</p>	
CLMLEN	<p>Enter the column length, measured from the top of the footing to the top of the pier cap, in feet. See CLMLEN in Figures 1 and 2.</p>	
FTGWDT	<p>NOTE: If the footing is to be designed by BRASS-PIER, omit the next three parameters.</p> <p>Enter the width of the footing, in feet. See FTGLEN in Figures 1 and 2.</p>	
FTGLEN	<p>Enter the length of the footing, in feet. See FTGLEN in Figures 1 and 2.</p>	
FTGT Default = 1.0 ft	<p>Enter the thickness of the footing, in feet. See FTGT in Figures 1 and 2.</p>	
(Continued)		

EXAMPLE

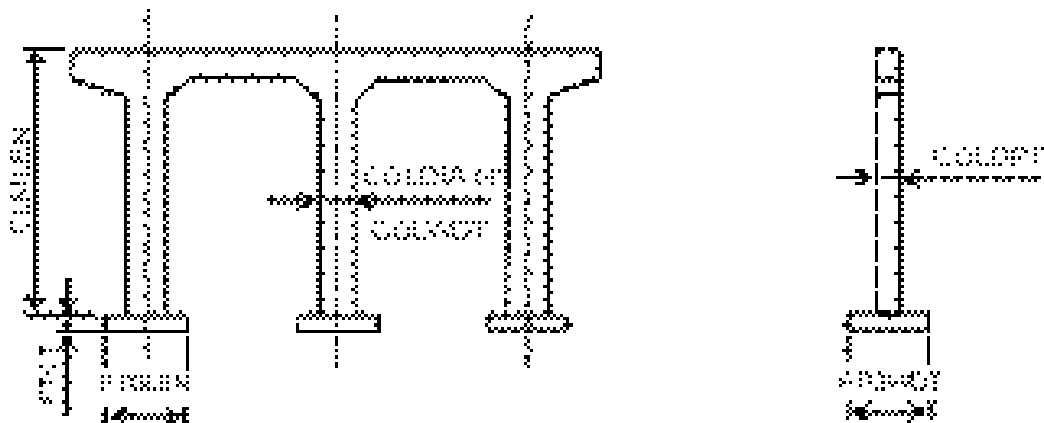
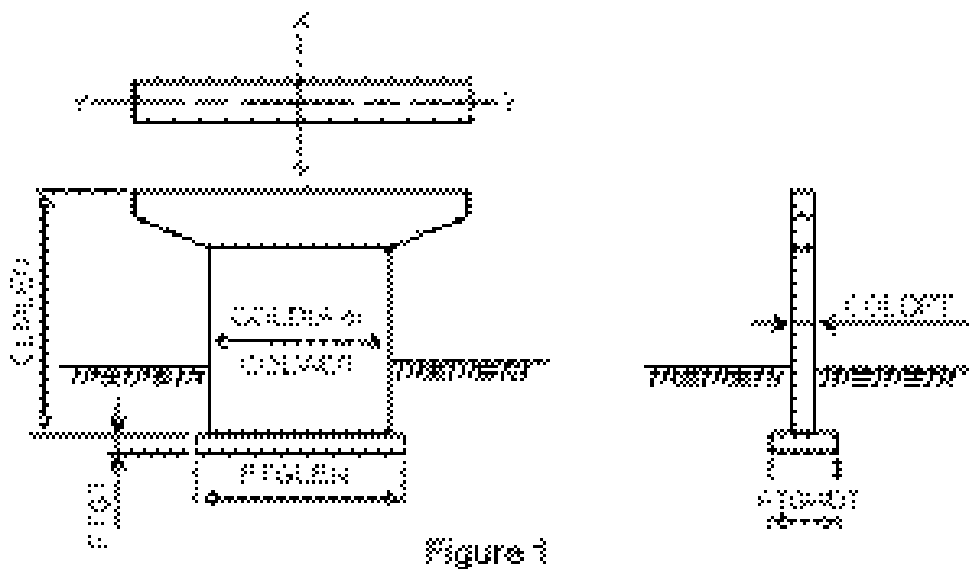
For a circular column No. 1, round column - diameter = 3 ft., column length = 30 ft., footing width = 6 ft., footing length = 6 ft., and footing thickness = 2 ft., code:

COL 1, 3, , 30, 6, 6, 2, 4, 0, 3

For a rectangular column No. 1, width = 3 ft., and depth = 4 ft., code:

COL 1, 3, 4, 30, 6, 6, 2, 4, 1

FIGURES



COMMAND PARAMETERS (Cont.)

DTF	<p>Enter the distance from the ground line to the top of the footing, in feet. See DTF in Figures 1 and 2.</p>
FIXITY	<p>The following parameters apply only to a frame pier.</p> <p>Enter a code to define the fixity at the bottom of the column.</p> <p>0 represents a column which is fully fixed (or rigid) at the bottom.</p> <p>1 represents a column which is pin connected at the bottom.</p> <p>The code may be any value between 0 and 1.</p>
Identical	<p>Enter the number of columns identical to this column.</p>

EXAMPLE

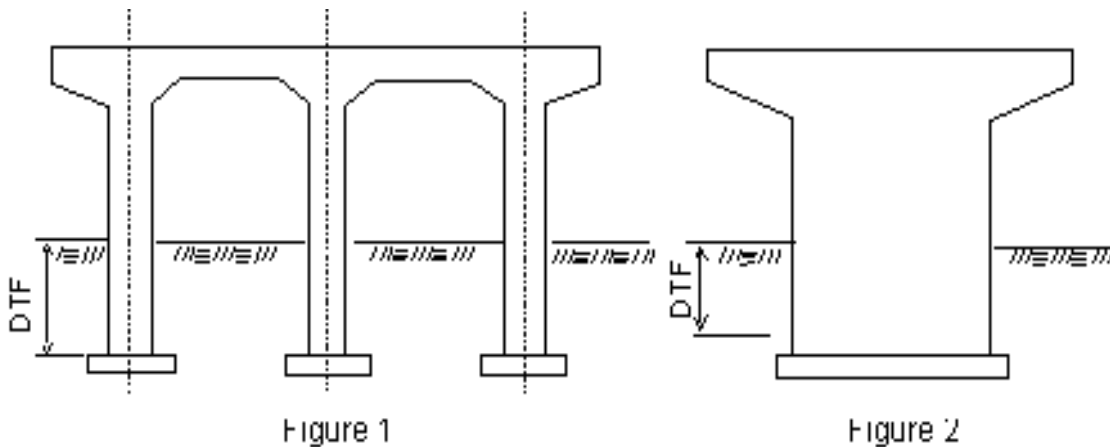
For a depth to top of footing = 4 ft., column "fixed" at the bottom, columns 2, 3, and 4 identical to column No. 1, code:

COL 1, 3, , 30, 6, 6, 2, 4, 0, 3

For a column "pin-connected" at bottom, code:

COL 1, 3, 4, 30, 6, 6, 2, 4, 1

FIGURES



NOTES

Notes for parameter No. 10.

The value entered in this parameter will be the number of columns identical to the column defined (adjacent and to the right), i.e., if parameter No. 1 is 2 and parameter No. 10 is 3 then columns 3, 4, and 5 will be identical to column No. 2.

Most of the loads applied to the pier are applied through the girder bearings. Therefore, it is

necessary to define the location and the position of the bearings on the pier, i.e., distance from the left end of the pier to the centerline of the bearing and offset from the centerline of the pier to the centerline of the bearing (for a double bearing pier only). For a single bearing pier the bearing is assumed to be placed over the centerline of the pier, Figure 8.3.

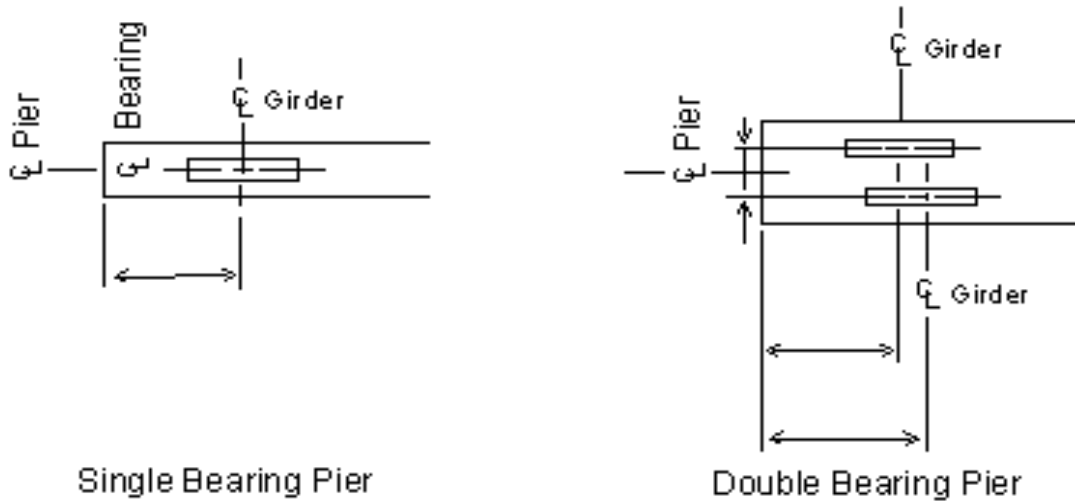


Figure 8.3

When defining the location of the bearings (or the loads to be applied to the bearings) for a double bearing pier, it is necessary to indicate which line of bearings is being defined. The bearings are described as being either back-on-line or ahead-on-line, Figure 8.4.

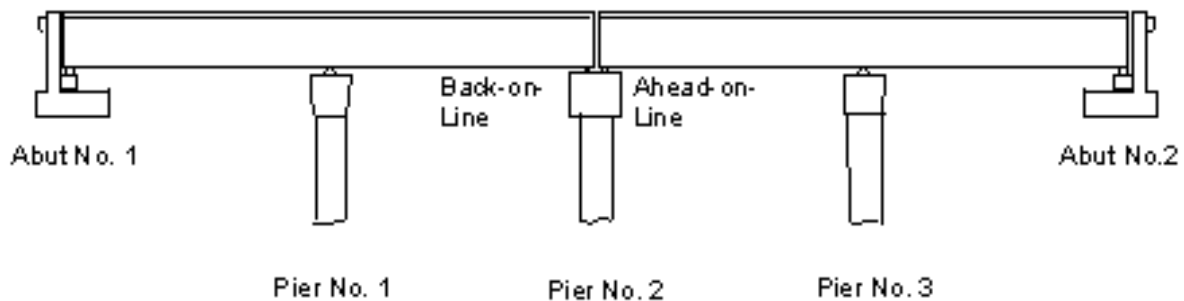


Figure 8.4

The orientation of the girder bearings refers to the relationship between the centerline of bearing and the centerline of the pier, normally called the skew. If the centerline of bearing is parallel to the centerline of the pier, the skew is 0° and the pier is referred to as a normal pier, Figure 8.3. When the centerline of bearing is not parallel to the centerline of the pier, the pier is referred to as a skewed pier and the angle between the centerline of bearing and pier (called the skew) must be given in decimal degrees. A right hand skew is positive and a left hand skew is negative, Figure 8.5.

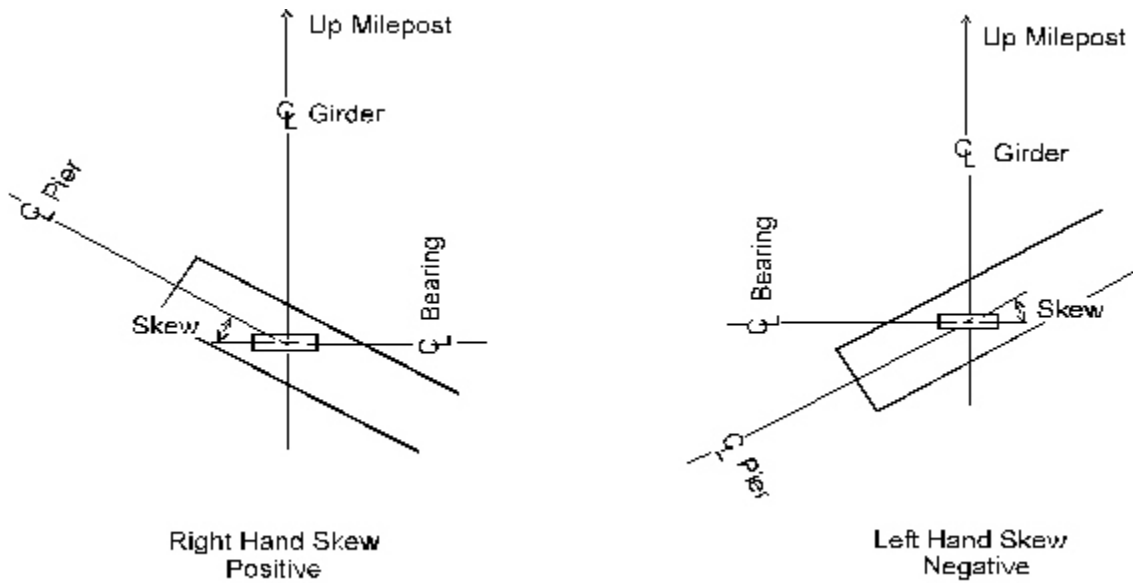


Figure 8.5

300	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	BEARING	
PURPOSE	BRG	
	<p>This series of commands defines the placement of the girders on the pier. One cap BEARING command is required for a single bearing pier and two are required for a double bearing pier.</p>	
8 COMMAND PARAMETERS		
Location	<p>Enter the location of this line of bearings.</p> <p>1 = Back-on-Line 2 = Ahead-on-Line Leave Blank for single bearing pier</p>	
Skew	<p>Enter the skew of the pier to this row of bearings in decimal degrees.</p> <p>Right skew is positive (see Figure 1).</p>	
Bearing Type	<p>Enter 1 if the bearings at this location are expansion bearings (allow horizontal movement of the girders). Enter 2 if the bearings at this location are fixed bearings (do not allow horizontal movement of the girders).</p>	
HB	<p>If the bearings at this location are fixed, enter the height of the bearings, in inches (see Figure 2).</p>	
X	<p>Enter the distance from the left end of the pier cap to the center of the first girder bearing in feet. This distance is measured parallel to the centerline of the pier cap. See X in Figure 3 and 4.</p>	
NG	<p>Enter the number of girders. Maximum of 20.</p>	
XS	<p>Enter the spacing of the girders, if not previously input on DECKC-DIM1 command, measured parallel to the centerline of the pier cap, in feet. See XS in Figure 3. If the girders are not evenly spaced, leave blank and use the BEARING-VS command. If the girder spacing was previously input on the DECKC-DIM1 command or the DECKC-GS command and this is a skewed pier, BRASS-PIER™ will adjust the distances correctly.</p>	
XB	<p>For a double bearing pier, enter the distance between the centerline of the pier cap and the centerline of the bearings, measured perpendicular to the centerline of the pier cap, in feet. See XB in Figure 4.</p>	

EXAMPLE

For an expansion bearing on a single bearing pier, skewed 20° right:

BRG 20, 1

For a fixed bearing, ahead-on-line on a double bearing pier, skewed 10° left, bearing height of 3 inches:

BRG 1, -10, 2, 3

For Figure 3:

BRG 0, , , 2.25, 5, 8.25

For Figure 5:

BRG 1, 0, 1, 2, 3, 5, 8, 1.5
 BRG 2, 0, 1, 2, 3, 5, 8, 1.5

FIGURES

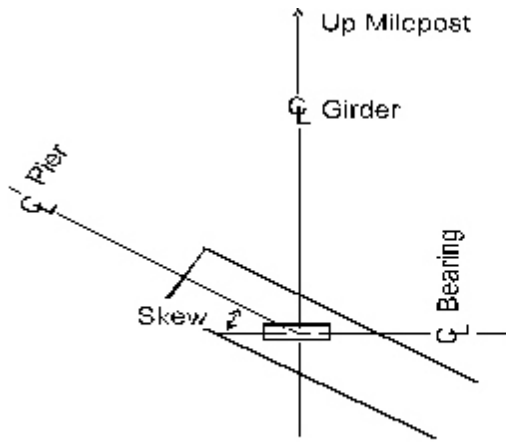


Figure 1

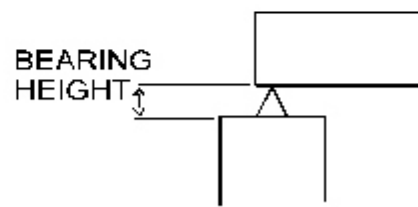


Figure 2

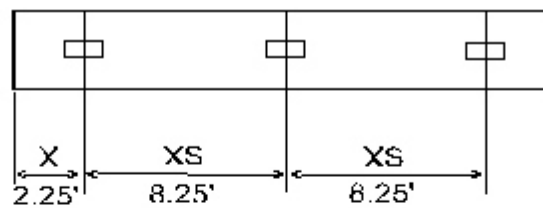


Figure 3

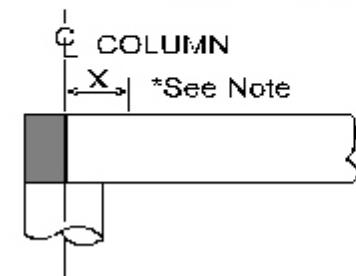


Figure 4



Figure 5

Note: If there is no cantilever coded, as shown, measure "X" from the center of the column. "X" may be negative, in which case BRASS-PIER™ will treat it as a load on a cantilever.

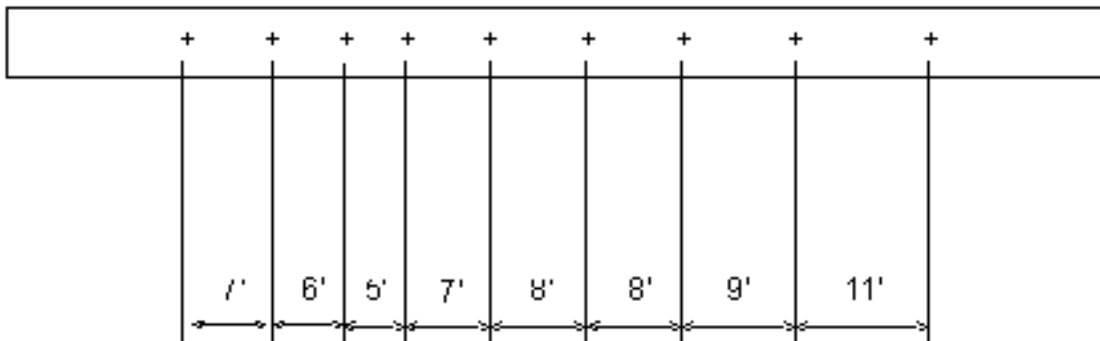
320	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	BEARING-VS	
PURPOSE	<p>This command defines the spacing of the girders when the girders are not evenly spaced. This command must be used when the girder spacing is left blank on the BEARING command or not previously input by the DECKC-GS command. If required, it must follow the BEARING command.</p>	
19 COMMAND PARAMETERS		
Space 1	Enter the space, in feet, between girders #1 and #2.	
Space 2	Enter the space, in feet, between girders #2 and #3.	
Space 3	Enter the space, in feet, between girders #3 and #4.	
Space 4	Enter the space, in feet, between girders #4 and #5.	
Space 5	Enter the space, in feet, between girders #5 and #6.	
Space 6	Enter the space, in feet, between girders #6 and #7.	
Space 7	Enter the space, in feet, between girders #7 and #8.	
"	" " " " " " " " Etc.	
Space 19	Enter the space, in feet, between girders #19 and #20.	

EXAMPLE

BRG

BRV 7, 6, 5, 7, 8, 8, 9, 11

FIGURES



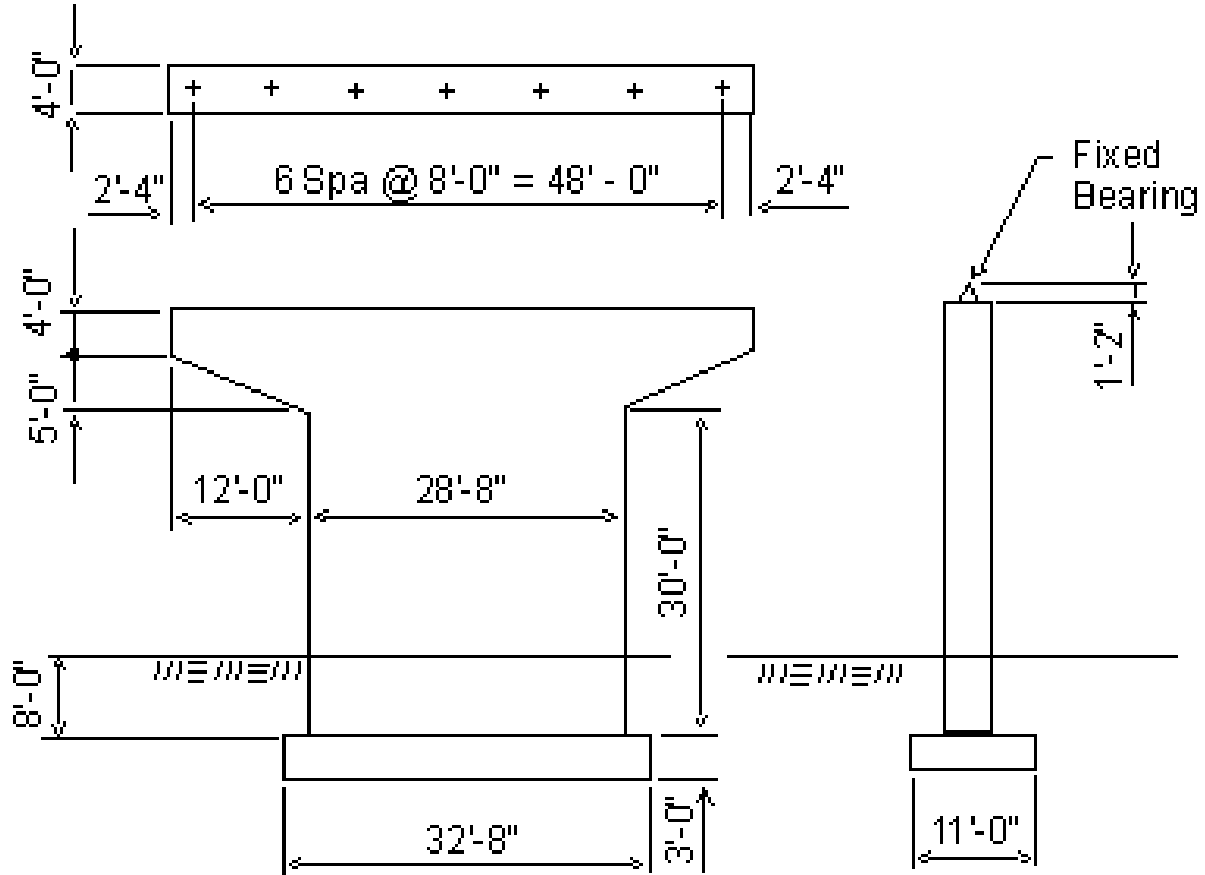
NOTES

Girder spacing for this command is measured parallel to the centerline of the pier. Girders are numbered from left to right.

See page 2.2 for information on continuation lines.

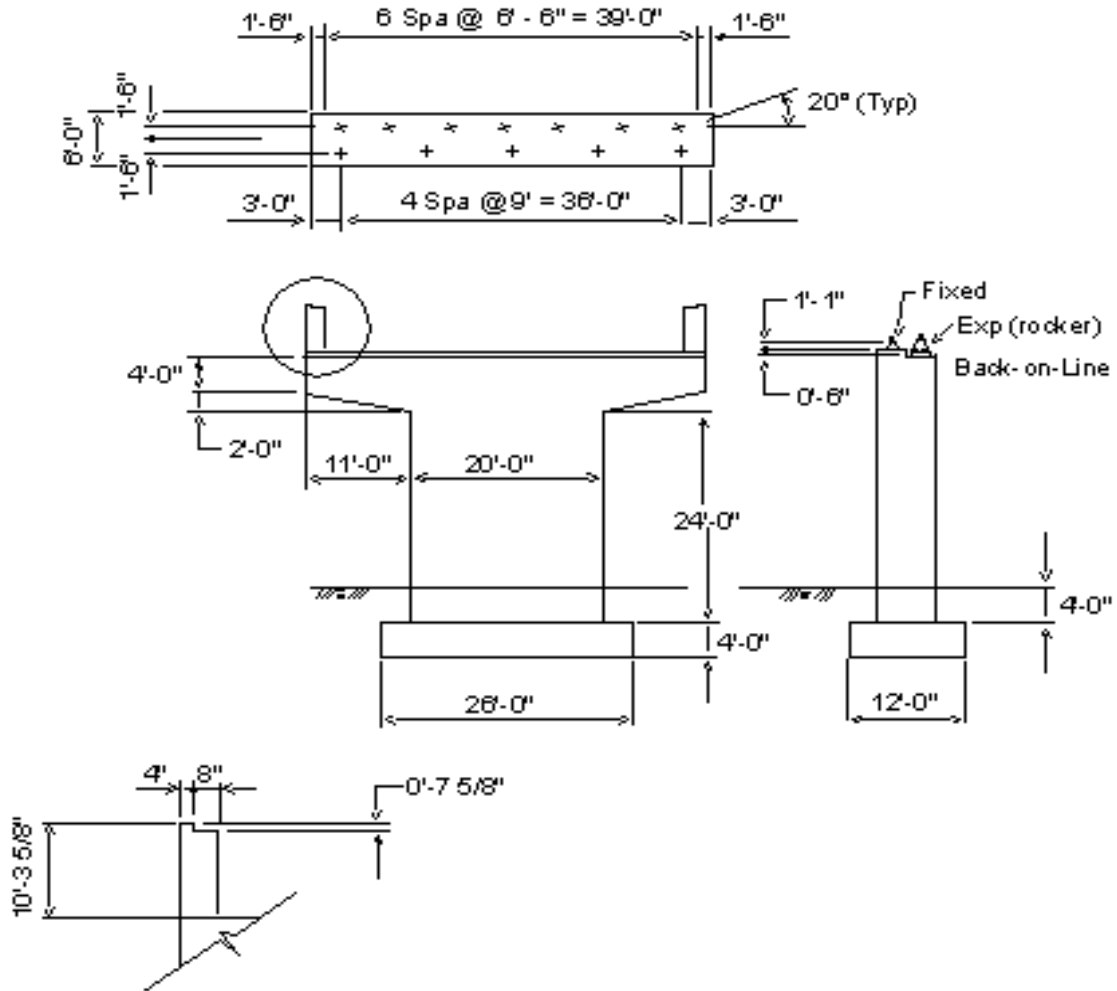
ANALYSIS section:

SOLID SHAFT PIER
SINGLE BEARING - FIXED
WITHOUT SKIRTWALLS



PIR	1,	2,	1							
CAP	L,	12,	4,	4,	1,	5,	,	,	,	1
COL	,	28.667,	4,	39,	11,	32.667,	3,	8		
BRG	,	0,	1,	14,	2.333,	7,	8			

SOLID SHAFT PIER
DOUBLE BEARING - FIX-EXP
WITH SKIRTWALLS



PIR	1,	2,	2,	.5,	2				
SKW	10.302,		12,	7.625,	4				
CAP	L,	6,	6,	4,	1,	2,	,	,	1
COL	,	20,	6,	30,	12,	26,	4,	4	
BRG	1,	0,	2,	,	3,	5,	9,	1.5	
BRG	2,	20,	1,	13,	1.5,	7,	6.5,	1.5	

9. PIER LOADS

This component will apply the following AASHTO loads to a pier:

- DEAD LOAD
- LIVE LOAD
- WIND LOAD
- CENTRIFUGAL FORCE
- LONGITUDINAL FORCE DUE TO LL
- BUOYANCY STREAM FLOW
- ICE PRESSURE
- EARTHQUAKE
- SHRINKAGE
- TEMPERATURE

The dead load of the pier will be calculated and applied based on the dimensions of the pier and the unit weight of the concrete input by the user. For a solid shaft pier, the dead load of the pier is applied as an axial load and a moment about the x-x axis (for a pier with non-identical cantilevers). For a frame pier, the dead load of the crossbeam is applied as a uniform load (or a non-uniform load if there are haunches) to the frame and the dead load of the columns are applied as axial loads. If a double bearing pier has a step, the weight of the step is applied as an axial load to a solid shaft pier and is applied as a uniform load to a frame pier. If the unit weight of the concrete is input as zero, the dead load of the pier will not be applied.

The dead load and live load of the superstructure are applied to a pier as point loads at the locations of the girder bearings. The dead load reactions (and the live load reactions for a solid shaft pier analysis) are input by the user. The live load reactions for a frame pier analysis may be either input by the user or generated by the DECK LOADING COMPONENT. The live load reactions generated by the DECK LOADING COMPONENT are the result of one truck (or lane) being moved from left to right across the deck at one foot intervals. Two methods of combining live load reaction for multiple loaded lanes are available and are controlled by the use of the LIVE-COMBINE command. In method one, the program applies the live load to the frame and generates actions due to each truck position then combines the actions due to all possible placement of trucks on the roadway and searches for maximums. Method one is activated when the DECK LOADING COMPONENT - Live Load to Girders Section is requested and the LIVE-COMBINE command is not entered. Method two, activated when the LIVE-COMBINE command is used, combines the actions due to the truck positions input on the LIVE-COMBINE commands and searches for maximums.

Placement of the trucks on the bridge roadway to search for maximum actions is accomplished as follows:

The maximum number of lanes possible for the given roadway is determined and the structure is loaded with the maximum number of lanes, all lanes shifted to the far left of the roadway, Figure 9.1.

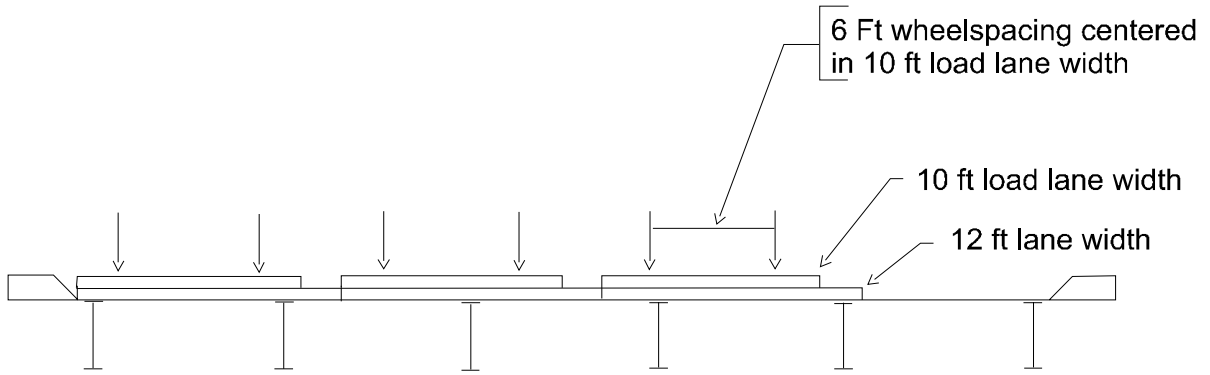


Figure 9.1

The rightmost loading lane is then shifted to the right at 1 ft. increments, until the lane reaches the far right of the roadway, Figure 9.2.

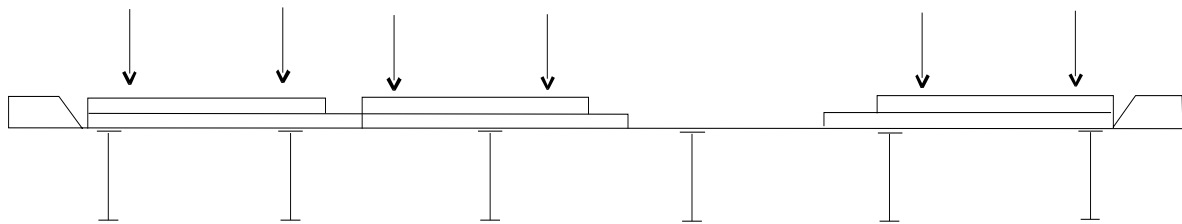


Figure 9.2

Each time the lane is moved, the new position of the lane combined with the positions of the remaining lanes defines a load case and the actions due to that load case are checked for maximums. The next to the rightmost lane is then shifted to the right by a 1 ft. increment and the rightmost lane is shifted as far left as it will go, Figure 9.3.

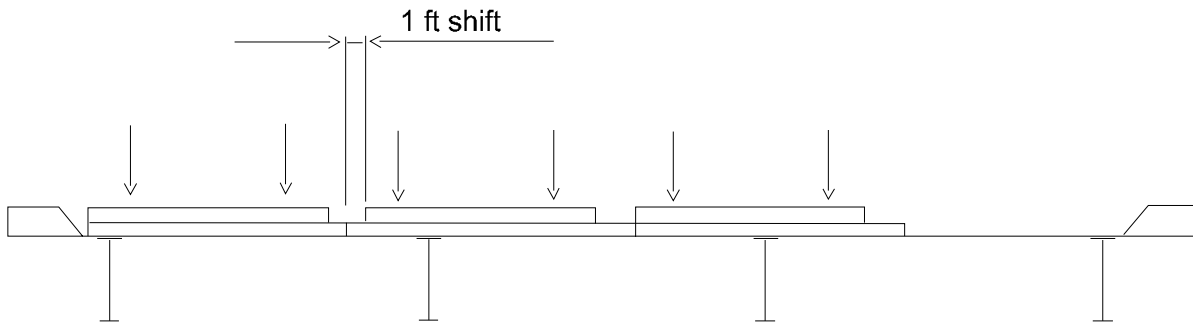


Figure 9.3

This procedure of shifting each lane to the left when the lanes to the right have reached the far right is repeated until all lanes are as far to the right as possible, Figure 9.4.

When this happens, the lanes are all shifted back to the far left and the rightmost lane is removed and the above procedure repeated. This procedure of removing the rightmost lane when all lanes

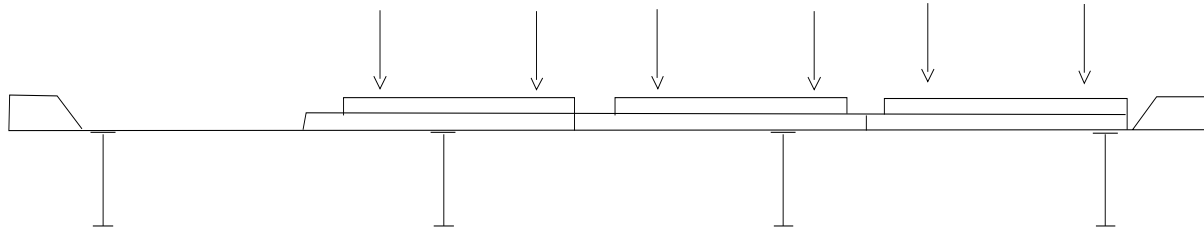


Figure 9.4

have been shifted as far right as possible is repeated until only one lane is left and it has been shifted to the far right. If the roadway width is not an integer, the process is repeated by placing the loads from right to left beginning at the right edge of the roadway.

As the lanes are being moved across the roadway, the crossbeam actions (shears, moments, reactions) are searched for maximums and the column actions are searched for the maximum vector length ($\sqrt{P^2 + M_1^2 + M_2^2}$) in each of the 50 "windows" of the failure surface. See Page 1.5.

If requested, the output will show the positions of the trucks and lanes which produce the maximum actions. For the crossbeam actions, the number will appear as: aa bb cc, where aa refers to the position of the first truck, bb refers to the position of the second truck, etc. For the column actions, the number will appear as: a bb cc dd, where a specifies the type of load - 1 = truck, 2 = lane, bb refers to the position of the first truck, cc refers to the position of the second truck, etc. Position No. 1 refers to a truck with its left edge of load lane at the left edge of the roadway and its left wheel 2 ft. from the left edge of the roadway, Figure 9.5.

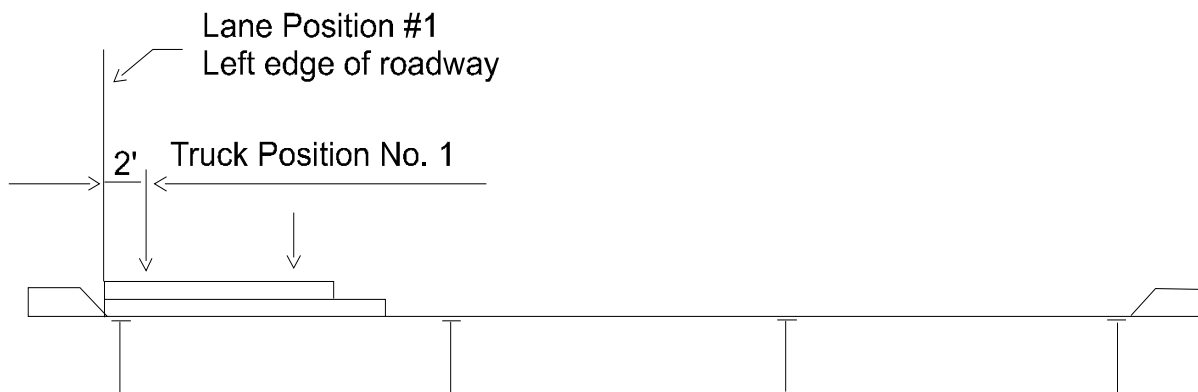


Figure 9.5

Therefore, the distance from the left edge of the roadway to the left edge of the load lane, in feet, is equal to the Position No. minus 1 and the distance from the left edge of the roadway to the left wheel of the truck, in feet, is equal to the Position No. plus 1, Figure 9.6.

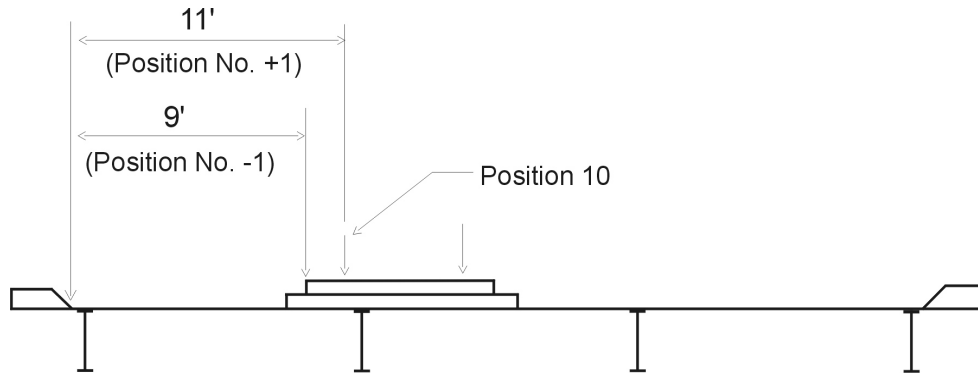
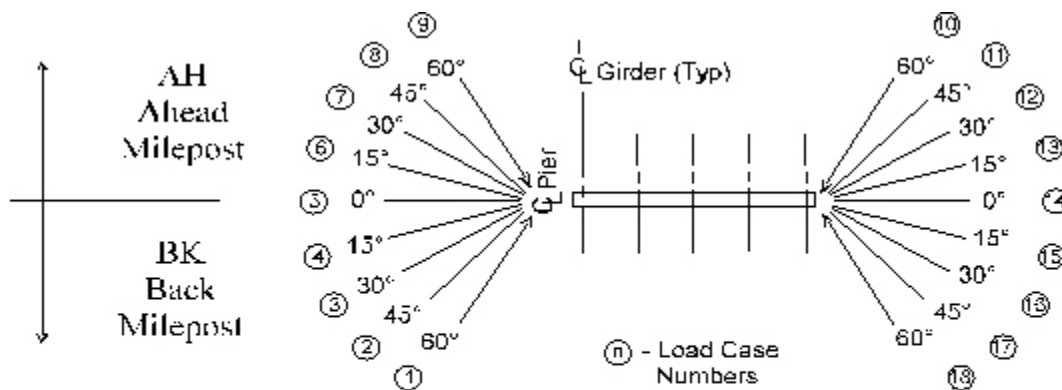


Figure 9.6

If the roadway width is not an integer and the live load placement is repeated by moving the truck from right to left, the Position Numbers are defined starting at the right edge of the roadway (a mirror image of Figures 9.5 and 9.6).

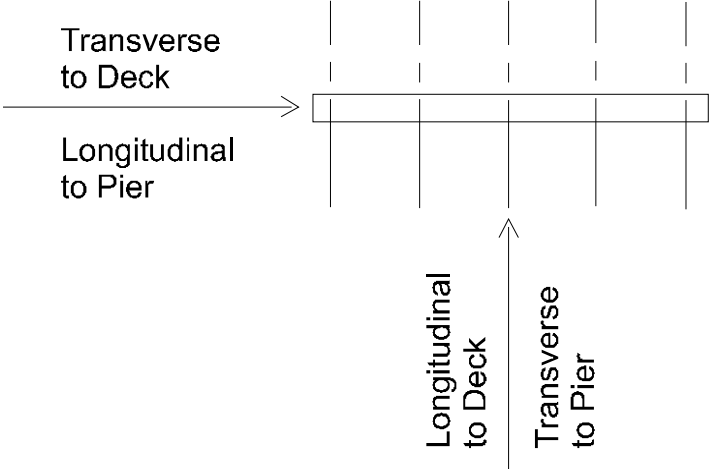
For a solid shaft pier, the option to input the action due to dead and live load (Axial load, Moments about x-x and y-y axis) is also available and is activated by the use of the DEAD-ACTION and LIVE-ACTION commands. For the live load to a solid shaft pier, the option is also available to input the reaction at the pier due to the placement of a truck or a lane load on the superstructure. The program will then place the truck or lane loads on the pier in numbers and positions to produce maximum actions on the pier.

The wind load forces will be calculated and applied to the pier based on the data entered in the WIND-LOAD and SUPERSTRUCTURE commands. Note, if the WIND-LOAD command is not in the data set, no wind load force will be applied. The wind load forces are calculated as per AASHTO 3.15.2, which specifies two methods for calculation and application of the wind load forces. The first method specifies that the forces due to the wind load be calculated for various angles of wind direction, Figure 9.7.



GENERAL METHOD
Figure 9.7

The second method, a simplified method which may be used when the superstructure span lengths do not exceed 125 feet, specifies a longitudinal and a transverse force to be applied simultaneously to the pier, Figure 9.8.



SIMPLIFIED METHOD
Figure 9.8

For skewed bridges the General Method and the Simplified Method would have wind loads applied to the structure, as shown in Figure 9.9

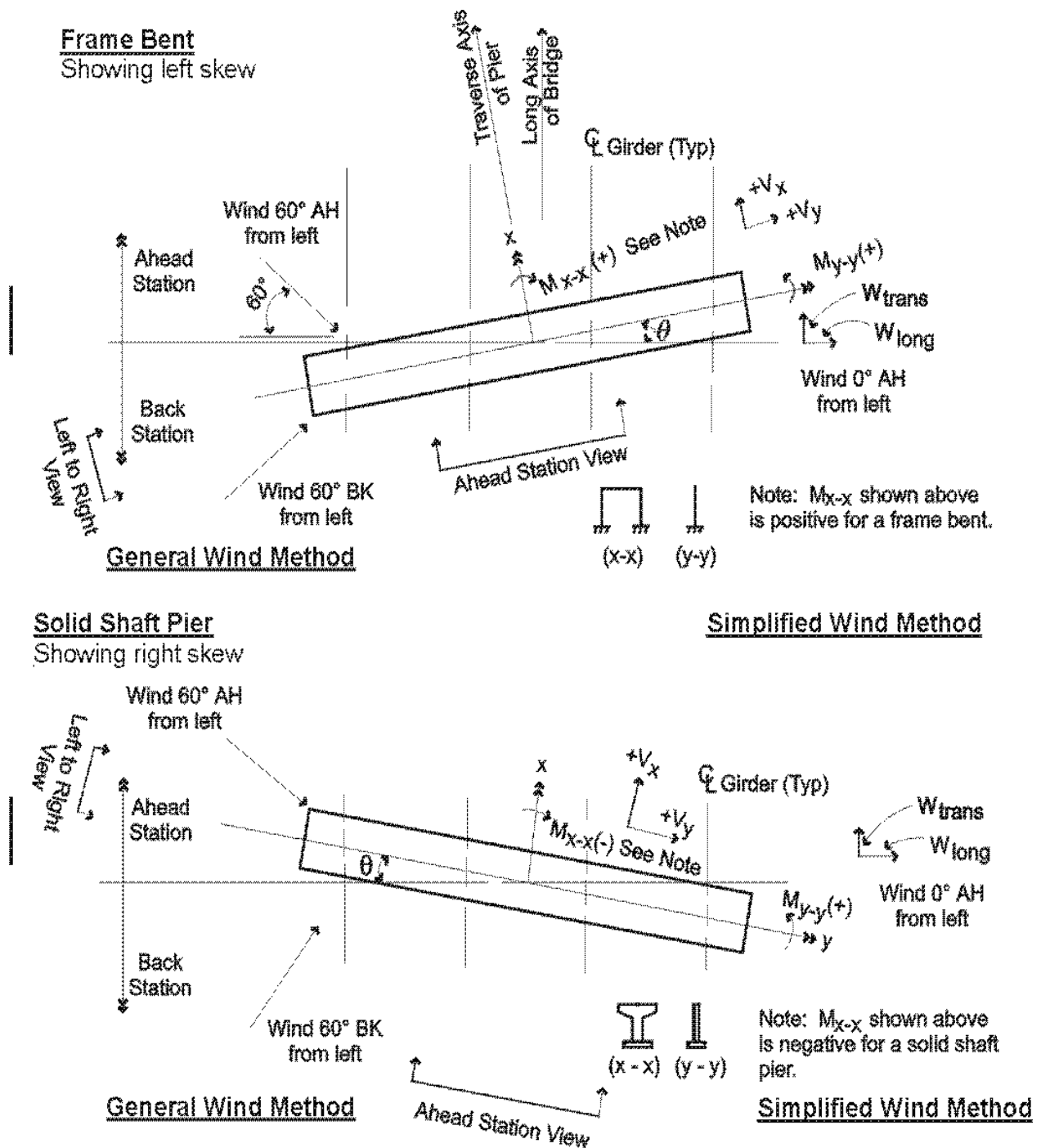


Figure 9.9

In addition to the wind load applied directly to the superstructure and transmitted to the pier, a wind load is applied to a moving live load and transmitted to the pier through the superstructure.

An upward force is applied at the windward quarter point of the transverse superstructure width, Figure 9.10. The user may select an option to ignore this force.

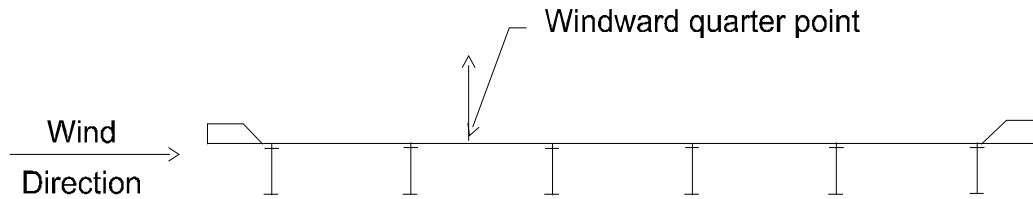


Figure 9.10

Normal design procedure, for ease of computations, is to apply the uplift force at a point on the pier cap which is directly beneath the quarter point of the transverse superstructure section, Figure 9.11.

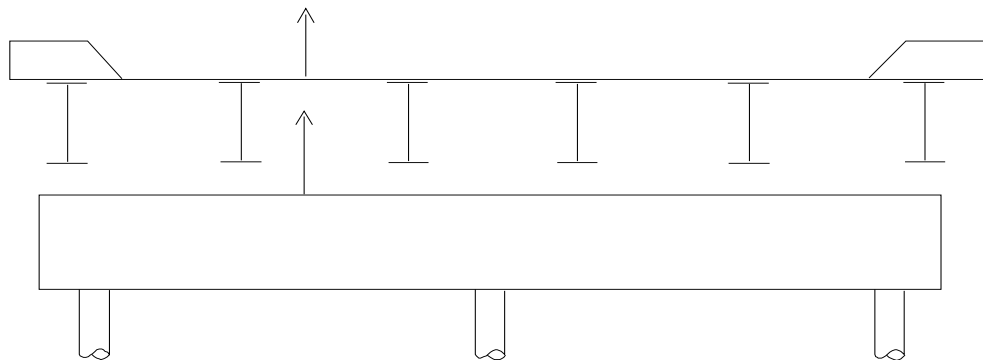
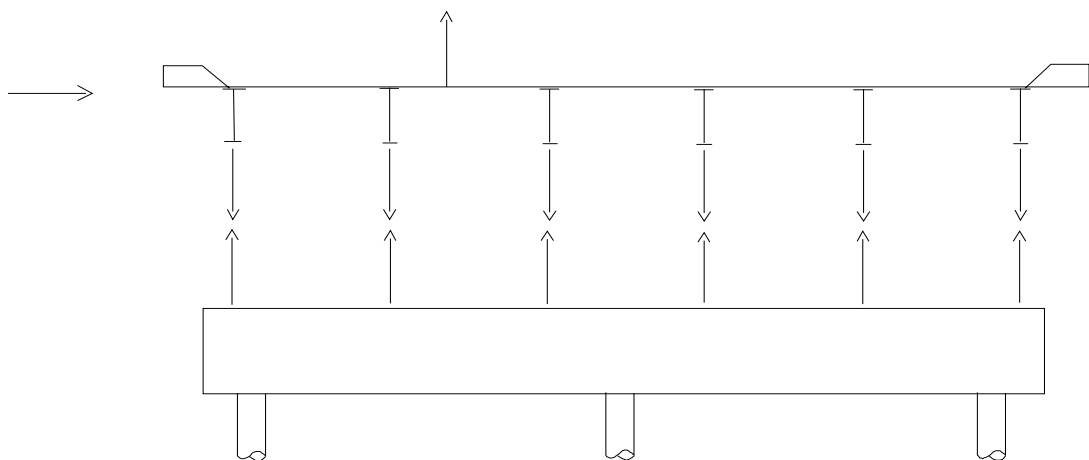


Figure 9.11

A more realistic approach is to distribute the uplift force to the girders and then to the pier

through the girder arings, Figure 12. This method may be used in BRASS-PIER™.



through the girder arings, Figure 12. This method may be used in BRASS-PIER™.

Figure 9.12

If neither the Deck Loading component - Live Load to Girders commands nor the WIND-REACTIONL or the WIND-REACTIONR commands are in the data set, the force will be applied to the pier at a point which is directly beneath the quarterpoint of the transverse superstructure section. When the Deck Loading Component - Live Load to Girders is executed in the same run as a pier analysis, the program will apply a unit uplift force to the deck at the quarterpoint and generate the girder reactions due to that unit load. As an option, in the case where the Deck Loading component is not executed, the user may input the girder reactions due to a unit uplift force applied at the quarterpoint. These reactions due to the unit uplift force will be multiplied by the actual uplift force to obtain the reactions to be applied to the pier.

For structures on a horizontal curve, the program will apply a centrifugal force to the pier. The force may be either input by the user or calculated from the data input by the user. The centrifugal force is applied at the top of the pier cap (or the top of a fixed bearing) parallel to the centerline of bearing, Figure 9.13.

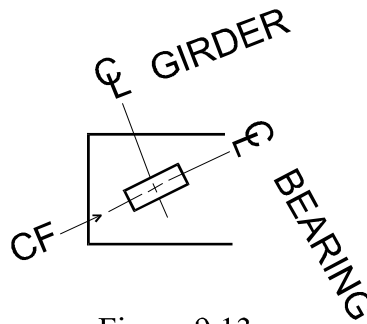


Figure 9.13

Braking of the vehicles on the bridge creates a force on the bridge deck which transfers a force to the pier. For a fixed bearing pier, the force calculated by BRASS-PIER™ is equal to 5% of the live load in all lanes headed in the same direction. For an expansion rocker bearing, the longitudinal force must be input by the user. The longitudinal force is applied at the top of the pier cap (or the top of a fixed bearing) parallel to the centerline of the girder, Figure 9.14.

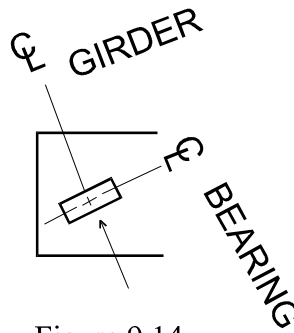


Figure 9.14

If the structure is skewed, the component of the longitudinal force parallel to the pier cap is applied at the center (top to bottom) of the pier cap, Figure 9.15.

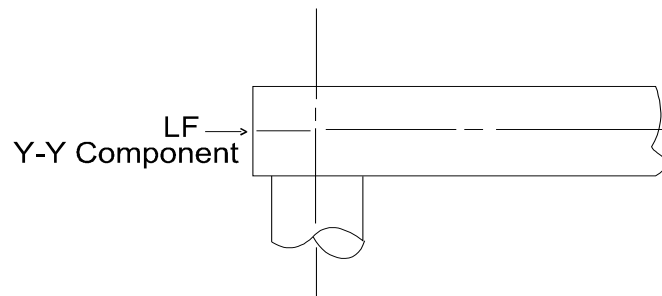


Figure 9.15

The force to the pier due to shrinkage of the superstructure may be input, or the horizontal deflection at the top of the pier may be input. The force to the pier due to the effects of change in temperature on the superstructure may be input, or the horizontal deflection at the top of the pier applied at the top of the pier cap (or the top of a fixed bearing) parallel to the centerline of the girder, Figure 9.14.

The modeling of a structure to determine the response to seismic forces is a complex process and is normally performed on a system designed exclusively for seismic analysis. However, when applicable, BRASS-PIER™ allows the user to apply a force at the top of the pier representing the movement of the structure during an earthquake. The program will determine the actions due to the applied force. The force is input as a component parallel to the centerline of the pier and a component normal to the center line of the pier.

The forces of the pier due to water (stream flow and buoyancy) and ice may be input by the user or the data required to calculate the forces may be input and the program will calculate the forces. The buoyancy force is applied as an upward force on the columns. The stream flow force is applied parallel to the centerline of the pier at one-half the water depth above the streambed level. The stream flow force is calculated as follows:

$$S = KV^2 d_w b \text{ where:}$$

S = stream flow force, in pounds

V = velocity of water, in feet per second

K = a constant based on the shape of the upstream edge of the pier.

The following values of K are used:

1.4 for square ends and all piers subject to drift buildup

0.5 for angle ends where the angle is 30° or less

0.7 for circular ends

d_w = Depth of water, in feet

b = Width of face of pier normal to stream flow or diameter of circular shaft

The ice pressure is applied to the pier as a force parallel to the centerline of the pier and a force normal to the centerline of the pier. The forces are applied at the center of the ice layer. The forces are calculated as follows:

$$F = C_N P t w$$

Where F = horizontal ice force, in pounds.
 C_N = coefficient for nose inclination, see Table 9.1.
 P = effective ice strength, in pounds per square inch.
 t = thickness of ice in contact with pier, in inches.
 w = width of pier or diameter of circular shaft at the level of the ice, in inches.

Inclination of Nose to Vertical	C_N
0° to 15°	1.00
15° to 30°	0.75
30° to 45°	0.50

Table 9.1

Based on the ratio of the pier width to ice thickness, the ice pressure force is multiplied by the appropriate coefficient obtained from Table 9.2.

b/t	Coefficient
0.5	1.8
1.0	1.3
1.5	1.1
2.0	1.0
3.0	0.9
4.0 or greater	0.8

Table 9.2

where b = thickness of pier
 t = design ice thickness

For piers placed with their y-y axis parallel to the principal direction of ice action, the force calculated by the formula is taken to act along parallel to the y-y axis. A force acting parallel to the x-x axis and amounting to not less than 15 percent of the total force acts simultaneously.

Where the y-y axis of a pier is not parallel to the principal direction of ice action, or where the direction of ice action may shift, the total force on the pier is figured by the formula and resolved into vector components. In such conditions, the force parallel to the x-x axis is not less than 20 percent of the total force.

The nose inclination, the effective ice strength, "p", the thickness of ice, "t", and the distance from the stream bed to the point of application of the ice pressure, are input by the user.

330	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	DEAD-LOAD		DLD
<p align="center">PURPOSE</p>	<p>This command controls the application of dead load to the pier.</p>		
<p>3 COMMAND PARAMETERS</p>			
<p>Unit weight Default = 150 pcf</p>	<p>Enter the unit weight of the concrete in the pier in lbs. per cubic foot. If 0 is coded, the dead load of the pier will not be applied.</p>		
<p>Impact Default = 1.3</p>	<p>If live loads are to be input, enter the impact factor.</p> <p>If the pier is a double bearing pier, enter the impact factor for the back-on-line structure.</p>		
<p>Impact Default = 1.3</p>	<p>If live loads are to be input, and the pier is a double bearing pier, enter the impact factor for the ahead-on-line structure.</p>		

EXAMPLE

For a unit weight of concrete of 150 pcf and an impact factor of 25.12%, code:

DLD 150, 1.2512

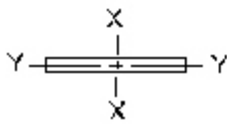
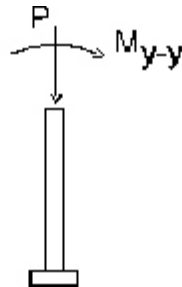
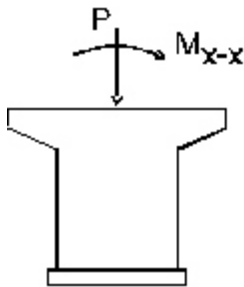
FIGURES**NOTES**

340	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DEAD-ACTION	DAC
<p style="text-align: center;">PURPOSE</p>	<p>This command defines the dead load actions (axial load, longitudinal and transverse moments) to be applied to a solid shaft pier. It is optional and if used should follow the DEAD-LOAD command.</p>	
3 COMMAND PARAMETERS		
P	Enter the axial load, in kips.	
M _{x-x}	Enter the moment about the x-x axis, in ft.-kips.	
M _{y-y}	Enter the moment about the y-y axis, in ft.-kips.	

EXAMPLE

For axial load P of 1170.37 Kips, M_{x-x} of 253.98 K-ft., & M_{y-y} of 0 K-ft., code:

DAC 1170.37, 253.98,0

FIGURES

M_{x-x} = Moment Longitudinal to Pier
(Transverse to Deck)

M_{y-y} = Moment Transverse to Pier
(Longitudinal to Deck)

NOTES

350	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	DEAD-REACTION	
PURPOSE	DRC	
	<p>This set of commands defines the dead load to be applied to the pier at each bearing location.</p>	
21 COMMAND PARAMETERS		
Location	<p>Enter the location of the line of bearing for which the reactions are given. 1 = Back-on-line 2 = Ahead-on-line Leave blank for a single bearing pier.</p>	
R1	Enter the reaction at girder No. 1 in kips.	
R2	Enter the reaction at girder No. 2 in kips.	
R3	Enter the reaction at girder No. 3 in kips.	
R4	Enter the reaction at girder No. 4 in kips.	
R5	Enter the reaction at girder No. 5 in kips.	
R6	Enter the reaction at girder No. 6 in kips.	
"	" " " " " Etc.	
R20	Enter the reaction at girder No. 20 in kips.	

EXAMPLE

Single Bearing Pier - 5 girders

DRC , 108.04, 99.99, 105.9, 99.88, 108.04

Single Bearing Pier - 8 girders

DRC , 172.03, 128.52, 144.47, 140.01, 142.48, 137.35, 173.70, 131.79

Double Bearing Pier - 4 Girders

COM BACK-ON-LINE

DRC 1, 157.23, 117.84, 135.59, 130.88

COM AHEAD-ON-LINE

DRC 2, 161.91, 110.90, 137.41, 130.41

Double Bearing Pier - 10 Girders

COM BACK-ON-LINE

DRC 1, 157.23, 117.84, 130.59, 130.88, 132.02, 132.16, 130.41, /
137.41, 110.90, 161.91

COM AHEAD-ON-LINE

DRC 2, 161.91, 110.90, 137.41, 130.41, 132.16, 132.02, 130.88, /
135.59, 117.84, 157.23

NOTES

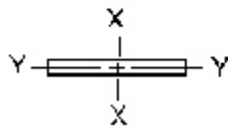
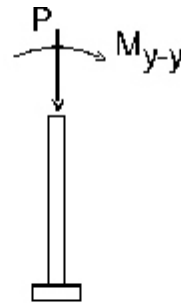
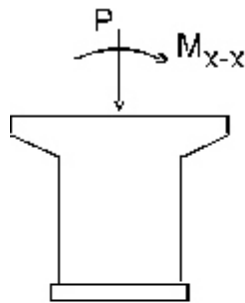
See page 2.2 for information on continuation lines.

Negative reactions are considered in the analysis.

380	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	LIVE-ACTION		LAC
PURPOSE	This command defines the live load actions (with impact) to be applied to a solid shaft pier. This command may be repeated to define up to 10 actions. This command is optional. Do not use if LIVE-SOLID1 and LIVE-SOLID2, or LIVE-REACTION is used.		
6 COMMAND PARAMETERS			
P	Enter the axial load, in kips, for case 1, 3, 5, etc.		
M_L	Enter the moment about the x-x axis, in ft.-kips.		
M_T	Enter the moment about the y-y axis, in ft.-kips.		
P	Enter the axial load, in kips, for case 2, 4, 6, etc.		
M_L	Enter the moment about the x-x axis, in ft.-kips.		
M_T	Enter the moment about the y-y axis, in ft.-kips.		

EXAMPLE

LAC 458.89, -3480, , 339.94, -4617.3

FIGURES

M_{x-x} = Moment Longitudinal to Pier
(Transverse to Deck)

M_{y-y} = Moment Transverse to Pier
(Longitudinal to Deck)

NOTES

Be sure to enter the amount of impact included in the live load on the DEAD-LOAD Command (330), unless the default value is acceptable. BRASS-PIER™ will divide out the impact for foundation analysis.

Negative reactions are considered in the analysis.

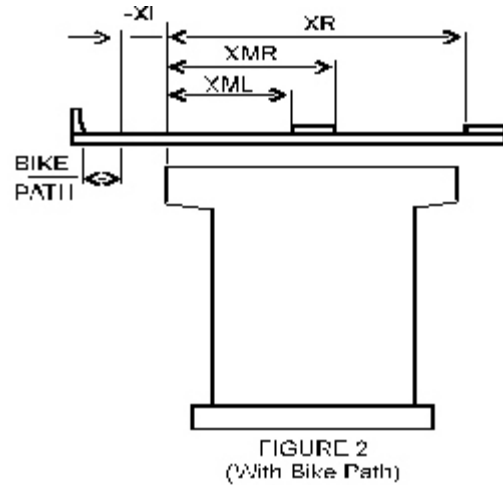
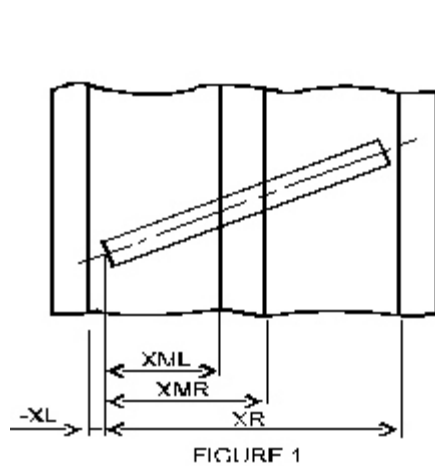
390	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	LIVE-SOLID1	
PURPOSE	<p>This set of commands defines the data necessary to calculate the live load forces on a solid shaft pier. This command is optional. Do not use if LIVE-ACTION or LIVE-REACTION is used.</p>	
6 COMMAND PARAMETERS		
XL	<p>Enter the distance from the left edge of the pier cap to the left edge of the roadway, in feet. See Notes 1 & 2 and Figures. If the edge of the roadway extends beyond the edge of the pier cap, enter a negative value. See Figures 3 & 4. This value controls the placement (limits) of the live load.</p>	
XR	<p>Enter the distance from the left edge of the pier cap to the right edge of the roadway, in feet. See Notes 1 & 2 and Figures. This value controls the placement (limits) of the live load.</p>	
XML	<p>Enter the distance from the left edge of the pier cap to the left edge of the median, in feet. If there is no median, leave blank. See Note 2 and Figures.</p>	
XMR	<p>Enter the distance from the left edge of the pier cap to the right edge of the median, in feet. If there is no median, leave blank. See Note 2 and Figures.</p>	
NL Default = $(XR - XL)/12 \geq 1$ or $(XML - XL)/12 \geq 1$	<p>If there is no median, enter the maximum number of traffic lanes. See Notes 2 & 3.</p> <p>If there is a median, enter the maximum number of traffic lanes to the left of the median.</p>	
NR Default = $(XR - XMR)/12 \geq 1$	<p>If there is a median, enter the maximum number of traffic lanes to the right of the median. See Notes 2 & 3.</p>	

EXAMPLE

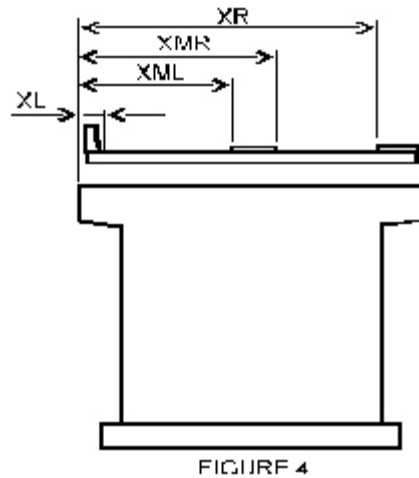
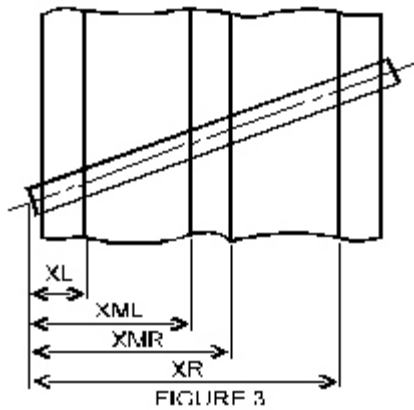
For left edge of roadway (XL) = 1.75 ft., right edge of roadway (XR) = 43.75, no median, and 3 lanes, code:

LS1 1.75, 43.75, , , 3

FIGURES



**EDGE OF ROADWAY EXTENDS
BEYOND EDGE OF PIER CAP**
(XL is Negative)



**EDGE OF PIER CAP EXTENDS
BEYOND EDGE OF ROADWAY**

NOTES

1. These values control the placement of the live load. The locations defined here may be different from the curb location (i.e. bike paths, shoulders, etc.).
2. Distances are normal to roadway.
3. The defaults for NL and NR will be integer values.

400	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	LIVE-SOLID2	
	LS2	
PURPOSE	<p>This command defines the load to be placed within the roadway defined on the LIVE-SOLID1 command. Required when the LIVE-SOLID1 command is used. This command must be repeated for a double bearing pier.</p>	
4 COMMAND PARAMETERS		
Location	<p>Enter the location of the live load being defined.</p> <ul style="list-style-type: none"> 1 = Back-on-Line 2 = Ahead-on-Line <p>Leave blank for a single bearing pier.</p>	
Load Type	<p>Enter a code to define the type of load.</p> <ul style="list-style-type: none"> 1 = Truck load 2 = Lane load 	
Maximum Load	<p>Enter the value of the maximum load.</p> <p>For a truck load, enter the reaction including impact at the pier due to one wheel line being placed longitudinally on the superstructure, in kips.</p> <p>For a lane load, calculate the reaction including impact at the pier due to the lane load being placed longitudinally on the superstructure, then distribute this reaction over the 10 ft. lane width. Enter this value, in kips/ft..</p>	
Minimum Load	<p>For a double bearing pier, enter the value of the minimum load (which may be an uplift) in kips (or kips/ft. for a lane load).</p>	

EXAMPLE

For a Single Bearing Pier, Lane Load equals 1.696 K/ft., code:

LS2 , 2, 1.696

For a Double Bearing Pier, Back-on-Line, Truck Load Maximum = 39.22 Kips. and Minimum = 0 Kips., code:

LS2 1, 1, 39.22, 0

For a Double Bearing Pier, Ahead-on-Line, Lane Load Maximum = 7.50 K/ft and Minimum = -0.588 K/ft., code:

LS2 2, 2, 7.50, -.588

FIGURES**NOTES**

Be sure to enter the amount of impact included in the live load on the DEAD-LOAD Command (330), unless the default value is acceptable. BRASS-PIER™ will divide out the impact for foundation analysis.

410	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	LIVE-REACTION	
PURPOSE	LRC	
	<p>This command defines the live load to be applied to the pier (solid shaft or frame) at each bearing location. This command is optional and is used to define the live load to be applied to the pier by input of the girder reactions. It is not required if live load distribution is requested on the DECK-CON command. It may also be repeated (up to 99 times) to model different truck positions. Do not use if LIVE-ACTION or LIVE-SOLID1 and LIVE-SOLID2 is used.</p>	
21 COMMAND PARAMETERS		
Location	<p>Enter the location of the line of bearings for which the reactions are given.</p> <p>1 = Back-on-Line 2 = Ahead-on-Line Leave blank for a single bearing pier.</p>	
R1	Enter the reaction at girder No. 1, in kips.	
R2	Enter the reaction at girder No. 2, in kips.	
R3	Enter the reaction at girder No. 3, in kips.	
R4	Enter the reaction at girder No. 4, in kips.	
R5	Enter the reaction at girder No. 5, in kips.	
"	" " " " " Etc.	
R20	Enter the reaction at girder No. 20, in kips.	

EXAMPLE

Single Bearing Pier - 4 Girders

LRC , 99.8, 100.6, 101.5, 92.4

Single Bearing Pier - 7 Girders

LRC , 62.4, 71.6, 72.5, 73.9, 74.1, 72.1, 51.0

Double Bearing Pier - 4 Girders

LRC 1, 21.3, 22.7, 22.1, 19.6

LRC 2, -.6, -1.5, -2.1, .9

Double Bearing Pier - 8 Girders

LRC 1, 127.5, 130.6, 131.4, 132.6, 132.6, 131.4, 130.6, 127.5

LRC 2, 142.9, 144.3, 145.4, 151.6, 141.5, 141.5, 151.6, 145.4

FIGURES**NOTES**

See page 2.2 for information on continuation lines.

Live load reactions should include impact. Therefore, be sure to enter the amount of impact included in the live load on the DEAD-LOAD Command (330), unless the default value is acceptable. BRASS-PIER™ will divide out the impact for foundation analysis.

430	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	LIVE-COMBINE	
PURPOSE	<p>This command defines the truck positions which will be combined to generate the actions for a load case. This command is optional for a frame pier and may be used when the "Deck Loading Component - Live Load to Girders" commands are included in the data set. See page 9.1 for further explanation.</p> <p>This command may be repeated for up to 50 load cases.</p>	
9 COMMAND PARAMETERS		
NP	Enter the number of truck positions (up to a maximum of 8) for this loading.	
P1	Enter the position of Truck No. 1.	
P2	Enter the position of Truck No. 2.	
P3	Enter the position of Truck No. 3.	
P4	Enter the position of Truck No. 4.	
P5	Enter the position of Truck No. 5.	
P6	Enter the position of Truck No. 6.	
P7	Enter the position of Truck No. 7.	
P8	Enter the position of Truck No. 8.	

EXAMPLE

5 Trucks - in positions 1, 13, 25, 37, and 49

LLC 5, 1, 13, 25, 37, 49

7 Trucks - in positions 3, 13, 25, 38, 50, 65, and 79

LLC 7, 3, 13, 25, 38, 50, 65, 79

FIGURES**NOTES**

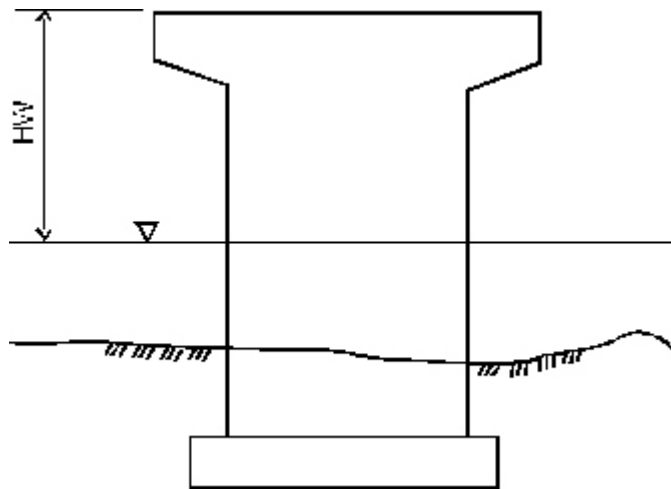
440	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	WIND-LOAD	
	WND	
<p align="center">PURPOSE</p>	<p>This command controls the application of wind load to the pier. This command is required when wind load is to be applied.</p>	
<p>4 COMMAND PARAMETERS</p>		
<p>Wind Load Option</p>	<p>Enter a code to select the type of wind load application desired. <u>Code</u> 1 General method - AASHTO 3.15.2.1.4 2 Simplified method - AASHTO 3.15.2.1.3 May be used for bridges with maximum span lengths of 125 feet.</p>	
<p>Deck Width</p>	<p>Enter the overall width of the deck, in feet.</p>	
<p>HW Default = Distance from top of pier cap to ground line or water line.</p>	<p>Enter the distance from the top of the pier cap to the lowest point on the pier to be loaded for wind load on the substructure, in feet.</p>	
<p>Uplift Default = 0</p>	<p><u>Code</u> 0 or blank Uplift due to wind is to be included. 1 Uplift due to wind is to be ignored.</p>	

EXAMPLE

For general method of wind load analysis with a deck width of 51.67 ft., and an exposed pier height of 21.5 ft., code:

WND 1, 51.67, 21.5

FIGURES



NOTES

450	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	SUPERSTRUCTURE	
PURPOSE	<p>This command defines the superstructure lengths which contribute to the reactions at the analysis pier due to wind force. The superstructure height is also defined. This command must follow the WIND-LOAD command. This command must be repeated for a double bearing pier.</p>	
6 COMMAND PARAMETERS		
Location	<p>Enter the location of the superstructure being defined.</p> <p>1 = Back-on-Line 2 = Ahead-on-Line</p> <p>Leave blank for a single bearing pier.</p>	
L1	<p>Enter the superstructure length, in feet, which contributes to the reaction at the analysis pier due to lateral wind force applied to the exposed area of the superstructure (see Figure).</p>	
L2	<p>Enter the superstructure length, in feet, which contributes to the reaction at the analysis pier due to lateral wind force applied to a moving live load (see Figure).</p>	
L3	<p>For an analysis pier with a fixed bearing, enter the superstructure length, in feet, which contributes to the reaction at the analysis pier due to longitudinal wind force applied to the superstructure (see Figure). Typically, this value would be the total length divided by the number of fixed supports.</p>	
HS	<p>Enter the height, in feet, of the superstructure (girder + deck + any solid traffic barrier).</p>	
L4 Default = L3	<p>For an analysis pier with a fixed bearing, enter the superstructure length, in feet, which contributes to the reaction at the analysis pier due to longitudinal wind force applied to a moving live load (see Figure).</p>	

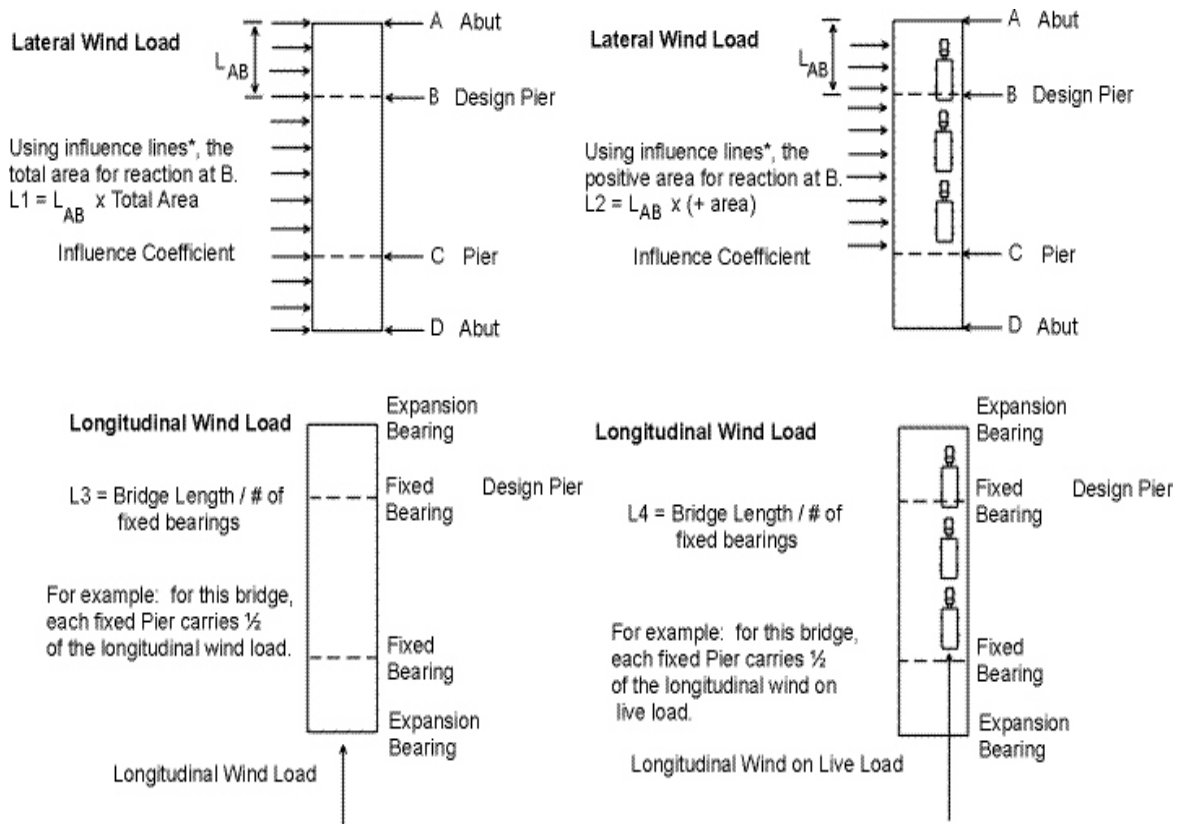
EXAMPLE

For a single bearing, three span, 456' long bridge with spans 1 and 3 = 138' and span 2 = 180', the span ratio is approximately 1.3. Using a table of moments, shears and reactions*, the reactions at Pier #1 are a function of the lateral wind force times the "+Area" and "Total Area" Influence Coefficients times the length of the exterior span. From the table, the +Area Influence Coefficient at Pier #1 is 1.3604 and the Total Area Influence Coefficient is 1.2855. $L1 = L_{AB} * \text{Total Area Influence Coefficient} = 138' * 1.2855 = 177.4'$. $L2 = L_{AB} * \text{+Area Influence Coefficient} = 138' * 1.3604 = 187.7'$. The reactions at Pier #1 are also a function of the longitudinal wind force on the superstructure and live loads times the superstructure length carried by a fixed bearing. In this example, $L3 = 456' / 2 \text{ fixed supports} = 228'$. The height of the exposed superstructure is 8.563 feet.

SPR , 177.4, 187.7, 456.0, 8.563

Other analysis programs may be used to calculate the superstructure lengths which influence the pier reactions.

FIGURES



* See Moments, Shears and Reactions, American Institute of Steel Construction, 1959 and 1966, (or comparable) for influence line coefficients.

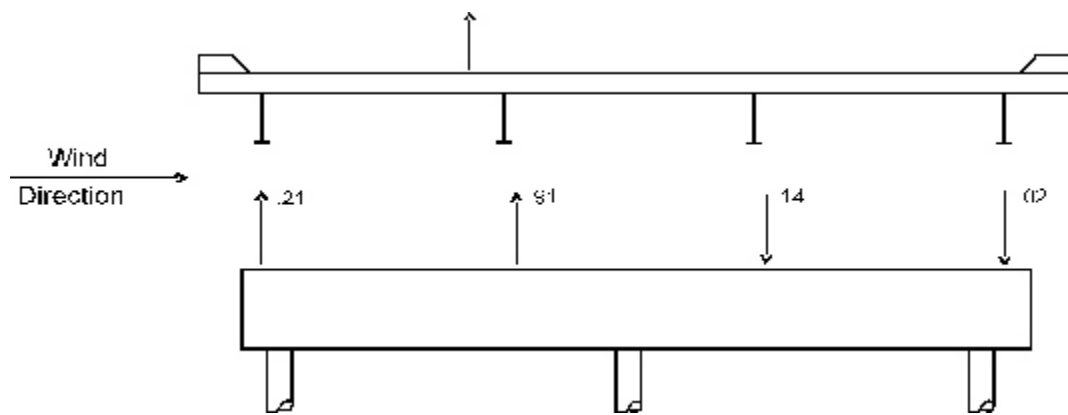
460	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	WIND-REACTIONL	WRL
PURPOSE	<p>This command defines user calculated reactions at the girders due to a unit uplift force placed at the windward quarter point of the transverse superstructure section when the wind is blowing on the left side of the superstructure. This command is optional for a frame pier. See page 9.7 for further explanation.</p>	
20 COMMAND PARAMETERS		
WR1	Enter the unit reaction at Girder No. 1.	
WR2	Enter the unit reaction at Girder No. 2.	
WR3	Enter the unit reaction at Girder No. 3.	
WR4	Enter the unit reaction at Girder No. 4.	
WR5	Enter the unit reaction at Girder No. 5.	
WR6	Enter the unit reaction at Girder No. 6.	
"	" " " " Etc.	
WR20	Enter the unit reaction at Girder No. 20.	

EXAMPLE

For the Figure shown:

WRL -.21, -.91, .14, .02

FIGURES



NOTES

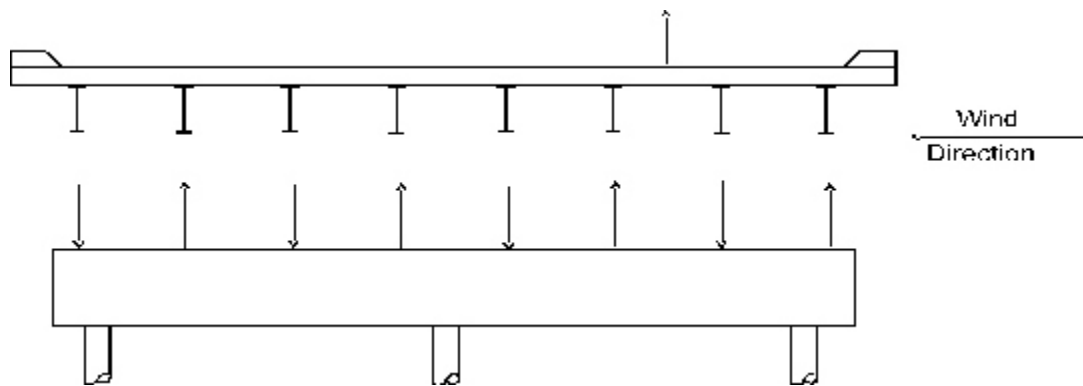
See page 2.2 for information on continuation lines.

470	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	WIND-REACTIONR		WRR
PURPOSE	<p>This command defines user calculated reactions at the girders due to a unit force placed at the windward quarter of the transverse superstructure section when the wind is blowing on the right side of the superstructure. This command is optional for a frame pier. See page 9.7 for further explanation.</p>		
20 COMMAND PARAMETERS			
WR1	Enter the unit reaction at girder 1.		
WR2	Enter the unit reaction at girder 2.		
WR3	Enter the unit reaction at girder 3.		
WR4	Enter the unit reaction at girder 4.		
WR5	Enter the unit reaction at girder 5.		
WR6	Enter the unit reaction at girder 6.		
"	" " " " " Etc.		
WR20	Enter the unit reaction at girder 20.		

EXAMPLE

For the Figure shown:

WRR .0004, -.0023, .0093, -.0348, .1298, -.6096, -.5663, .0735

FIGURES**NOTES**

See page 2.2 for information on continuation lines.

480	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	CENTRIFUGAL	
CTF		
PURPOSE	<p>This command defines the centrifugal force to be applied to the pier. The user may either input the force or input the data necessary to calculate the force.</p> <p>NOTE: Enter 2 command parameters for Option A or 5 command parameters for Option B.</p>	
2 or 5 COMMAND PARAMETERS		
CF	<p>A. <u>Centrifugal Force Input by User</u></p> <p>Enter the centrifugal force perpendicular to the centerline of roadway, in kips. (Back on-line for a double bearing pier).</p>	
CFA	<p>For a double bearing pier, enter the centrifugal force from the Ahead-on-Line structure perpendicular to the centerline of roadway, in kips.</p>	
Curve Type	<p>B. <u>Centrifugal Force to be Calculated by Program</u></p> <p>Enter 1 for a left curve. Enter 2 for a right curve, See Figures.</p>	
V	<p>Enter the design speed, in mph.</p>	
D	<p>Enter the degree of the curve, in decimal degrees.</p>	
LL _R	<p>Enter the reaction at the pier due to live road with all lanes loaded, in kips. The loading shall be a truck loading, not a lane loading. (Back-on-Line for a double bearing pier.)</p>	
LL _R	<p>For a double bearing pier, enter the reaction at the pier due to live load with all lanes loaded, Ahead-on-Line, in kips.</p>	

EXAMPLE

Centrifugal force input

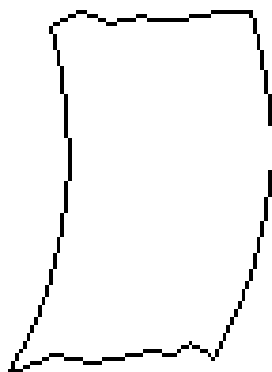
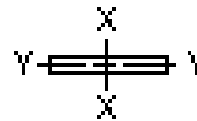
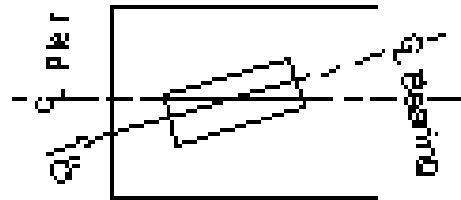
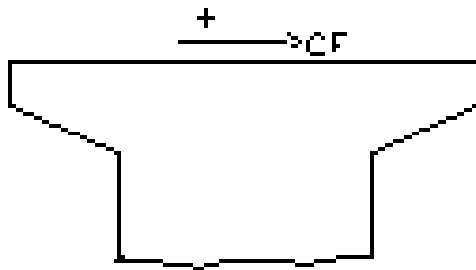
CFT 40.12

Centrifugal force to be calculated

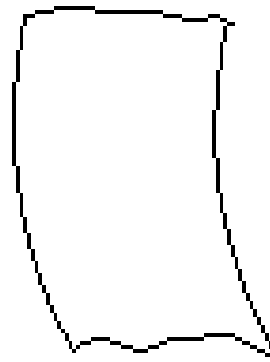
For a left curve, 60 mph design speed, 1.5 degree curve, and live load reaction of 100.6 kips., code:

CFT 1, 60, 1.5, 100.6

FIGURES



Left Curve



Right Curve

Curve Types

490	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	LONGITUDINAL	
LTF		
<p align="center">PURPOSE</p>	<p>This command defines the longitudinal force to be applied to the pier.</p> <p>The user may either input the force or input the data necessary to calculate the force. This command must be repeated for a double bearing pier.</p>	
<p>3 or 5 COMMAND PARAMETERS</p>		
<p>Location</p>	<p>Enter the location of the data being defined.</p> <p>1 = Back-on-Line 2 = Ahead-on-Line Leave blank for single bearing pier</p>	
<p>Direction Default = 3</p>	<p>Enter a code to specify the direction of application of the longitudinal forces.</p> <p>1 = longitudinal force applied for trucks moving up mile post only. 2 = longitudinal force applied for trucks moving down mile post only. 3 = longitudinal force applied in both directions.</p>	
<p>LF</p>	<p>NOTE: For the following parameter(s), select Option A-Parameter #3 or Option B-Parameters #3, 4, and 5.</p> <p>A. <u>Longitudinal Force Input by User</u></p> <p>If longitudinal force is to be input, enter the longitudinal force, in kips. See Temperature command for Pin Friction.</p>	
<p>Bridge Length</p>	<p>B. <u>Longitudinal Force to be Calculated by Program</u></p> <p>Enter the overall length of the bridge, in feet.</p>	
<p>Number of Substructures Default = 1</p>	<p>Enter the number of substructures over which the longitudinal force is to be distributed.</p>	
<p>Number of Lanes</p>	<p>Enter the number of traffic lanes.</p>	

EXAMPLE

Single bearing pier, same force in each direction.

LTF , 1, 10.12

LTF , 1, 429.5, 2, 5

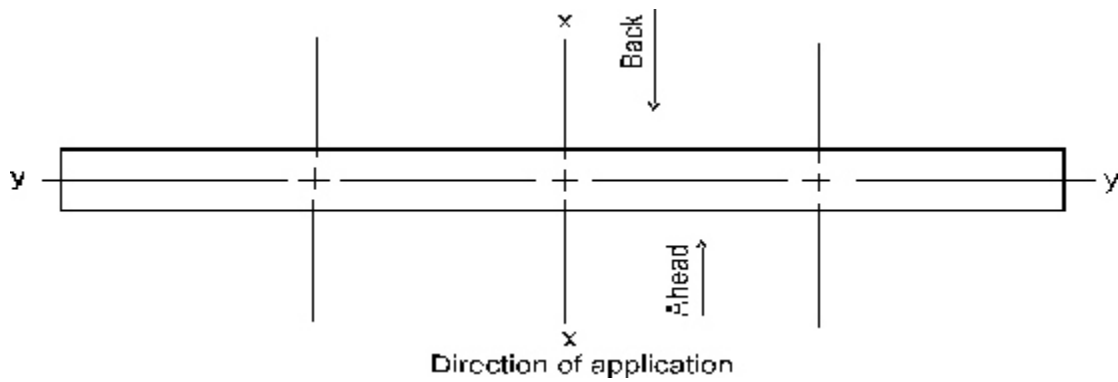
Single bearing pier, force in each direction differs.

LTF , 2, 10.12

LTF , 3, 15.65

LTF , 2, 429.5, 2, 4

LTF , 3, 16.17

FIGURES**NOTES**

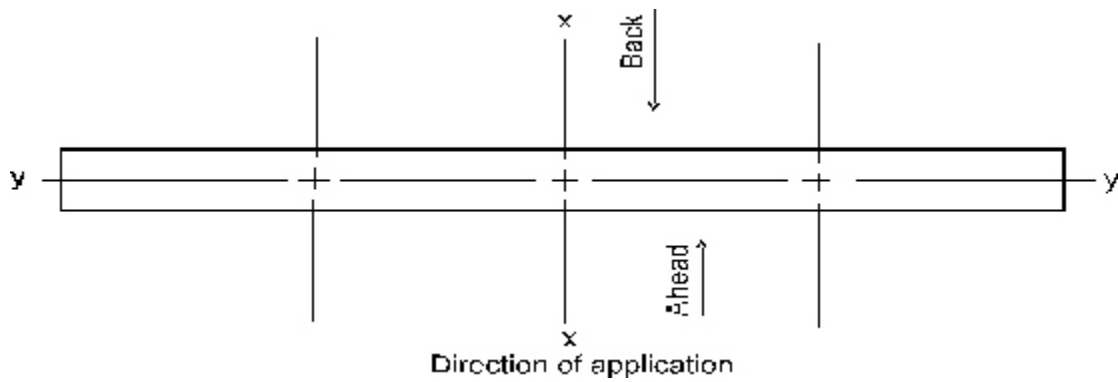
500	BRASS-PIER™	COMMAND DESCRIPTION						
COMMAND NAME	SHRINKAGE							
PURPOSE	This command defines the shrinkage force to be applied to the pier. The user may either input the shrinkage force or the deflection at the top of the pier due to shrinkage.							
3 COMMAND PARAMETERS								
Direction	<p>Enter a code to specify the direction of application of the shrinkage force.</p> <table border="0" data-bbox="574 747 1175 861"> <thead> <tr> <th style="text-align: left;">Code</th> <th style="text-align: left;"><u>Direction of Pier Movement</u></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Ahead</td> </tr> <tr> <td>2</td> <td>Back</td> </tr> </tbody> </table>		Code	<u>Direction of Pier Movement</u>	1	Ahead	2	Back
Code	<u>Direction of Pier Movement</u>							
1	Ahead							
2	Back							
SH	If the shrinkage force is to be input, enter the shrinkage force in kips.							
Δs	If the shrinkage force is to be calculated by the program, enter the deflection of the top of the pier, measured parallel to the centerline of the girder, in inches.							

EXAMPLE

Shrinkage force input
SHR 1, 16.57

Deflection input-.15 in.
SHR 2, , .15

FIGURES



NOTES

510	BRASS-PIER™	COMMAND DESCRIPTION								
COMMAND NAME	TEMPERATURE									
	TMP									
PURPOSE	<p>This command defines the temperature force to be applied to the pier. The user may either input the temperature force or the deflection at the top of the pier due to temperature.</p>									
3 COMMAND PARAMETERS										
Direction	<p>Enter a code to specify the direction of application of the temperature force.</p> <table border="0" data-bbox="574 827 1114 972"> <thead> <tr> <th style="text-align: left;"><u>Code</u></th> <th style="text-align: left;"><u>Direction of Movement</u></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Both directions</td> </tr> <tr> <td>2</td> <td>Ahead only</td> </tr> <tr> <td>3</td> <td>Back only</td> </tr> </tbody> </table>		<u>Code</u>	<u>Direction of Movement</u>	1	Both directions	2	Ahead only	3	Back only
<u>Code</u>	<u>Direction of Movement</u>									
1	Both directions									
2	Ahead only									
3	Back only									
T	<p>If the temperature force is to be input, enter the temperature force, in kips. Include Pin Friction.</p>									
<div style="display: flex; align-items: center;"> Δ Temp </div>	<p>If the temperature force is to be calculated by the program, enter the deflection of the top of the pier, measured parallel to the centerline of the girders, in inches. Do not enter 0.0. It is not a valid entry.</p>									

EXAMPLE

For the Figures shown below:

Same temperature movement in each direction.

Case 1

TMP 1, 10.12

Case 2

TMP 1, , .15

Temperature movement differs for each direction.

Case 3

TMP 2, 11.5

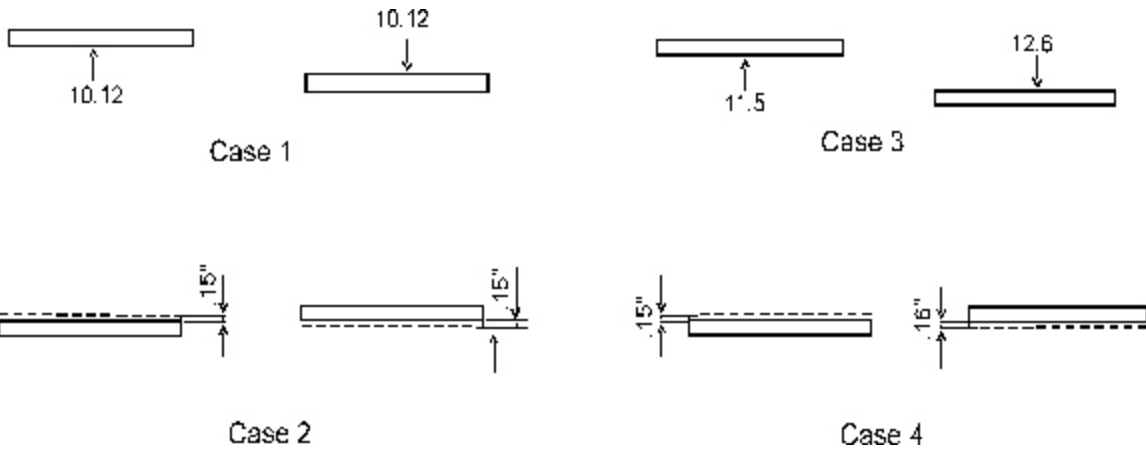
TMP 3, 12.6

Case 4

TMP 2, 10.7

TMP 3, , .16

FIGURES



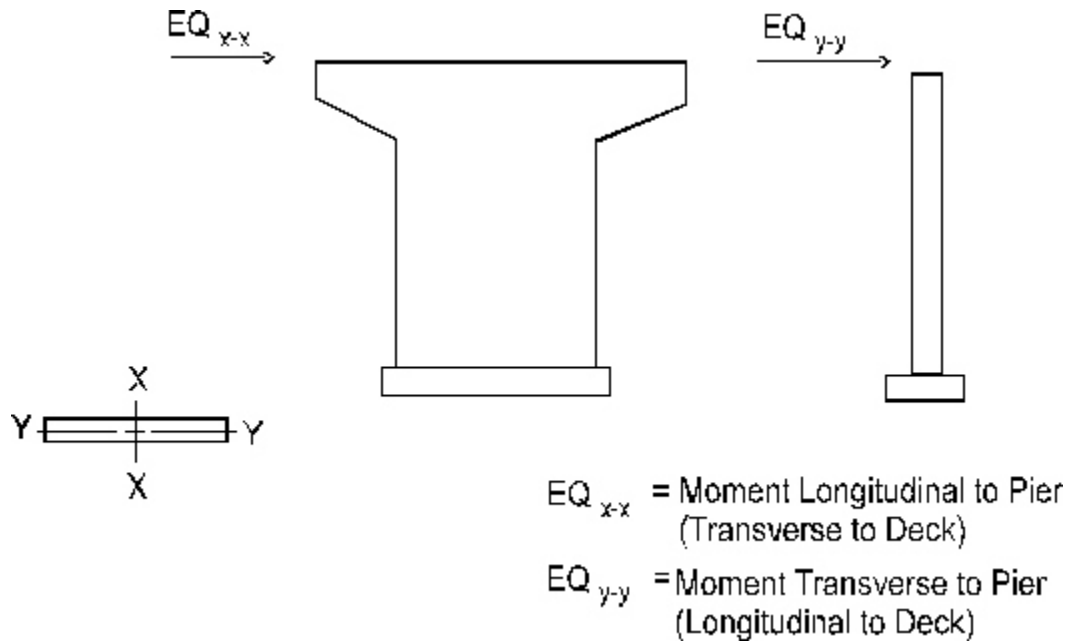
NOTES

515	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	EARTHQUAKE		ETQ
PURPOSE	This command defines the earthquake forces to be applied to the pier.		
3 COMMAND PARAMETERS			
Eq _{x-x}	Enter the component of the earthquake force parallel to the centerline of the pier, in kips.		
Eq _{y-y}	Enter the component of the earthquake force normal to the centerline of the pier, in kips.		
EQ _{LA} Default = Earthquake force applied to top of pier.	Enter the distance from the top of the footing to the point of application of the earthquake force, in feet.		

EXAMPLE

For a parallel component of 10.5 kips., a normal component of 5.1 kips., the lever arm is the default (apply at top of pier cap)., code:

ETQ 10.5, 5.1,

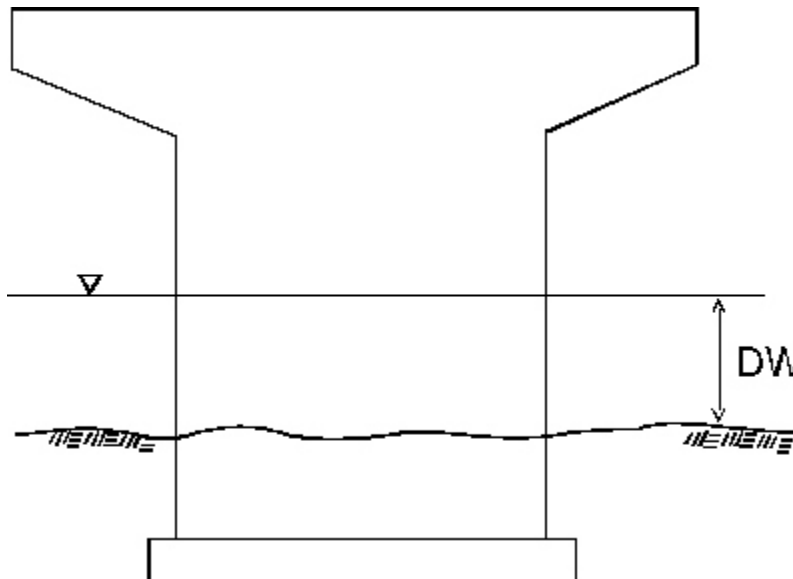
FIGURES**NOTES**

520	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	BUOYANCY		BUY
PURPOSE	<p>This command defines the buoyancy force to be applied to the pier. The user may either input the force (parameters 1 and 2) or input the data necessary to calculate the force (parameter 3).</p>		
3 COMMAND PARAMETERS			
B_C	<p>If the buoyancy force is to be input, enter the buoyancy force for column design, in kips. Uplift is positive.</p>		
B_F	<p>If the buoyancy force is to be input, enter the buoyancy force for footing design, in kips. Uplift is positive.</p>		
D_W	<p>If the buoyancy force is to be calculated by the program, enter the water depth, in feet.</p>		

EXAMPLE

Buoyancy force input
BUY 15.6, 9.5

Depth of water input
BUY , , 5.5

FIGURES**NOTES**

Frame pier - water depth for buoyancy, stream flow, and wind (if applicable) is measured from column 1. Water surface and top of pier cap assumed level.

Buoyancy force for the footing includes the buoyancy force for the column. Buoyancy of the soil on the footing is also accounted for.

530	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	STREAM-FLOW	
PURPOSE	STF	
	<p>This command defines the stream flow force to be applied to the pier.</p> <p>The user may either input the stream flow force (parameters 1 and 2) or input the data necessary to calculate the force parameters 3, 4, 5, and 6).</p>	
6 COMMAND PARAMETERS		
SF	If the stream flow force is to be input, enter the stream flow force per column, in kips.	
LA	If the stream flow force is to be input, enter the distance from the top of the footing to the point of application of the stream flow force, in kips.	
DW Default = Water depth in BUOYANCY command	If the stream flow force is to be calculated by the program, enter the water depth, in feet.	
V	If the stream flow force is to be calculated by the program, enter the velocity of the stream in fps.	
Direction	<p>If the stream flow force is to be calculated by the program, enter a code to specify the direction of the stream flow, see Figures.</p> <p style="padding-left: 40px;">1 = left to right 2 = right to left</p>	
Column Type	<p>If the stream flow force is to be calculated by the program, enter a code to describe the shape of the edge of the pier breaking the water.</p> <p style="padding-left: 40px;">1 = square ends 2 = circular end 3 = angle end</p>	

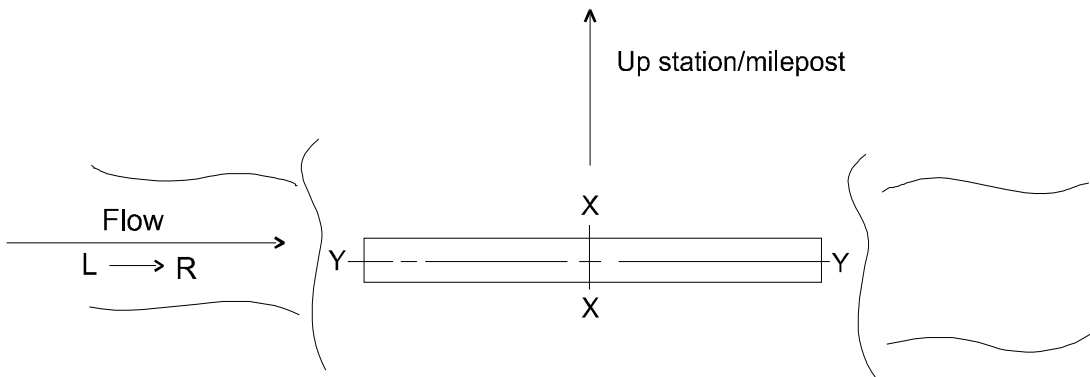
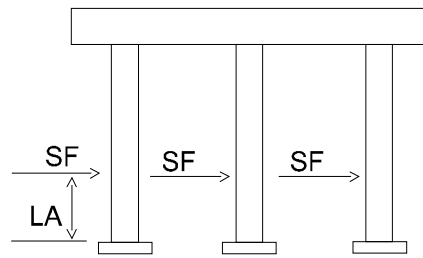
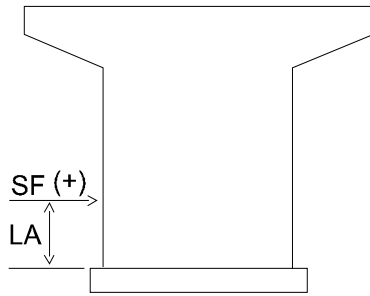
EXAMPLE

For the Figures shown below:

Stream flow force input
STF 10.2, 6.5

Data to calculate stream flow force to be input
For a water depth of 5.5 ft., a velocity of 2.1 fps., water flows from left to right, and has circular ends, code:
STF , , 5.5, 2.1, 1, 2

FIGURES



540	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	ICE-PRESSURE	
PURPOSE	ICE	
	<p>This command defines the forces due to ice pressure or the data necessary to calculate the force due to the ice pressure.</p> <p>NOTE: Enter 4 command parameters for Option A or 6 command parameters for Option B.</p>	
4 or 6 COMMAND PARAMETERS		
ICE _p	<p>A. <u>Input of Forces Due to Ice Pressure</u></p> <p>Enter the component of the force to be applied parallel to the centerline of the pier, in kips. See Figures 1 & 3 and Notes.</p>	
ICE _N	<p>Enter the component of the force to be applied normal to the centerline of the pier, in kips. See Figure 1 and Notes</p>	
LA	<p>Enter the distance from the top of the footing to the point of application of the force, in feet. See Figure 3.</p>	
Apply ice to all columns Default = 0	<p>For a frame pier, enter 1 if the ice force is to be applied equally to all columns. If 0 or blank, the ice force will be applied only to the upstream column.</p>	
P	<p>B. <u>Forces Due to Ice Pressure, Calculated by Program</u></p> <p>Enter the effective ice strength in pounds per square inch.</p>	
T	<p>Enter the thickness of the ice, in feet. See Figure 4.</p>	
LA	<p>Enter the distance from the top of the footing to the center of the ice layer, in feet. See Figure 3.</p>	
DIR	<p>Enter the direction of the ice flow, in decimal degrees, See Figure 2. This is a required entry, even if the angle is zero degrees.</p>	
I	<p>Enter the inclination of the pier nose to vertical, in decimal degrees. See Figure 4. This is a required entry, even if the angle is zero degrees.</p>	
Apply ice to all columns Default = 0	<p>For a frame pier, enter 1 if the ice force is to be applied equally to all columns. If 0 or blank, the ice force will be applied only to the upstream column.</p>	

EXAMPLE

For ice flow from left to right, code:

ICE +50.1, 7.5, 6.3

For ice flow from right to left, code:

ICE -50.1, 7.5, 6.3

For an ice strength of 200 psi, an ice thickness of 2 ft., a distance from the top of the footing to the center of the ice layer is 3.5 ft., an ice flow from right to left, and pier inclination is zero degrees, code:

ICE 200, 2, 3.5, 180, 0

FIGURES

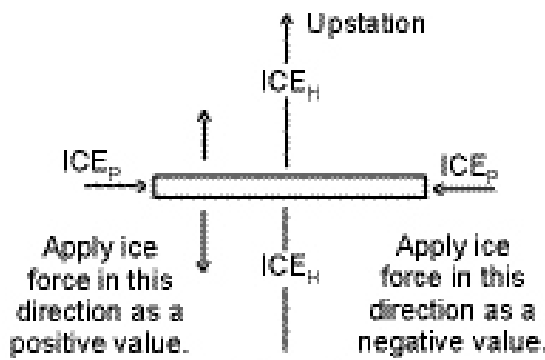


Figure 1

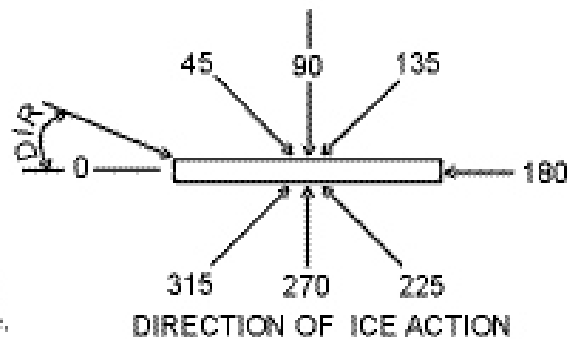


Figure 2

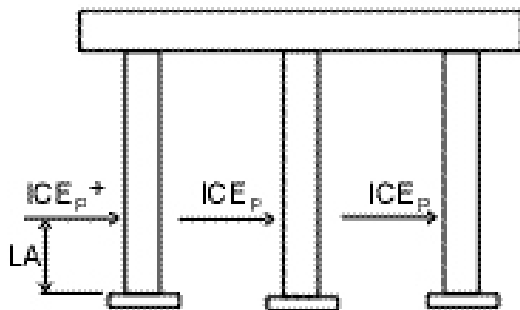
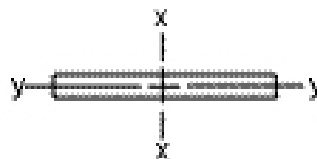


Figure 3

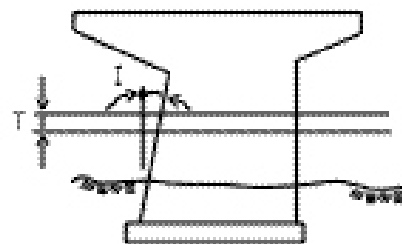


Figure 4

NOTES

Ice forces normal to the centerline of the pier are applied up station and down station automatically by the program and both cases analyzed for maximum actions.

10. COMBINATION OF LOADS

The combination of crossbeam and column actions due to various loadings applied to the pier is performed automatically by BRASS-PIER™. The combining of loads is performed as per AASHTO 3.22.

This section describes the capability to run the Combination of Loads Component as a stand-alone program. The following commands are required:

TITLE
GROUP-CONTROL
GROUP-A
GROUP-B
GROUP-C

550	BRASS-PIER™	COMMAND DESCRIPTION						
COMMAND NAME	GROUP-CONTROL							
PURPOSE	This command controls the combination of loads as per AASHTO 3.22.							
2 COMMAND PARAMETERS								
Design Type	<p>Enter a code to specify the design type.</p> <table border="0" data-bbox="574 709 1036 831"> <thead> <tr> <th style="text-align: center; border-bottom: 1px solid black;">Code</th> <th style="text-align: center; border-bottom: 1px solid black;">Type</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>Load Factor</td> </tr> <tr> <td style="text-align: center;">2</td> <td>Service Load</td> </tr> </tbody> </table>		Code	Type	1	Load Factor	2	Service Load
Code	Type							
1	Load Factor							
2	Service Load							
Print Option	Enter 1 to print a report of the input values for each load case.							

EXAMPLE

To combine loads as per Load Factor criteria, with no report, code:

GRP 1, 0

FIGURES**NOTES**

560	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	GROUP-A	GRA
<p style="text-align: center;">PURPOSE</p>	<p>This is the first in a series of three commands to define the various loads to be combined as per AASHTO 3.22. This series of commands may be repeated as required to define up to 99 load cases.</p>	
6 COMMAND PARAMETERS		
β_E	Enter the earth pressure coefficient.	
β_D	Enter the dead load coefficient.	
I	Enter the Impact Factor.	
D	Enter the dead load force (See notes).	
L	Enter the live load force (See notes).	
CF	Enter the centrifugal force (See notes).	

III

EXAMPLE

GRA 1.3, .75, 1.255, 100.6, 190.5, -30.7

FIGURES**NOTES**

All loads in the same load case must have the same units.

570	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	GROUP-B	
	GRB	
PURPOSE	This is the second in a series of three commands to define the various loads to be combined as per AASHTO 3.22.	
6 COMMAND PARAMETERS		
E	Enter the earth pressure force (See notes).	
B	Enter the buoyancy force (See notes).	
SF	Enter the stream flow force (See notes).	
WL	Enter the force due to wind load on the structure (See notes).	
WOL	Enter the force due to wind on the live load (See notes).	
LF	Enter the longitudinal force (See notes).	

EXAMPLE

GRB , -30.2, 10.7, 1.6, 3.5, 2.1

FIGURES**NOTES**

All loads in the same load case must have the same units.

580	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	GROUP-C		GRC
PURPOSE	This is the third in a series of three commands to define the various loads to be combined as per AASHTO 3.22.		
5 COMMAND PARAMETERS			
R	Enter the rib shortening force (See notes).		
S	Enter the shrinkage force (See notes).		
T	Enter the temperature force (See notes).		
ICE	Enter the ice pressure force (See notes).		
EQ	Enter the earthquake force (See notes).		

EXAMPLE

GRC , 1.6, 2.1, 10.5, -20.7

FIGURES**NOTES**

All loads in the same load case must have the same units.

11. COLUMN DESIGN / ANALYSIS

General Information

The original version of this computer program was developed by Mr. Jose M. Nieves while serving as Manager of Computer Services, Portland Cement Association.

While the Portland Cement Association has taken every precaution to utilize the existing state of the art and to assure the correctness of the analytical solution and design techniques used in the program, the responsibility for modeling the structure to develop input data, applying engineering judgement to evaluate the output, and implementation into engineering drawings remains with the structural engineer of record. Accordingly, the Portland Cement Association does and must disclaim any and all responsibility for defects or failures in structures in connection with which this program is used.

The Wyoming Department of Transportation revised this program's input and output format and added the capability to take into account slenderness effects magnifying moments. It was then incorporated into BRASS-PIER™. This was done so that the free format command structured input could be utilized and the output headings would be appropriate.

Program Description

The purpose of this program is to give engineers the capability to design reinforced concrete compression members to resist a given combination of loadings or to investigate the adequacy of a given cross section to resist a similar set of loadings. Each loading case consists of an axial compressive load combined with uniaxial or biaxial bending. The method of solution is based on accepted ultimate strength theories for reinforced concrete design.

The program will compute the moment magnifiers to take into account slenderness effects. It will magnify all input moments when axial load and moments are input (LOAD-COMBINED command, page 11.28).

Types of Members

The program recognizes round and rectangular concrete cross sections with circular or rectangular reinforcement patterns. For the purpose of definition, member types are classified as Round, Spiral, and Tied. A round member defines a circular cross section with a circular reinforcement pattern; a spiral member defines a rectangular cross section with a circular reinforcement pattern; and a tied member a rectangular cross section with a rectangular reinforcement pattern.

In the investigation option, it is also possible to define irregular reinforcement patterns by means of individual bar areas and location.

Reinforcing Steel

The program will only design or investigate bar sizes 2 through 11, 14, and 18.

Design Capabilities

Under the design option, the program will magnify the moments if requested when axial loads and moments are used, and find size, number, and distribution of bars that will result in the minimum area of reinforcement with all bars of the same size required to satisfy all the loading conditions imposed on the cross section. For tied members the number of bars in the sides may be different than in the top and bottom of the cross section.

Investigation Capabilities

At the option of the engineer, the program has the capability of generating interaction data or of determining the adequacy of a cross section to resist a given combination of loads. The strength of the cross section for the combination of axial force and moments will then be computed, and the relationship between the strength and the applied loading will be reported.

Method of Solution

The method of solution is based on accepted ultimate strength theories for reinforced concrete design. Where applicable, the design assumptions and limits used conform to the provisions of both specifications cited in Design Specifications, Page 11.1. A brief summary of the method of solution follows:

- (1) When requested, moment magnifiers are calculated based on the following:
 - (a) The unsupported length l_U is considered in each direction of bending for members; i.e., l_{Ux} and l_{Uy} must be input.
 - (b) The radius of gyration used by the program is 0.30 times the overall dimension in the direction in which stability is being considered for rectangular members, and 0.25 times the diameter for circular compression members. Other shapes cannot be used if the moment magnifier is required.
 - (c) The effective length factor, k , must be calculated and input by the user.
 - (d) The program checks the value of Kl_U/r and for members braced against sidesway ignores effects of slenderness when it is less than $34-12M_1/M_2$. For members not braced against sidesway, it ignores slenderness effects when kl_U/r is less than 22. If it is greater than 100, a message will be output and the program will terminate.
 - (e) The design moments are magnified by δ

$$\text{Where } \delta = \frac{C_m}{1-(P_U/\Phi P_C)} \geq 1.0$$

Φ is set by the program at 0.70 for tied member and 0.75 for round or spiral members.

P_C is calculated by $\pi^2 EI (k l_U)^2$

If the analysis is for an investigation of an existing design and the size and number of reinforcing steel bars are known, the program uses the greater of AASHTO Equation 8-43 or 8-44 to calculate EI. If the analysis is for a design, then the program uses Equation 8-44.

B_d and E_C are input by the user.

I_g is calculated by $\frac{bh^3}{12}$ for rectangular members and by $\frac{\pi d^4}{64}$ for round members.

C_M is calculated by $0.6 + 0.4(M_1/M_2)$ but not less than 0.4.

M_1 and M_2 are input by the user.

(f) The program will not handle column groups.

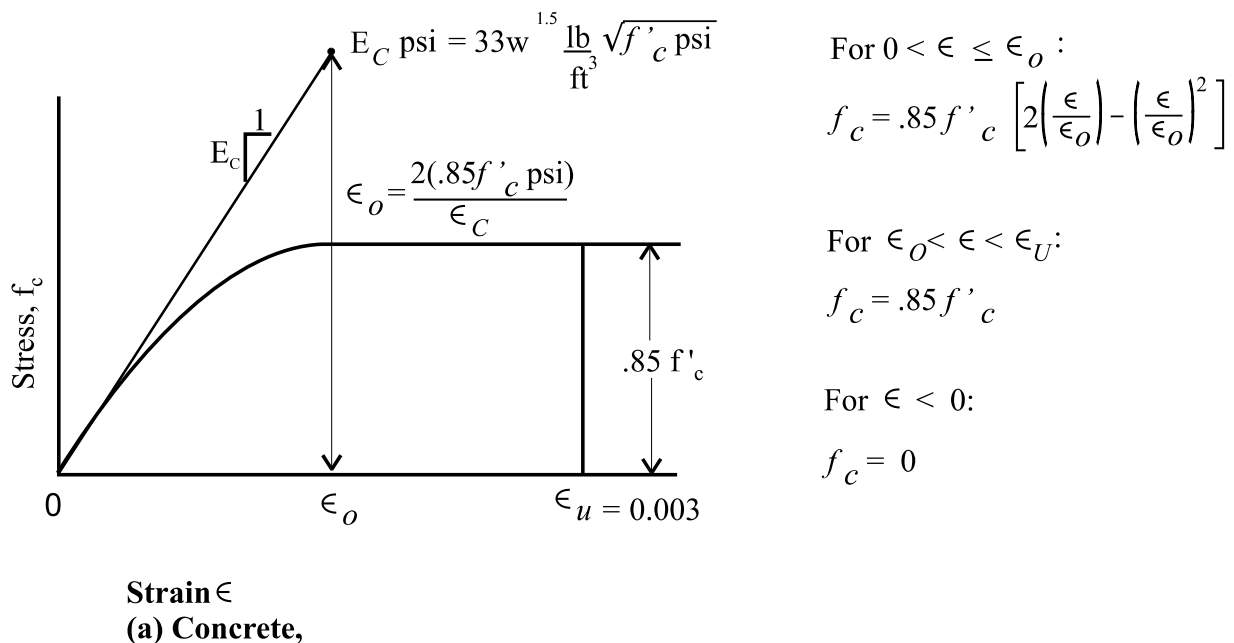


Figure 11.1

(2) Computations of strength are based on the satisfaction of the applicable conditions of equilibrium and compatibility of strains. The stress-strain relationship for concrete is assumed as shown in Figure 11.1

There are provisions in the input to enable the user to change some of the parameters which affect the shape of the compression block.

(3) Concrete displaced by reinforcement in compression is deducted from the compression block.

- (4) Stress in the reinforcement below the design yield strength, f_y , is directly proportional to the strain. For strains greater than that corresponding to the design yield strength, the reinforcement stress remains constant and equal to f_y . The modulus of elasticity E_s , is taken as 29,000,000 psi, unless otherwise changes in the input data.
- (5) Stress in the reinforcement is based on the strain at the actual location of each bar. Reinforcement is defined by the area of each bar and x-y coordinates referred from the centroidal axis of the cross section.
- (6) All moments are referred to the centroid of the gross concrete section whether the reinforcement pattern is symmetrical or unsymmetrical.
- (7) Computations for biaxial loading are based on a three-dimensional interaction surface. The method of solution is presented in PCA Advanced Engineering Bulletins No. 18 and 20.
- (8) The program first computes the theoretical strength of a member on the basis of the strength of the materials, then reduces the theoretical strength to the design strength by the capacity reduction factor.

BRASS-PIER™ has been designed so that when requested, the column dimensions input to, and the loads generated by, the PIER ANALYSIS component are transferred internally to the COLUMN DESIGN/ANALYSIS component. This option is activated when the COLUMN-DESIGN command is preceded in the data set by a PIER command. The only data that is required to be input by the user are the run type and the reinforcement data. The user may, if desired, override any of the column dimensions by entering the appropriate value. For example, AASHTO 8.18.1.2 specified that “when the cross-section is larger than that required by consideration of loading, a reduced effective area may be used”. To illustrate, consider a solid shaft (hammer head pier), Figure 11.2. The column has a cross section which is larger than required for load carrying capabilities.

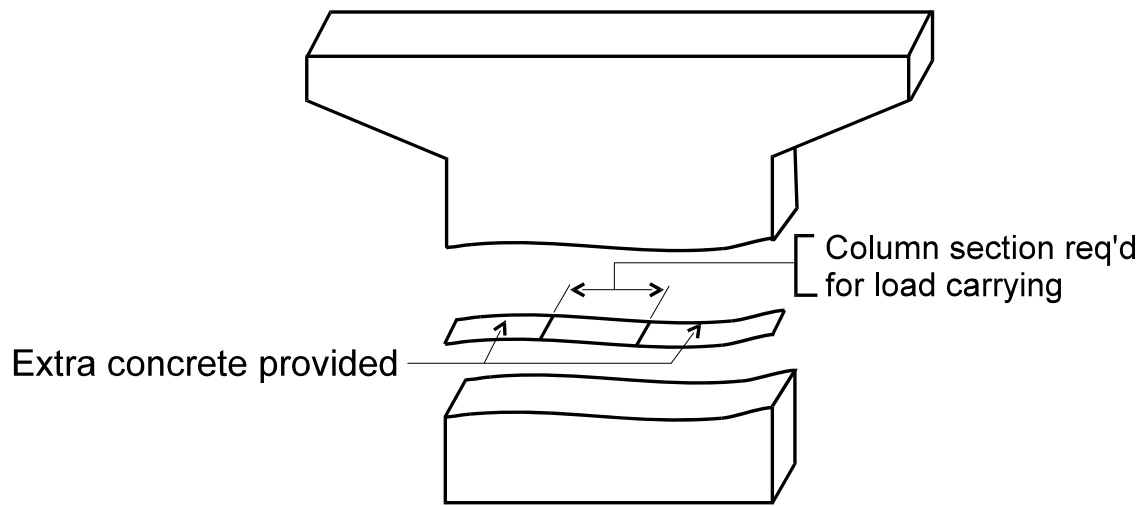


Figure 11.2

To reduce the amount of reinforcement required for a lightly loaded column, where the minimum reinforcement ratio would govern, enter the reduced column width.

590	BRASS-PIER™	COMMAND DESCRIPTION								
COMMAND NAME	COLUMN-DESIGN									
PURPOSE	This command controls the design/analysis of a reinforced concrete compression member.									
7 COMMAND PARAMETERS										
Problem Type	Enter 1 if this is a design problem. Enter 2 if this is an investigation problem.									
Column Type Default = 3	Enter a code to specify the type of column being designed/investigated. <table border="0" style="width: 100%;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;">Code</th> <th style="text-align: left; border-bottom: 1px solid black;">Column Type</th> </tr> </thead> <tbody> <tr> <td style="padding-left: 20px;">1</td> <td>Round Member - Circular cross section with circular reinforcement pattern.</td> </tr> <tr> <td style="padding-left: 20px;">2</td> <td>Spiral Member - Rectangular cross section with circular reinforcement pattern.</td> </tr> <tr> <td style="padding-left: 20px;">3</td> <td>Tied Member - Rectangular cross section with rectangular reinforcement pattern.</td> </tr> </tbody> </table>		Code	Column Type	1	Round Member - Circular cross section with circular reinforcement pattern.	2	Spiral Member - Rectangular cross section with circular reinforcement pattern.	3	Tied Member - Rectangular cross section with rectangular reinforcement pattern.
Code	Column Type									
1	Round Member - Circular cross section with circular reinforcement pattern.									
2	Spiral Member - Rectangular cross section with circular reinforcement pattern.									
3	Tied Member - Rectangular cross section with rectangular reinforcement pattern.									
B	Enter the dimension parallel to the x-x axis for a rectangular cross section or the diameter for a circular cross section, IN INCHES . DEFAULTS: <div style="text-align: center;"> Solid shaft pier or Frame pier w/circular columns Column Type 1 B = COLDIA </div> <div style="text-align: center; margin-top: 20px;"> Solid shaft pier or Frame pier w/rectangular columns Column Type 3 B = COLDPT </div> See Pages 8.12 and 8.13. (Continued)									

COMMAND PARAMETERS (Cont.)	
T	<p>For a rectangular cross section, enter the dimension parallel to the y-y axis, IN INCHES.</p> <p>DEFAULTS:</p> <p>Solid shaft pier or Frame pier w/circular columns Column Type 1 T = COLDIA</p> <p>Solid shaft pier or Frame pier w/rectangular columns Column Type 3 T = COLWDT</p> <p>See Page 8.12</p>
Design Column	<p>For a frame pier (this command preceded by the PIER command), enter the number of the design column. If this entry is left blank, one of three processes will occur based on the column properties. See Note 1.</p> <p>For a solid shaft pier or when a column design only is requested (this command is not preceded by the PIER command), enter 1 (Default = 1). See Page 11.4.</p>
IOX	<p>Enter 1 if interaction information is requested about the x-x axis (investigation only), otherwise leave blank. See Note 2.</p>
IOY	<p>Enter 1 if interaction information is requested about the y-y axis (investigation only), otherwise leave blank. See Note 2.</p>

EXAMPLE

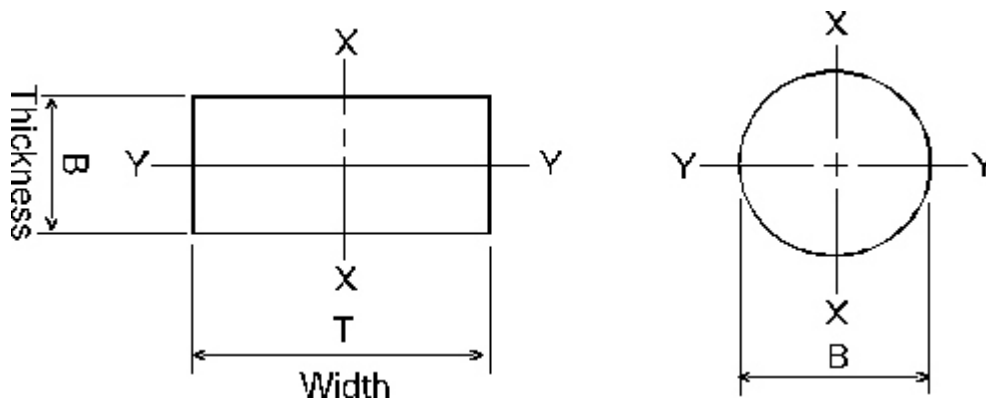
For a 30" diameter round member, design column #2, IOX=1 and IOY=1, code:

PCA 1, 1, 30, , 2, 1, 1

For a 30" X 40" rectangular tied member, code:

PCA 1, 3, 30, 40

FIGURES



NOTES

1. For a frame pier, if the Design Column is left blank one of three processes will occur based on the column properties:
 - 1) If the cross-sections and lengths are identical for all columns, BRASS will make one pass through the moment magnifier and PCA analysis for the worst loading case of all columns.
 - 2) If the column cross-sections are identical but the column lengths differ, BRASS will make one pass through the moment magnifier for each column and one pass through the PCA analysis for the worst case of all columns.
 - 3) If the column cross-sections differ, BRASS will make one pass through the moment magnifier and the PCA analysis for each column.

NOTE: The same steel will be assumed for each column for investigation and the same limits will be assumed for each column for design.

2. Investigative Option The IOX and IOY indicators enable the user to specify what axis of bending is to be considered and reported in the output for the investigative option.

(Continued)

NOTES
(continued)

The following analysis and output is obtained depending on the condition of

IOX IOY

- | | | | |
|-------|-------|---|---|
| 1. | blank | - | Only information about the x-axis is given. |
| blank | 1. | - | Only information about the y-axis is given. |
| 1. | 1. | - | Interaction information is furnished about both the x and y axes and also about the diagonal axis to enable the computation of biaxial bending strength of the cross section. |
| or | | | |
| blank | blank | - | No information given. |

600	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	FACTORS	
PURPOSE	FCT	
	<p>This command defines the constant factors used in the analysis of a compression member.</p> <p>If this command is not used, the factors to be defined will be assigned the default values listed below.</p>	
5 COMMAND PARAMETERS		
Φ_C Default = .75 for spiral members, .7 for tied members.	Enter the capacity reduction factor for compression. See Note.	
Φ_B Default = .9	Enter the capacity reduction factor for bending.	
R_{MIN} Default = .01	Enter the minimum reinforcement ratio	
R_{MAX} Default = .08	Enter the maximum reinforcement ratio.	
S_{CLEAR} Default = 1.5 inches	Enter the minimum clear distance between reinforcing bars, in inches	

EXAMPLE

For the minimum reinforcement ratio (R_{MIN}) of .005, and all other values default, code:

FCT , , .005

FIGURES**NOTES**

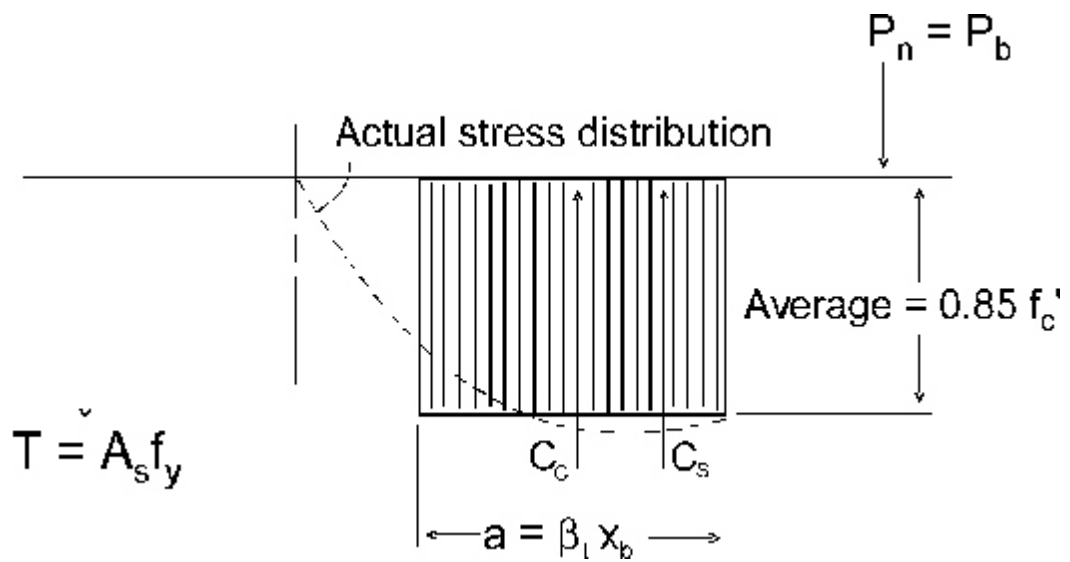
610	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	PROPERTIES	
PURPOSE	<p>This command defines the physical properties of the concrete and reinforcement in the column. If this command is not used, the properties to be defined will be assigned to default values listed below.</p>	
6 COMMAND PARAMETERS		
f'_c Default = 3.250 ksi	Enter the compressive strength of the concrete used in the column, in kips per square inch.	
F_Y Default = 60 ksi	Enter the yield strength of the reinforcing steel, in kips per square inch.	
f_c Default = $.85f'_c$	Enter the average concrete stress at ultimate strain, in kips per square inch, see Figure.	
E_c Default = $145^{1.5} \times 33 \times f_c^{0.5}$, ksi	Enter the modulus of elasticity of the concrete, in kips per square inch.	
E_s Default = 29000 ksi	Enter the modulus of elasticity of the reinforcing steel, in kips per square inch.	
E_U Default = .003	Enter the maximum usable strain at the extreme compression fiber.	

EXAMPLE

For the compressive strength of f'_c of 3500 psi and all other values default, code:

PRP 3.5

FIGURES



NOTES

620	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	REINFORCEMENT-A	
	RNA	
<p align="center">PURPOSE</p>	<p>This command defines the number and size of bars to be placed in the column for an investigation (or the limits on the number and size of bars for a design) when the reinforcement pattern is circular (round or spiral members) or a tied member with an equal number of bars in each face.</p> <p>NOTE: Enter 5 command parameters for Option A or 3 command parameters for option B or 5 command parameters for Option C or 3 command parameters for Option D.</p>	
5 or 3 COMMAND PARAMETERS		
Cover	<p>A. <u>Circular Pattern - Design</u></p> <p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches.</p>	
Bar Size Lower Limit Default = 5	Enter the minimum bar size to be considered by the program.	
Bar Size Upper Limit Default = 11	Enter the maximum bar size to be considered by the program.	
Number of Bars Lower Limit Default = 6	Enter the minimum number of bars to be considered by the program.	
Number of Bars Upper Limit Default = 100	Enter the maximum number of bars to be considered by the program.	
Cover	<p>B. <u>Circular Pattern - Investigation</u></p> <p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches.</p>	
Bar Size	Enter the bar size. Must be a standard bar designation.	
Number of Bars	Enter the number of bars. Must be between 6 and 100.	
(Continued)		

COMMAND PARAMETERS (Cont.)	
Cover	<p>C. <u>Tied Member (Equal Number of Bars in Each Face) - Design</u></p> <p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches. For a rectangular spiral member, cover must be the amount of cover in the least dimension.</p> <p>Enter the minimum bar size to be considered by the program.</p> <p>Enter the maximum bar size to be considered by the program.</p> <p>Enter the minimum number of bars to be placed in each face.</p> <p>Enter the maximum number of bars to be placed in each face.</p>
Bar Size Lower Limit Default = 5	
Bar Size Upper Limit Default = 11	
Number of Bars Lower Limit Default = 2	
Number of Bars Upper Limit Default = 26	
Cover	<p>D. <u>Tied Member (Equal Number of Bars in Each Face) - Investigation</u></p> <p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches. For a rectangular spiral member, cover must be the amount of cover in the least dimension.</p> <p>Enter the bar size. Must be a standard bar designation.</p> <p>Enter the number of bars. Must be an even number between 4 and 100. One bar will be placed in each corner and the remaining bars will be distributed equally among the four faces. When the number of bars is not a multiple of four, the extra bars will be placed in rows 1 and 2.</p>
Bar Size	
Number of Bars	

EXAMPLE

A. Circular Pattern - Design

Cover - 1.375 in., bar size (#6 - #9), no. bars (10-50)

RNA 1.375, 6, 9, 10, 50

B. Circular Pattern - Investigation

Cover = 1.5 in., 20 - #7 bars

RNA 1.5, 7, 20

C. Tied Member - Design

Cover = 1.5 in., bar size (5 - 9), no. bars (4 - 26)

RNA 1.5, , 9, 4

D. Tied Member - Investigation

Cover = 1.5 in., 16 - #8 bars

RNA 1.5, 8, 16

FIGURES**NOTES**

630	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	REINFORCEMENT-B	
PURPOSE	RNB	
	<p>This command defines the placement and size of bars in the column for an investigation (or the limits on the number and size of bars for a design) of a tied member when the number of bars in rows 1 and 2 differ from the number of bars in rows 3 and 4.</p> <p>NOTE: Enter 8 command parameters for Option A or 10 command parameters for Option B.</p>	
8 or 10 COMMAND PARAMETERS		
Cover	<p>A. <u>Design</u></p> <p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches, for Rows 1 and 2. For a rectangular spiral member, cover must be the amount of cover in the least dimension.</p>	
Cover Default = Cover for Rows 1 and 2	<p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches, for Rows 3 and 4. For a rectangular spiral member, cover must be the amount of cover in the least dimension.</p>	
Bar Size Lower Limit Default = 5	<p>Enter the minimum bar size to be considered by the program.</p>	
Bar Size Upper Limit Default = 11	<p>Enter the maximum bar size to be considered by the program.</p>	
Number of Bars Lower Limit Default = 2	<p>Enter the minimum number of bars to be placed in Rows 1 and 2.</p>	
Number of Bars Upper Limit Default = 26	<p>Enter the maximum number of bars to be placed in Rows 1 and 2.</p>	
Number of Bars Lower Limit Default = 0	<p>Enter the minimum number of bars to be placed in Rows 3 and 4.</p>	
Upper Limit Default 1. If Lower Limit = 0 Default = 0 2. If Lower Limit ≠ 0 Default = 24	<p>Enter the maximum number of bars to be placed in Rows 3 and 4. If Upper Limit = 0, no bars will be placed in Rows 3 and 4.</p>	
(Continued)		

COMMAND PARAMETERS (Cont.)

Cover	<p>B. <u>Investigation</u></p> <p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches, for Rows 1 and 2. For a rectangular spiral member, cover must be the amount of cover in the least dimension.</p>
Cover Default = cover in Rows 1 and 2	<p>Enter the cover (clear distance from the <u>main reinforcement</u> to the face of the member, i.e., cover must include the diameter of ties or spirals), in inches, for Rows 3 and 4. For a rectangular spiral member, cover must be the amount of cover in the least dimension.</p>
Number of Bars Row 1	<p>Enter the number of bars in Row 1.</p>
Bar Size Row 1	<p>Enter the size of the bars in Row 1. Must be a standard bar designation.</p>
Number of Bars Row 2 Default = No. of Bars in Row 1	<p>Enter the number of bars in Row 2.</p>
Bar Size Row 2 Default = Bar Size for Row 1	<p>Enter the size of bars in Row 2.</p>
Number of Bars Row 3	<p>Enter the number of bars in Row 3.</p>
Bar Size Row 3	<p>Enter the size of bars in Row 3.</p>
Number of Bars Row 4 Default = No. of Bars in Row 3	<p>Enter the number of bars in Row 4.</p>
Bar Size Row 4 Default = Bar Size for Row 3	<p>Enter the size of the bars in Row 4.</p>

EXAMPLE

Design

RNB 1.5, , 6, 9, 2, 15, 2, 24

Defines: Cover of 1.5 inches all around
Rows 1 and 2 - 2 to 15 bars, size 6 - 9
Rows 3 and 4 - 2 to 24 bars, size 6 - 9

RNB 1.5, 2, 6, 9, 2, 15, , 8

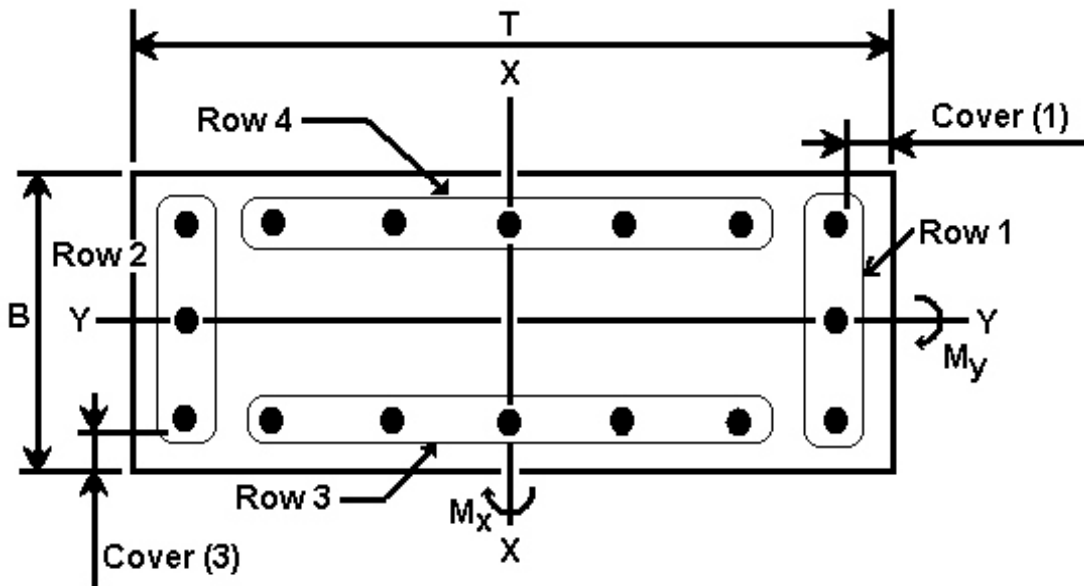
Defines: Cover of 1.5 inches for Rows 1 and 2, 2 inches for Rows 3 and 4.
Rows 1 and 2 - 2 to 15 bars, size 6 - 9
Rows 3 and 4 - 0 to 8 bars, size 6 - 9

Investigation

RNB 1.5, 2, 5, 6, 5, 6, 10, 6, 10, 6

Defines: Cover of 1.5 inches for Rows 1 and 2, 2 inches for Rows 3 and 4.
5 - #6 bars in Rows 1 and 2
10 - #6 bars in Rows 3 and 4

FIGURES

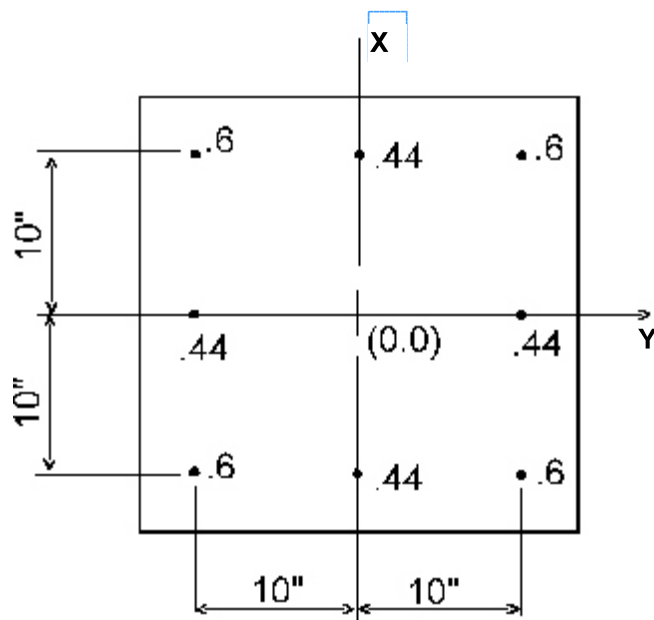


640	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	REINFORCEMENT-C		RNC
PURPOSE	This command defines the placement of reinforcement in a column with an irregular reinforcement pattern. This command may be repeated as needed to define up to 100 bars.		
6 COMMAND PARAMETERS			
A _i Default = A _i - 1	Enter the area of No. i, in square inches.		
X _i	Enter the x-coordinate of bar No. i, in inches.		
Y _i	Enter the y-coordinate of bar No. i, in inches.		
A _{i+1} Default = A _i	Enter the area of bar No. i + 1, in square inches.		
X _i	Enter the x-coordinate of bar No. i + 1, in inches.		
Y _i	Enter the y-coordinate of bar No. i + 1, in inches.		

EXAMPLE

For the Figure shown below:

RNC 6, -10, 10, .6, 10, 10
RNC , 10, -10, .6, -10, 10
RNC .44, 10, 0, .44, 0, 10
RNC , -10, 0, .44, 0, 10

FIGURES**NOTES**

660	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	LOAD-AXIAL		AXL
PURPOSE	<p>This command defines axial loads to be applied to the column. This command may only be used for an investigation problem. It may be repeated as needed to define up to 70 axial loads.</p> <p>DO NOT USE THIS COMMAND IF THE COLUMN-DESIGN COMMAND IS PRECEDED IN THE COMMAND SET BY A PIER COMMAND.</p>		
6 COMMAND PARAMETERS			
P	Enter the axial load, in kips.		
P	Enter the axial load, in kips.		
P	Enter the axial load, in kips.		
P	Enter the axial load, in kips.		
P	Enter the axial load, in kips.		
P	Enter the axial load, in kips.		

EXAMPLE

AXL	100,	150,	200,	250,	300,	400
AXL	500,	600,	700,	800,	1000,	1200
AXL	1400,	1600,	2000			

FIGURES**NOTES**

670	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	LOAD-INCREMENT		INC
PURPOSE	<p>This command defines groups of axial loads to be applied to the column. Each group consists of an initial axial load, a final axial load and in increment value. This command may be repeated as needed, however, the number of axial loads may not exceed 70. This command may only be used for an investigation problem.</p> <p>DO NOT USE THIS COMMAND IF THE COLUMN-DESIGN COMMAND IS PRECEDED IN THE COMMAND SET BY A PIER COMMAND.</p>		
6 COMMAND PARAMETERS			
P_i	Enter the initial axial load value, in kips.		
P_f	Enter the final axial load value, in kips.		
ΔP	Enter the increment value, in kips.		
P_i	Enter the initial axial load value, in kips.		
P_f	Enter the final axial load value, in kips.		
ΔP	Enter the increment value, in kips.		

EXAMPLE

The following example:

INC 100, 5000, 100, 50, 6000, 150 defines:

100^K to 5000^K in increments of 100^K and 50^K to 6000^K in increments of 150^K as follows:

50^K
200^K
250^K
...
...
5600^K
5750^K
5900^K

FIGURES**NOTES**

680	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	LOAD-COMBINED	CMB
PURPOSE	<p>This command defines axial loads combined with uniaxial or biaxial moments to be applied to the column. This command may be repeated as needed to define up to 70 load cases.</p> <p>DO NOT USE THIS COMMAND IF THE COLUMN-DESIGN COMMAND IS PRECEDED IN THIS COMMAND SET BY A PIER COMMAND.</p>	
6 COMMAND PARAMETERS		
P	Enter the axial load, in kips.	
M_x	Enter the moment applied about the x-x axis, in foot-kips.	
M_y	Enter the moment applied about the y-y axis, in foot-kips.	
P	Enter the axial load, in kips.	
M_x	Enter the moment applied about the x-x axis, in foot-kips.	
M_y	Enter the moment applied about the y-y axis, in foot-kips.	

EXAMPLE

The following defines axial loads & moments for 6 load cases.

CMB	300.23,	37.53,	37.53,	75.06,	39.55,	68.22
CMB	50.6,	39.55,	68.72,	212.45,	114.41,	55.76
CMB	187,	98,	14.41,	55.76		

NOTES

For this case, when the actual member is subjected to biaxial bending, the user can resolve the two components into one resultant and input this as a uniaxial moment. In the design option, the axis chosen must be the same for all loadings. In the investigation option, the axis chosen must be the one indicated in the COLUMN-DESIGN command under IOX and IOY.

690	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	SLENDERNESS-A		SLA
PURPOSE	This command defines the constant factors used in calculating the moment magnifiers which approximate the effects of slenderness according to AASHTO 8.16.5.2.		
7 COMMAND PARAMETERS			
BRACE _x	Enter 1 if the column is braced against bending about the x-axis, otherwise leave blank.		
BRACE _y	Enter 1 if the column is braced against bending about the y-axis, otherwise leave blank.		
l_x	Enter the length of the column to be used when bending is about the x-axis, in feet. Entering a value will trigger moment magnification calculations.		
l_y	Enter the length of the column to be used when bending is about the y-axis, in feet. Entering a value will trigger moment magnification calculations.		
k _x	Enter the effective length factor to be used when bending is about the x-axis.		
k _y	<p>Enter the effective length factor to be used when bending is about the y-axis.</p> <p>When the COLUMN-DESIGN command is preceded in the command set by a PIER command, then defaults will be as follows:</p> <ul style="list-style-type: none"> • Default for BRACE_x = 0 • Default for BRACE_y = 0 • Solid Shaft Pier <ul style="list-style-type: none"> Default for l_x = CLMLLEN (p. 8.12) Default for l_y = CLMLLEN (p. 8.12) Default for k_x = 2.1 Default for k_y = 2.1 • Frame Pier <ul style="list-style-type: none"> Default for l_x = CLMLLEN-NOMINAL DEPTH (p. 8.12) Default for l_y = CLMLLEN (p. 8.12) Default for k_y = 2.1 Default for k_x is calculated to the method given in the ACI commentary - 10.11.2. 		

COMMAND PARAMETERS (Cont.)

β_d Calculation Method

Default = 1

Enter:

1 - Calculate β_d for each load case for M_x and M_y .

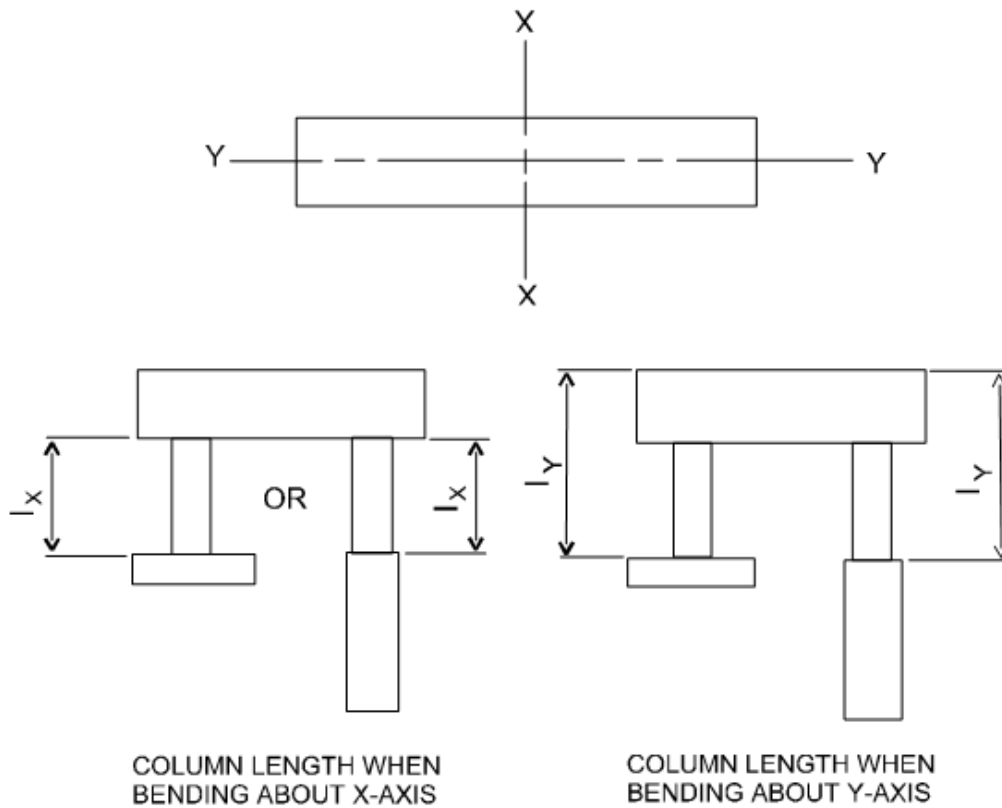
2 - Calculate β_d using the maximum dead load divided by the maximum total load for M_x and M_y .

EXAMPLE

For a structure not braced against bending about the x-axis (1st blank), not braced against bending about the y-axis (2nd blank), a column length when bending about the x-axis of 26 feet, a column length when bending about the y-axis of 29 feet, an effective length factor for bending about the x-axis of 1.2, and an effective length factor for bending about the y-axis of 2.1, code:

SLA , , 26, 29, 1.2, 2.1

FIGURES



700	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	SLENDERNESS-B		SLB
<p align="center">PURPOSE</p>	<p>This command defines the factors used in the moment magnifiers computations which are unique for each load case. This command must be used once for each load case defined with the LOAD-COMBINED command.</p> <p>DO NOT USE THIS COMMAND IF THE COLUMN-DESIGN COMMAND IS PRECEDED IN THE COMMAND SET BY A PIER COMMAND.</p>		
6 COMMAND PARAMETERS			
β_{Dx}	<p>Enter the value for β_D (the ratio of the dead load moment to the total moment) when bending is about the x-axis. β_D is always positive. If the above moments have opposite signs, the value of β_D should be 0 (zero). See Note 1.</p>		
M_{1x}	<p>Enter the value of M_1 (the value of the smaller design end dead load moment on the compression member calculated from a conventional elastic analysis; positive if the member is bent in a single curvature, negative if bent in double curvature) when bending is about the x-axis, in foot-kips. Enter 1 if not applicable due to zero end moment. See Note 2.</p>		
M_{2x}	<p>Enter the value of M_2 (the value of the larger design end dead load moment on the compression member calculated from a conventional elastic analysis, always positive) when bending is about the x-axis, in foot-kips. Enter 1 if not applicable due to a zero end moment or if M_1 is zero. See Note 2.</p>		
β_{Dy}	<p>Enter the value for β_D when bending is about the y-axis.</p>		
M_{1y}	<p>Enter the value of M_1 when bending is about the y-axis, in foot-kips. Enter 1 if not applicable.</p>		
M_{2y}	<p>Enter the value of M_2 when bending is about the y-axis, in foot-kips. Enter 1 if not applicable.</p>		

EXAMPLE

SLB	0,	1,	1,	0,	1,	1
SLB	.130,	170.6,	200.1,	.08,	-3.2,	10.7

FIGURES**NOTES**

Note 1. See AASHTO 8.16.5.2.7

Note 2. See AASHTO Equation 8.45

The design phase of the column analysis component of BRASS-PIER™ determines the minimum amount of reinforcement that will satisfy all the loading conditions given in the input. The reinforcement pattern to be used, and any restrictions as to number of bars and bar sizes, is under the control of the engineer through the stipulations given in the input data.

If no restrictions are given, the program will investigate the full range of number of bars and bar sizes, until the optimum area of steel is found. Even though there are built-in procedures to eliminate the checking of obviously inadequate bar patterns (such as total area of reinforcement outside the reinforcement ratios permitted by the specifications, bar patterns which result in bar spacings where the clear distance between bars is less than allowed by the specifications, total area of steel more than an area which has already been found satisfactory, etc.) The amount of computer time required to solve the problem increases proportionally with the number of load cases to be checked, and the range of the limits set for number of bars and bar sizes.

Obviously, the engineer can be of great help in increasing the efficiency of the computer operation. By using proper judgement and previous experience, input data can be prepared that will shorten the computer run to solve a given problem. There are several means available:

- (1) A minimum ratio of reinforcement can be input by use of the FACTORS command, if it can be predetermined that the ratio of reinforcement will be within a narrower range than the .01 to .08 used in the program.
- (2) The minimum acceptable clear spacing of bars can be increased in the input if this is a detailing requirement.
- (3) If the approximate number of bars can be predetermined, or if restrictions can be set for bar sizes, the limits can be input by use of the REINFORCEMENT-A or REINFORCEMENT-B commands.

In the design option, when it is determined that a certain bar arrangement is satisfactory, the program proceeds to compute the strength of the cross section under combined flexure and axial load, and compares this to the applied loadings. Each loading is checked in the same sequence given in the input. The first time that one of the loadings is not satisfied the checking procedure is terminated and the bar arrangement is rejected. A bar arrangement is accepted only when all the applied loadings are satisfied. In order to speed up the checking procedure, the more critical loading conditions should be input first.

The program rejects any cross section when the load strength is less than 0.99 of the applied load. It should be noted that the computed theoretical strength is reduced by the capacity reduction factor before the comparison is made. For axial loads less than $0.10 f'cA_g$, the factor varies between that for compression members to that for pure flexure.

The engineer may also wish to set standards for acceptance of a cross section. For example, a strength “overstress” of 5% may be acceptable instead of 1% programmed. The 5% acceptance criteria can be adopted by inputting the FACTORS command. A factor of 0.735 will result in computed strengths 5% larger than those computed for $\Phi_c = 0.7$.

It should also be noted that the method used in this solution of the strength design of compression members is more rigorous than most other methods used in current standards and design aids. For example, the solution uses a parabolic stress diagram for concrete, stress-strain compatibility is used in computing stresses, reinforcement is considered as the actual bars in the actual location (instead of the usual simplifying assumption of a line, which leads to an over-estimation of the contribution of the bars to the strength of the section), and the area of concrete displaced by bars in compression is deducted in the computations. Therefore, the solution has eliminated some of the simplifications which, because of the possible excess load effects, require larger safety factors in the present specifications. For these reasons, it is reasonable to suggest that the engineer can use less strength reduction (higher factors) when using this program for design of reinforced concrete compression members.

The engineer should be aware that this program computes the strength of the cross section based on moments about the geometric centroid of the gross cross section. Therefore, all input moments must also be referenced to the geometric axes of the concrete section, and all output data should be interpreted likewise. The design capabilities of the program are limited to finding the minimum area of steel for symmetrical reinforcement patterns only.

However, under the investigation option, the program accepts any type of reinforcement configuration, including unsymmetrical patterns. If the engineer desires to compare applied loadings with computed strengths, then the input moments must be given about the geometric centroid.

It should be noted that any reference axis can be used for a design, as long as the applied moment and resisting moments are both referenced to that axis. The geometric centroid is most convenient, since its location is fixed and does not depend on the amount of distribution of the reinforcement. Furthermore, the frame analysis of the structure is usually made using the geometric centroid of the gross cross section. The moments thus obtained can then be used directly as input to the program. If the engineer has computed applied moments about any other axis, then the moments can be easily transferred to the geometric axis by adding a moment equal to the axial load times the distance between the two axes.

Of course, it is not the intention of this program to dictate standards or procedure for design. Every effort has been made to allow maximum flexibility to give the engineer the capability of setting his own criteria for design, and conform with the normal practices in his office. The validity of the solution, and the accuracy of the results, have been thoroughly checked and found satisfactory for all the cases tested. However, to assure proper use, it is advisable that results of the program be first checked against previous designs.

Description of Output

Output listings are for the most part self-explanatory. After the program identification, the information given in the title command is printed out, followed by the verification of input which shows entry by the actual command input values.

If slenderness effects are to be considered and the column is slender, the magnified moments are output next. Load case numbers correspond to the order in which the load cases are entered in the LOAD-COMBINED commands.

The next page of output is the design or investigations results which gives the problem type option, and the type of member defined in the input.

Pertinent dimension data for the member will be printed in the next line. If the option is investigation, the given reinforcement data will be printed on the next line. If the option is design, the data for the selected reinforcement will be printed after the design is completed. If no reinforcement pattern was found to satisfy the loading conditions, a message will be printed after the design is completed. If no reinforcement pattern was found to satisfy the loading conditions, a message will be printed so stating.

The form of the output that will follow the reinforcement data will depend on the type of problem being solved, and on the information given in the load commands. All axial loads are given in kips and moments are given in kip-feet. The data will be printed as follows:

Design Option Output. For each loading condition, the following data will be printed:

(1) Loading Case Number

(2) The applied loadings as given in the input.

AP = Applied axial load

AMX = Applied moment component in the direction of the x-axis.

AMY = Applied moment component in the direction of the y-axis.

(3) The computed strength under combined flexure and axial load for the selected reinforcement assuming that the eccentricity of the axial remains constant.

UP = P_U = Axial load strength.

UMX = M_X = Moment strength component in the direction of the x-axis.

UMY = M_Y = Moment strength component in the direction of the y-axis.

(4) The ratio of the axial load strength to the applied axial load (UP/AP). This ratio will always be larger than .990.

Investigation Option Output

When neither LOAD-AXIAL, LOAD-INCREMENT nor LOAD-COMBINED commands are used:

The control points of the interaction diagram will be printed for each of the axis requested in the input. Control points are identified as follows:

PZ = P_O axial load strength of section in pure compression.

PB = P_B axial load strength of section at simultaneous assumed ultimate strain of concrete and yielding of tension reinforcement (balanced conditions).

MB = M_B moment strength of section at simultaneous assumed ultimate strain of concrete and yielding of tension reinforcement (balanced conditions)

MZ = M_O moment strength in pure flexure ($P_U = 0$).

When commands LOAD-AXIAL or LOAD-INCREMENT are used:

Moment strengths will be printed for each axial load listed in the input (combined bending and axial load strengths). If uniaxial interaction data was requested in the input, only the moment strength

about the specified axis will be printed. If biaxial interaction data was requested in the input, the following information will be printed for each axial load:

(1) Loading Case Number

(2) UP = P_U = axial load strength.

UMX = M_{UX} = moment strength in the direction of the x-axis with bending considered about the x-axis only.

UMY = M_{UY} = moment strength in the direction of the y-axis with bending considered about the y-axis only.

DXM = M_X = moment strength component in the direction of the x-axis when the neutral axis is parallel to the diagonal axis through the corners of a rectangular cross section or a 45° axis for circular cross section.

DYM = M_Y = moment component corresponding to DXM above.

DRM = the resultant of the DXM and DYM moments defined above. For a circular or a square cross section DRM is the moment strength for biaxial bending about the diagonal axis.

BETA = a coefficient which defines the interaction contour for the biaxial moment relationship (see reference cited under Item (6), Paragraph 1.7 Method of Solution).

EXP = n = Exponent used in the biaxial bending design formula:

$$\frac{M_x}{M_{u_x}} + \frac{M_y}{M_{u_y}} = 1$$

For the use of this formula refer to the references cited under Item (7), Method of Solution.

When command LOAD-COMBINED is used:

The output will be comparison between the applied loadings given in the input and the computed strength of the cross section under combined flexure and axial load. The form of the output will be identical to that printed for the design option output. The adequacy of the section investigated to resist the applied loadings can be readily determined from the ratio of UP/AP printed in the last column of the listing.

References. Advanced Engineering Bulletin 18, "Capacity of Reinforced Rectangular Columns Subject to Biaxial Bending" and Advanced Engineering Bulletin 20, "Biaxial and Uniaxial Capacity of Rectangular Columns" published by the Portland Cement Association.

12. FOOTING ANALYSIS DESIGN

The Footing Analysis/Design Component can analyze or design a spread or pile footing. Service Load requirements are used to determine the size (length and width), and the number of piles and spacing in the case of a pile footing. The thickness and reinforcement steel requirements are determined from Service Load or Load Factor requirements. AASHTO Articles 4.4.7.1.1.1 (Eccentric Loading) and 4.4.8 (Geotechnical Design on Rock) are not considered.

In the case of a spread footing, the soil is assumed to resist no tension. The critical section for beam shear is at d from the face of the column, and at $d/2$ for peripheral shear. In a design, the width of the footing in the direction of the maximum moment (M^+ or M^-) will be incremented unless the width ratio is exceeded.

In the case of a pile footing, the critical section for beam shear is at d from the face of the column and at $d/2$ for peripheral shear. The program does not check the peripheral shear for an individual pile. In the design of a pile footing the program starts with a minimum (4 or the input value) number of piles at the minimum spacing. The spacing is increased as required until the maximum spacing is reached. Then a pile is added and the spacing is set to the minimum, and the process is repeated. The maximum number of piles is 25.

The thickness of the footing is increased when the beam and peripheral shear and moment capacities of the footing section are exceeded.

Impact is removed from the live load effects in the footing analysis/design process.

BRASS-PIER™ has been designed so that, when requested, the column and footing dimensions input to, and the loads generated by, the PIER-ANALYSIS component are transferred internally to the FOOTING component. This option is activated when the FOOTING command is preceded in the command set by a PIER command. The only data that is required to be input is the problem type, allowable stresses, and the reinforcement data.

In the footing design output, the final footing actions are given. The group loads are calculated according to Table 3.22.1a of the AASHTO specifications, for each group. These loads are passed to the spread and pile footing subroutines. The service load results are **not** adjusted based on column 14 of Table 3.22.1a in the "FINAL FOOTING ACTIONS" report. The allowable soil pressure and the allowable pile loads are increased accordingly based on the value in Column 14.

If you code a "1" in parameter 9 of the REPORT-LEVEL command, intermediate output will be generated as the program designs a spread footing. The value of overstress being used is reported.

A set of footing commands (commands 710 through 800) is required to define each footing to be analyzed. BRASS-PIER determines the 25 worst loading cases and designs for footing for the worst case.

The value for d_p in AASHTO Standard Specifications, Article 4.4.11.3.2 is always assumed to be 12".

710	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	FOOTING		FTG
PURPOSE	This command controls the design/investigation of a spread footing or pile cap.		
5 COMMAND PARAMETERS			
Footing Type	Enter S if the footing is a spread footing. Enter P if the footing is a pile cap.		
Problem Type	Enter D if this is a design of the footing size and reinforcement. Enter R if this is a design of the footing reinforcement only (footing size is already known). Enter I if this is an investigation (footing size and reinforcement known).		
Design Type	Enter S for Service Load design/investigation of the footing reinforcement. Enter L for Load Factor design/investigation of the footing reinforcement.		
Footing/Column Number No default	The following parameters are used when the SPREAD-FOOTING command is preceded in the command set by a PIER command. For a solid shaft pier - enter 1 For a frame pier - enter the number of the design/analysis column. If only one column is designed, enter the number of that column.		
Identical	If the footing being designed is to be identical to a previously defined footing - enter the number of the previously defined footing. When repeating commands for multiple footings, this parameter is left blank for the first footing. The identical footings will have the same actions applied to them as the previously defined footing.		

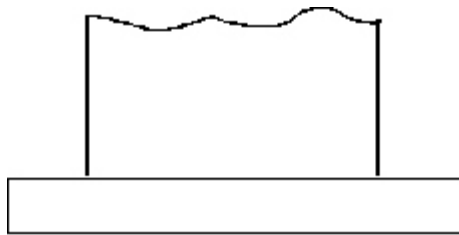
EXAMPLE

For a spread footing, a design of the footing size and reinforcement is required and load factor design for reinforcement is needed for column number 1, code:

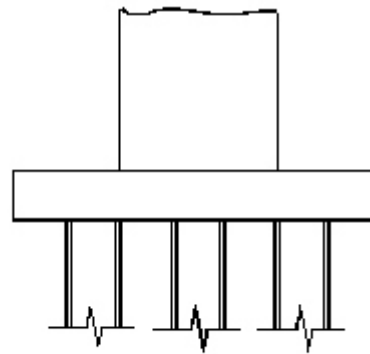
FTG S, D, L, 1

For a pile cap footing (design of reinforcement only, footing size is known), load factor design for reinforcement is needed and column No. 2 is desired, code:

FTG P, R, L, 2

FIGURES

SPREAD FOOTING



PILE CAP

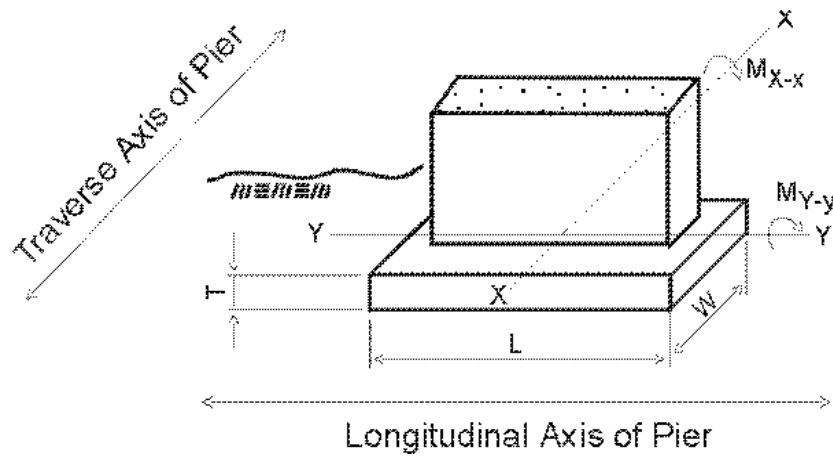
NOTES

720	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	SPREAD		SPF
<p align="center">PURPOSE</p>	<p>This command defines the dimensions of a spread footing for investigation (when the footing size is known) or the minimum dimensions of a spread footing for design.</p> <p>Required unless preceded by Command 250, COLUMN-DIM.</p>		
<p>3 COMMAND PARAMETERS</p>			
<p>Width, W Default - FTGWDT</p>	<p>Enter the dimension parallel to the x-x axis, in feet (or minimum if design).</p>		
<p>Length, L Default = FTGLEN</p>	<p>Enter the dimension parallel to the y-y axis, in feet (or minimum if design).</p>		
<p>Thickness, T Default = FTGT</p>	<p>Enter the footing thickness, in feet (or minimum if design).</p> <p>See Page 8.12</p>		

EXAMPLE

For $W = 10$ feet, $L = 20$ feet, and $T = 3$ feet:

SPF 10, 20, 3

FIGURES**NOTES**

M_{y-y} = Moment about the y - y axis caused by force in transverse direction. See page 12.32.

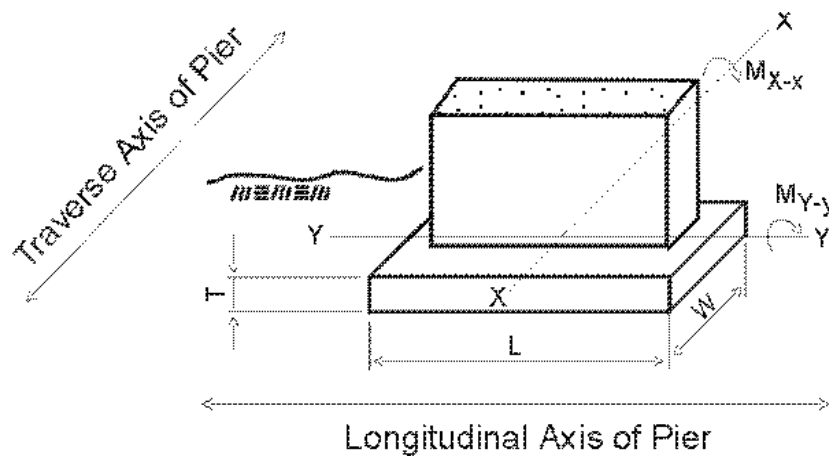
730	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	SPREAD-DESIGN		SPD
PURPOSE	This command defines the controls on the design of the footing size. This command is required for the Problem Type D for a Spread Footing. See FOOTING command.		
7 COMMAND PARAMETERS			
Allowable Soil Pressure	Enter the allowable soil pressure, in kips per square foot. See Notes.		
ΔW	Enter the amount by which the dimension parallel to the x-x axis is to be incremented during the design process, in feet.		
ΔL	Enter the amount by which the dimension parallel to the y-y axis is to be incremented during the design process, in feet.		
ΔT	Enter the amount by which the footing thickness is to be incremented during the design process, in feet.		
Ratio L to W	Enter the maximum allowable ratio of the footing length to width.		
Ratio W to L	Enter the maximum allowable ratio of the footing width to length.		
Foundation Material Default = 0	Enter 1 if the footing is on soil. Enter 0 or leave blank if the footing is on rock.		

EXAMPLE

For the design of a footing with an allowable soil pressure = 8 ksf., $\Delta W = 3$ in., $\Delta L = 3$ in., $\Delta T = 3$ in., maximum ratio of L to W = 2, and maximum ratio of W to L = 1, code:

SPD 8, .25, .25, .25, 2, 1

FIGURES



NOTES

The value entered in Parameter 1 must include the factor of safety. Generally, the value given to the bridge designer by the geotechnical engineer includes the factor of safety.

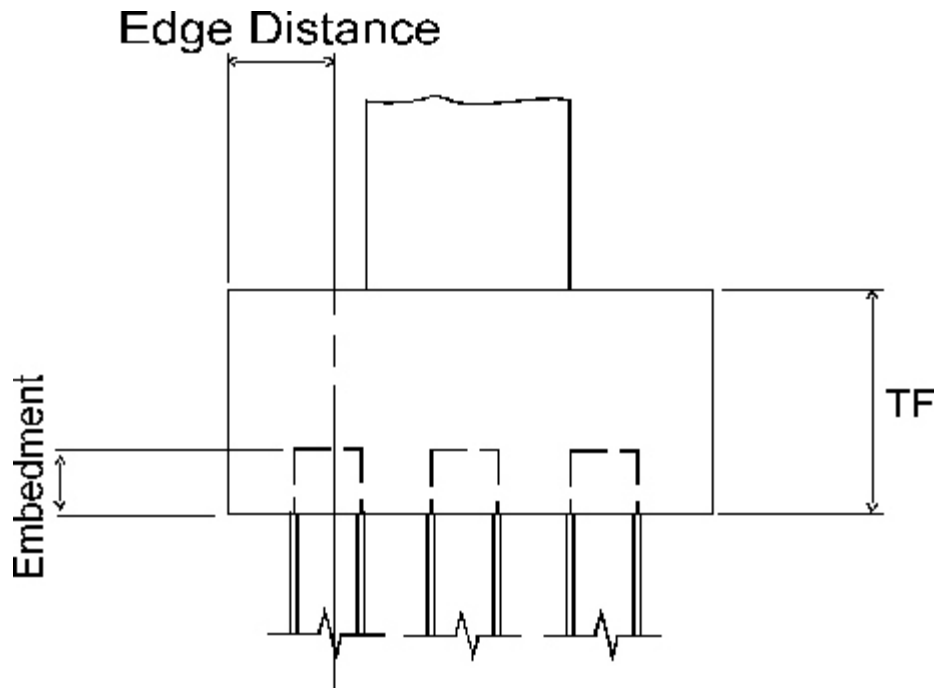
740	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	PILE		PIL
PURPOSE	This command defines the dimensions of a pile cap. This command is required for design and investigation of a pile cap.		
6 COMMAND PARAMETERS			
Spacing y-y axis D_p	For an investigation or the design of reinforcement only, enter the distance from the centerline of the footing to the first row of piles parallel to the y-y axis, in feet. See Note.		
Spacing x-x axis B_p	For investigation or the design of reinforcement only, enter the distance from the centerline of the footing to the first row of piles parallel to the x-x axis, in feet. See Note.		
Edge Distance C	Enter the distance from the edge of the footing to the center of the outside piles, in feet.		
Embedment	Enter the distance from the bottom of the footing to the top of the piles, in feet.		
Thickness	<p>Enter the thickness of the footing, in feet (or minimum thickness for a design).</p> <p>If an investigation is desired and the FOOTING command is preceded in the command set by the COLUMN-DIM command, the default will be as follows:</p> <p>Default for Thickness = FTGT</p> <p>See page 8.12</p>		
Number of Piles	For an investigation or the design of reinforcement only, enter either the number of piles in the pile cap or the minimum number of piles. See Design Option Notes, page 12.15.		

EXAMPLE

For a pier with pile spacing parallel to y-y axis = 8 ft., pile spacing parallel to x-x axis = 2.5 ft., edge distance = 18 in., pile embedment = 12 in., footing thickness = 3 ft., and No. of piles = 6, code:

PIL 8, 2.5, 1.5, 1, 3, 6

FIGURES

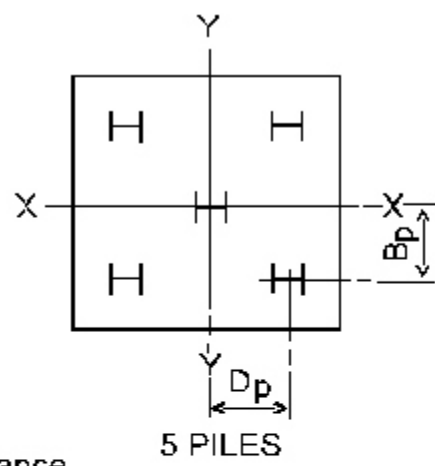
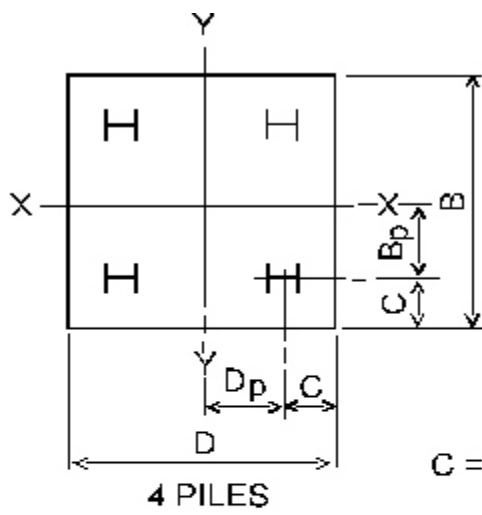


NOTES

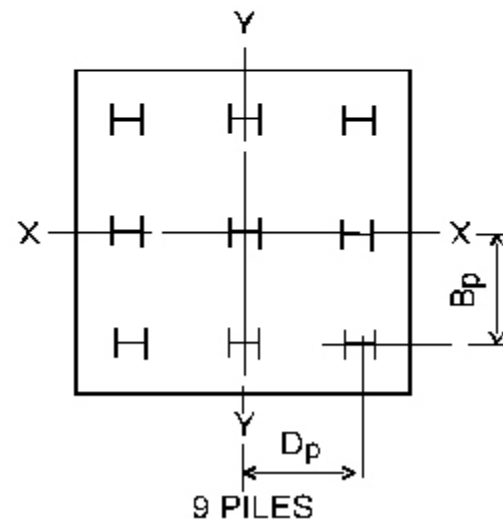
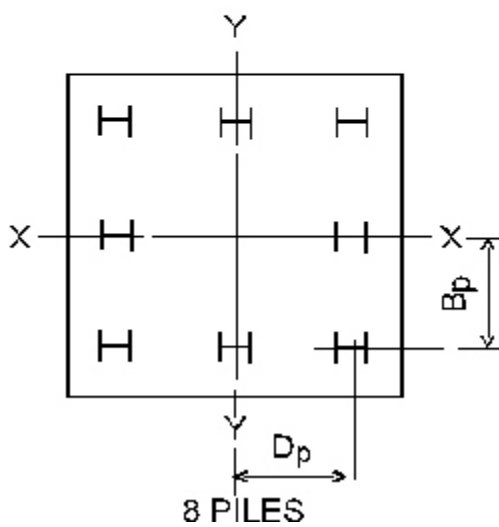
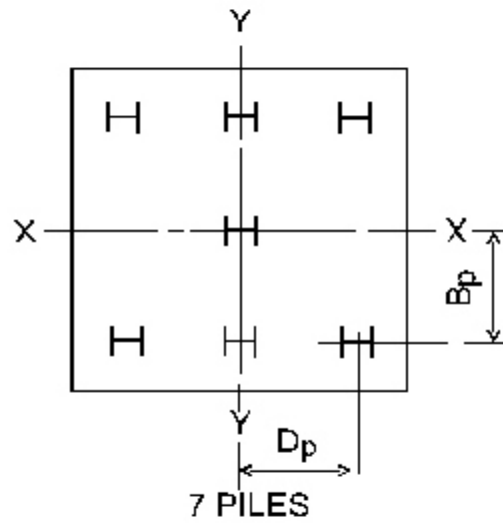
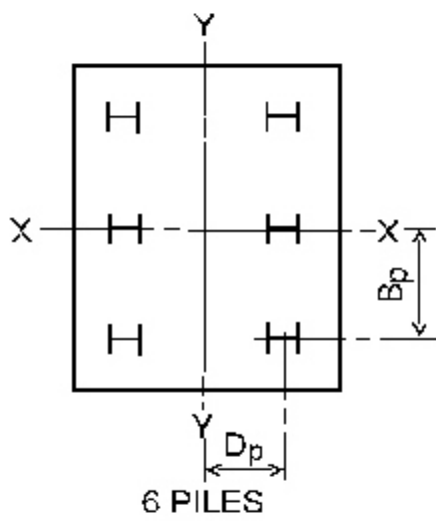
Only the pile configuration shown on pages 12.10 - 12.14 may be used

For design, TF, will be incremented as needed. ΔT on page 12.16 controls the footing thickness increment.

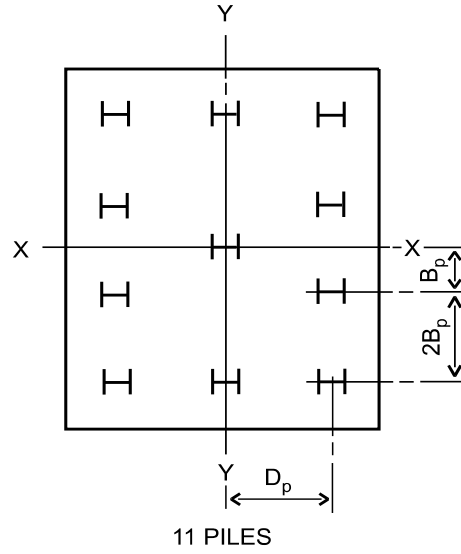
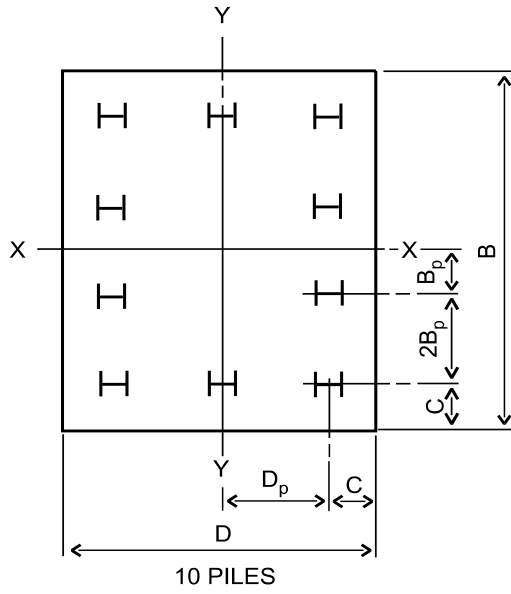
FIGURES



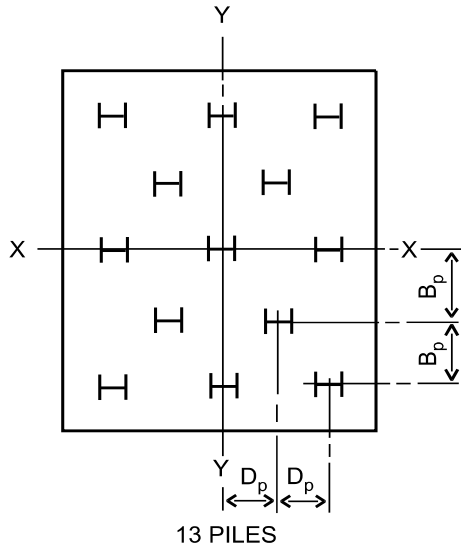
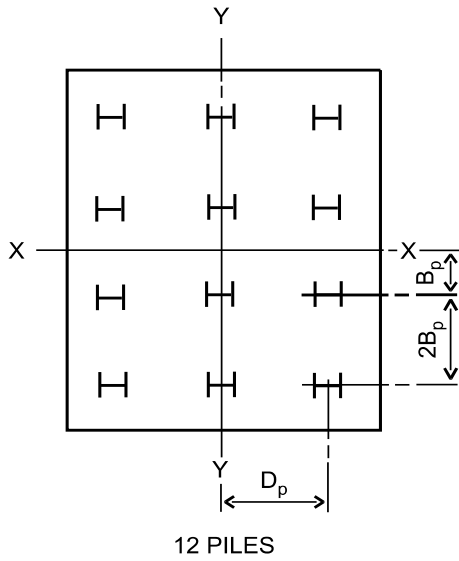
C = Edge Distance



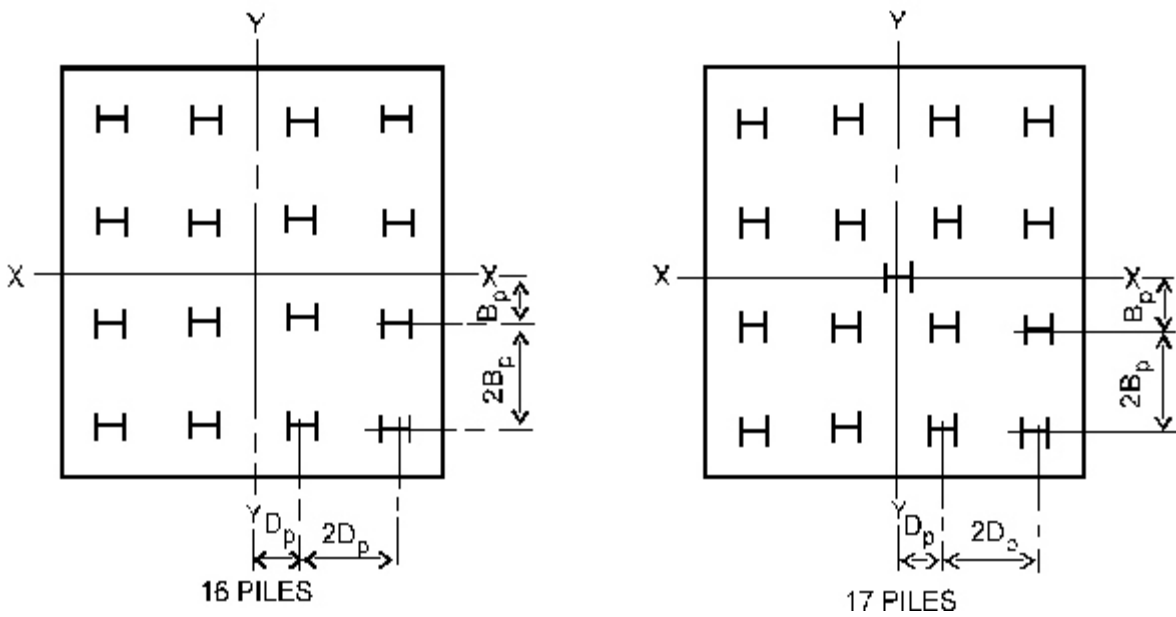
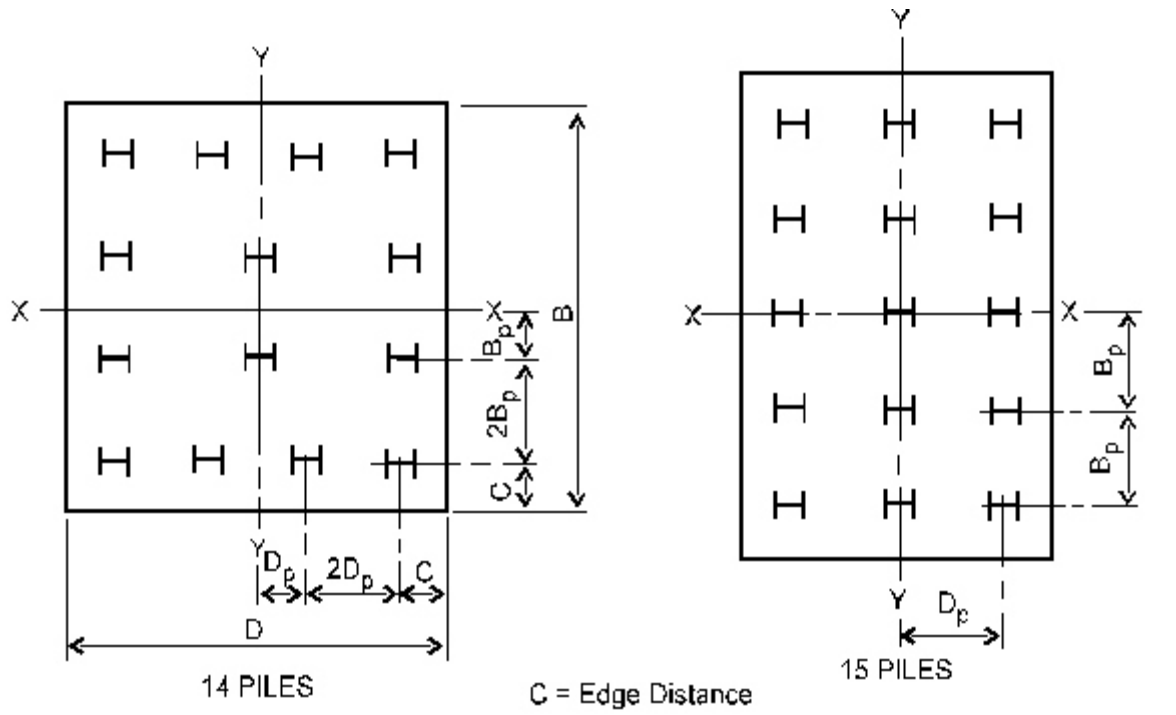
FIGURES



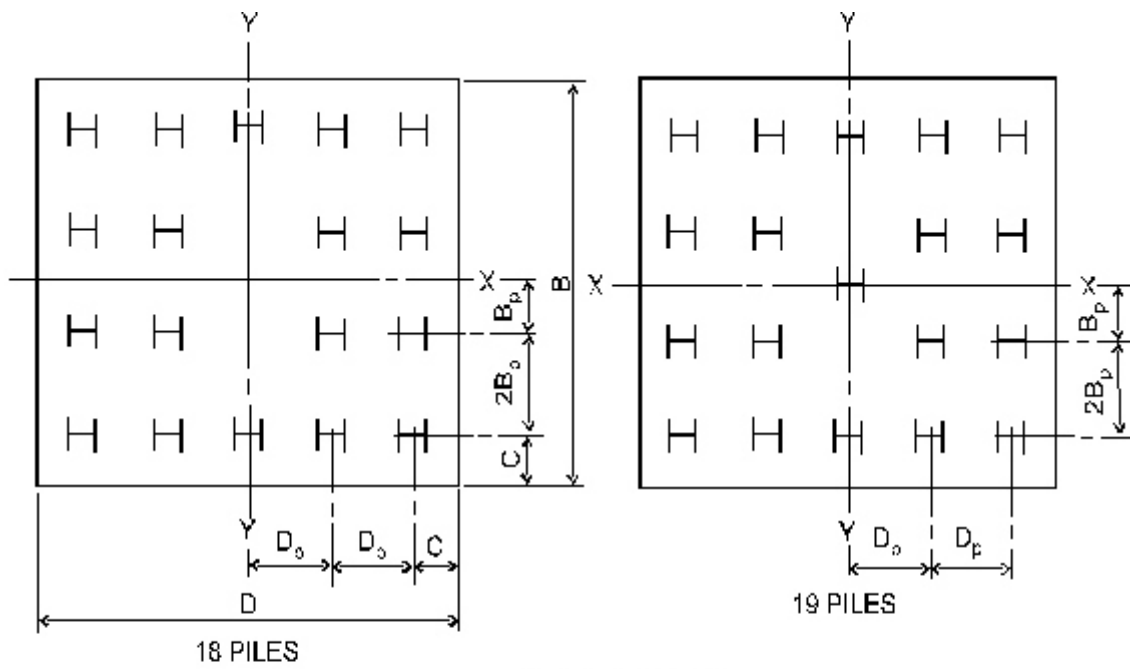
C=Edge Distance



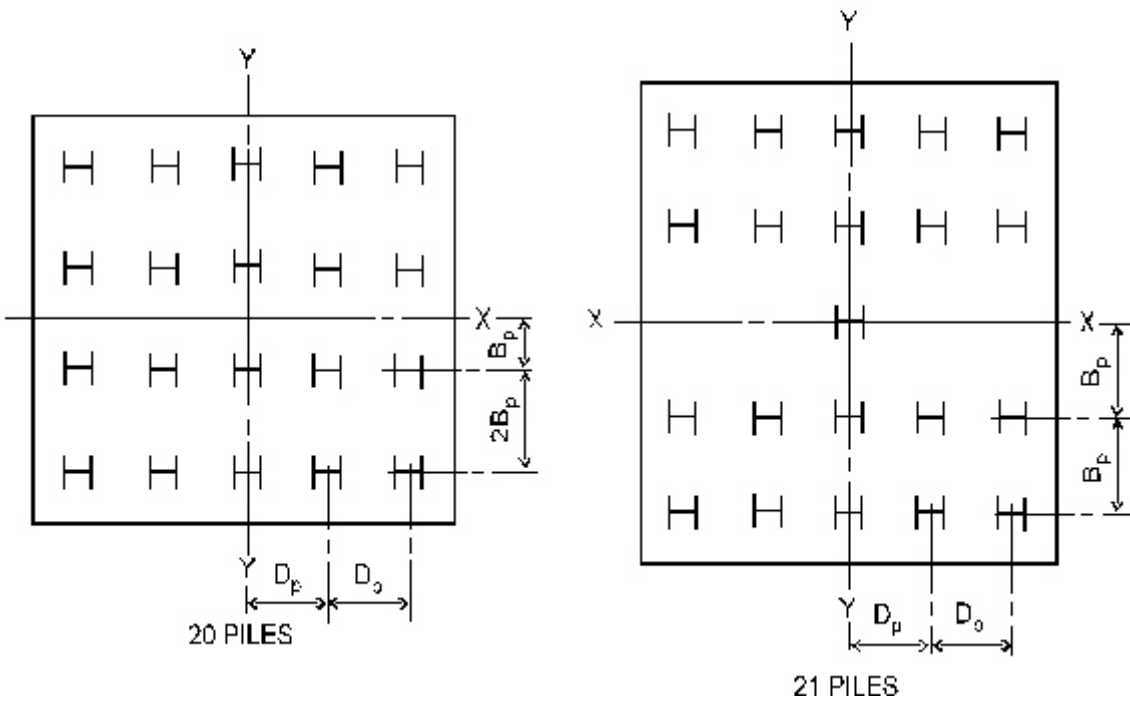
FIGURES



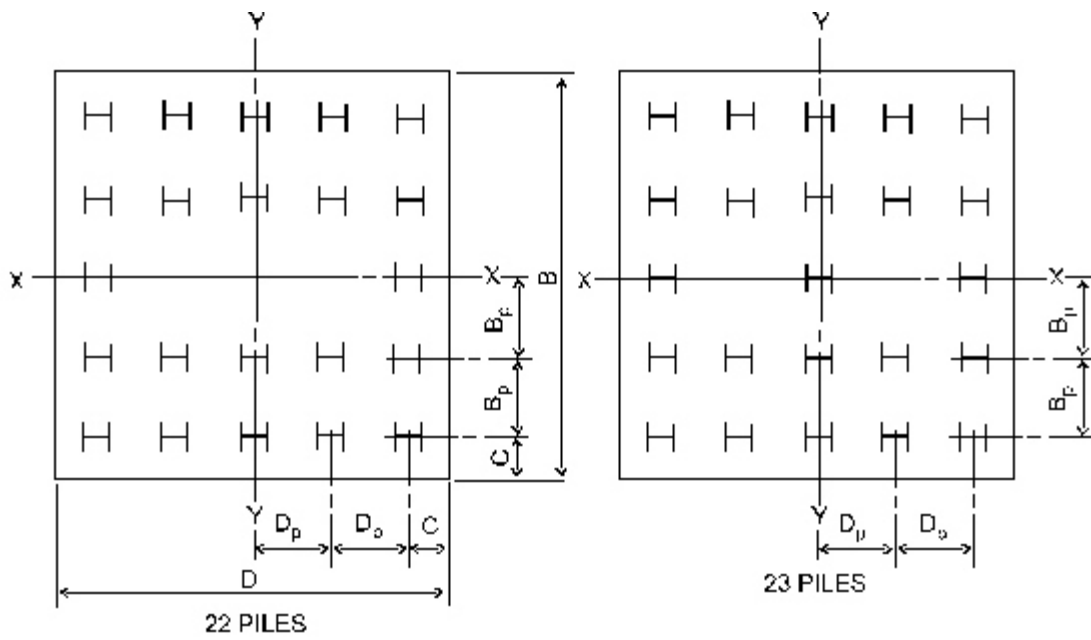
FIGURES



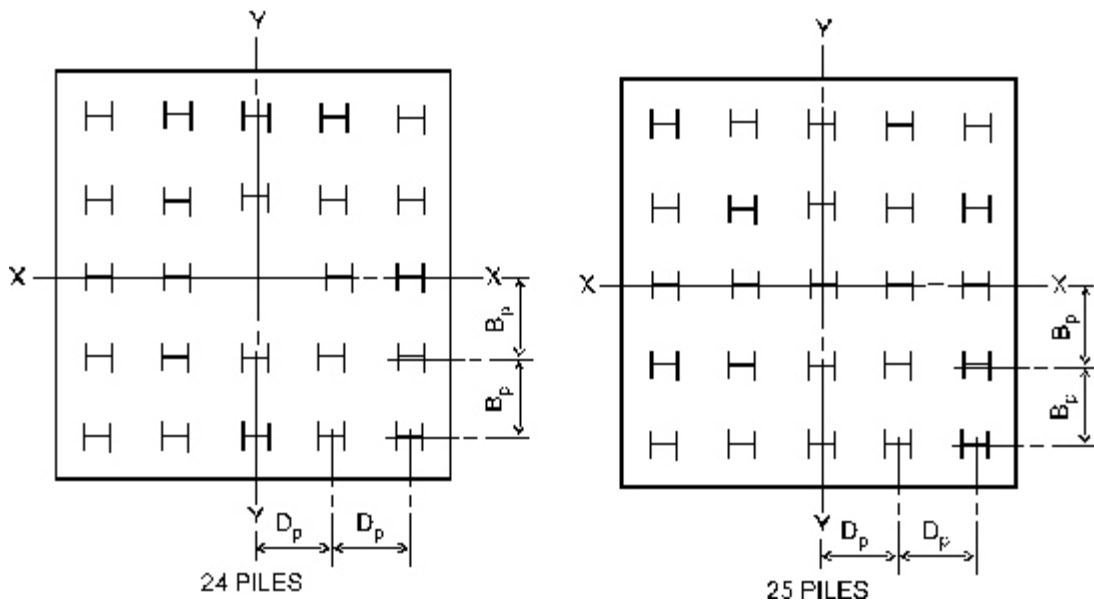
$C = \text{Edge Distance}$



FIGURES



C = Edge Distance



NOTES

Spacing Increments in feet for pile configurations and factors for minimum spacing and maximum spacing:

Number of piles	Delta Bp	Delta Dp	BMCF	DMCF
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.125	0.125	0.5	0.5
5	0.125	0.125	0.7	0.7
6	0.125	0.25	0.5	1.0
7	0.25	0.25	1.0	1.0
8	0.25	0.25	1.0	1.0
9	0.25	0.25	1.0	1.0
10	0.25	0.25	1.0	0.5
11	0.25	0.25	1.0	0.5
12	0.25	0.125	1.0	0.5
13	0.125	0.125	0.7	0.7
14	0.125	0.125	0.5	0.5
15	0.25	0.25	1.0	1.0
16	0.125	0.125	0.5	0.5
17	0.125	0.125	0.7	0.7
18	0.25	0.125	1.0	0.5
19	0.25	0.125	1.0	0.5
20	0.25	0.125	1.0	0.5
21	0.25	0.125	1.0	1.0
22	0.25	0.25	1.0	1.0
23	0.25	0.25	1.0	1.0
24	0.25	0.25	1.0	1.0
25	0.25	0.25	1.0	1.0

Design Option Notes:

The minimum and maximum pile spacing for a given number of piles, NP, are determined by the equations:

For spacing parallel to the y axis:

$$\text{Min. Pile Spacing} = \text{BMCF (NP)} \times \text{PSPMIN}$$

$$\text{Max. Pile Spacing} = \text{BMCF (NP)} \times \text{PSPMAX}$$

For spacing parallel to the x axis:

$$\text{Min. Pile Spacing} = \text{DMCF (NP)} \times \text{PSPMIN}$$

$$\text{Max. Pile Spacing} = \text{DMCF (NP)} \times \text{PSPMAX}$$

PSPMIN and PSPMAX are the minimum and maximum pile spacing input on the PILE-DESIGN command. The Min. Pile Spacing is the starting point for the design cycles. If the maximum pile spacing is exceeded and the load on a pile exceeds the allowable load (Pile Capacity input on the PILE-DESIGN command), then the number of piles is incremented by one.

Comments on increment control on the PILE-DESIGN command: To understand this option, look at the pile configuration for 15 piles shown on page 12.12. This arrangement as shown would typically be used to support a column when moments about the x-x axis are higher than moments about the y-y axis. If the designer wants to use this configuration for a case where Myy is considerably higher than Mxx, the designer may code the increment control as a 2 and the actions and axes are reversed.

750	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	PILE-DESIGN	PLD
PURPOSE	This command defines the controls on the design of the pile footing size. This command is required for the Problem Type D for a Pile Cap, see FOOTING command.	
6 COMMAND PARAMETERS		
PSPMIN	Enter the minimum pile spacing, in feet.	
PSPMAX	Enter the maximum pile spacing, in feet.	
ΔT	Enter the amount by which the footing thickness is to be incremented during the design process, in feet.	
Pile Capacity	Enter the allowable load on a pile, in kips.	
Uplift Capacity	Enter the allowable uplift capacity of a pile, in kips. This value must be input as a negative number.	
Increment Control	<p>This parameter controls the placement of the piles during the design process. If coded:</p> <ul style="list-style-type: none"> 0 = The pile spacing will be incremented based on moments about each axis. 1 = The pile spacing will be incremented in both directions, at the same time. 2 = The pile arrangement will be rotated 90 degrees. 3 = Produces a pattern where the corner piles are each equidistant from the center. 	

EXAMPLE

For a design of a pile cap, minimum pile spacing = 2 ft., maximum pile spacing = 10 ft., $\Delta T = 3$ in., pile capacity = 200 kips., uplift capacity = - 10 kips. and pile spacing will be incremented equally in each direction, code:

PLD 2, 10, 0.25, 200, -10, 1

FIGURES**NOTES**

For best results, let the program design the number of piles. To do this, always enter 4 as the minimum number of piles. In some cases, the design will not be logical for the loading conditions and column size. In this case, try using option 2 for Increment Control (6th parameter). An illogical design may occur as the design process makes some assumptions that may not work for the loads involved.

For design, the minimum pile spacing will be used and incremented as shown on page 12.15.

760	BRASS-PIER™	COMMAND DESCRIPTION
COMMAND NAME	COLUMN-DATA	CDM
PURPOSE	This command defines the dimensions and properties of the column supported by the footing.	
6 COMMAND PARAMETERS		
Shape	<p>This parameter specifies the shape of the column, see Figure 1. If coded:</p> <p style="margin-left: 40px;">1 = Round column 2 = Column with rounded ends 3 = Rectangular column</p> <p>See Notes.</p>	
Type Default = 1	<p>This parameter specifies the column type. If coded:</p> <p style="margin-left: 40px;">1 = Concrete column 2 = Masonry wall 3 = Column on a metal base</p>	
Width, CW	Enter the column width (dimension parallel to the x-x axis), in feet, see Figure 2 and Notes.	
Length, CL	Enter the column length (dimension parallel to the y-y axis), in feet, see Figure 2 and Notes. If the column is round, leave this parameter blank.	
Bar Size	Enter the bar size of the longitudinal reinforcement in the column.	
Soil Height, C	Enter the distance from the ground surface to the top of the footing, in feet, see Figure 2 and Notes.	

EXAMPLE

For a rectangular column (see Figure 1) default (blank) = 1 for concrete, width (CW) = 3 ft., length (CL) = 7 ft., #8 bars in column, and cover on top of footing = 5 ft., code:

CDM 3, , 3, 7, 8, 5

FIGURES

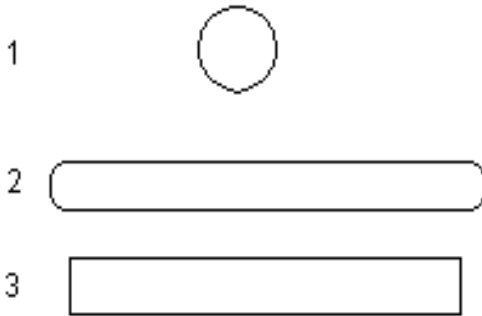


Figure 1 - Column Shapes

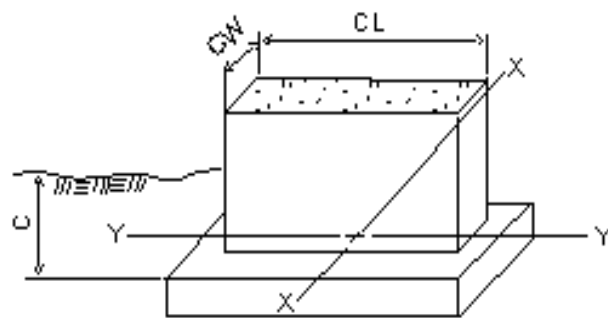


Figure 2 - Column Dimensions

NOTES

When the FOOTING command is preceded in the command set by a COLUMN-DIM command, the defaults will be as follows:

Default for Shape = 1 for circular column
2 for rectangular column

Default for Width (CW) = COLDPT
Default for Length (CL) = COLWDT
Default for C = DTF

See page 8.12.

770	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	MATERIALS		MTR
PURPOSE	This command defines the properties of the concrete and reinforcement, and the unit weight of the soil.		
9 COMMAND PARAMETERS			
f' _c Default = 3.25 ksi	Enter the compressive strength of the concrete in kips per square inch.		
f _y Default = 60 ksi	Enter the yield strength of the reinforcement, in kips per square inch.		
E _c Default = AASHTO 8.7.1	Enter the modulus of elasticity of the concrete, in kips per square inch.		
f _c Default = .4 x f' _c	For service load design/analysis of the reinforcement, enter the allowable concrete stress, in kips per square inch.		
f _s Default = .4 x f _y	For service load design/analysis of the reinforcement, enter the allowable stress in the reinforcement, in kips per square inch.		
Soil Weight Default = 0.120 kips/ft ³	Enter the unit weight of the soil, in kips per cubic foot.		
Ø _V Default = 0.85	Enter the strength reduction factor for concrete shear.		
Ø _M Default = 0.90	Enter the strength reduction factor for concrete flexure.		
WT _C Default = 0.15 kips/ft ³	Enter the weight of concrete in kips per cubic foot.		

EXAMPLE

For concrete properties, $f'_c = 3$ ksi., f_y - default = 60 ksi., $E_c = 3250$ ksi., $f_c = 1.5$ ksi., f_s - default = 24 ksi., and unit weight of soil = 0.110 kips/cu. ft., code:

MTR 3, , 3250, 1.5, , 0.110

FIGURES**NOTES**

780	BRASS-PIER™	COMMAND DESCRIPTION						
COMMAND NAME	REINFORCEMENT							
PURPOSE	RNF							
	<p>This command defines the limits on the bar sizes to be considered in a design or the size and spacing of bars for an investigation. This command is required.</p> <p>NOTE: Use 6 command parameters for Option A or 6 command parameters for Option B.</p>							
6 COMMAND PARAMETERS								
Bar Size Lower Limit Default = 4	A. <u>Design</u> See Note 1. Enter the minimum bar size to be considered.							
Bar Size Upper Limit Default = 11	Enter the maximum bar size to be considered.							
Cover Bottom Default = 15 in. For pile footings = 3 in. for spread footings	Enter the clear distance, in inches, from the bottom of the footing to the bottom layer of reinforcement in the footing. See Note 3.							
Maximum Bar Spacing Default = 18 inches	Enter the maximum bar spacing, in inches, to be used in both the x and y direction.							
Minimum Bar Spacing Default = The diameter of the bar number being considered in the design iteration.	Enter the minimum bar spacing, in inches, to be used in both the x and y direction.							
Bar size for Effective Shear Depth Default = Bar Size Upper Limit	Enter the bar size to be used to determine the effective depth for shear for footing thickness design. See Note 2.							
Bar Direction	B. <u>Investigation</u> Enter a code to specify the direction of reinforcement in the mat. <table border="0" style="width: 100%;"> <tr> <td style="text-align: left;"><u>Code</u></td> <td style="text-align: left;"><u>Location</u></td> </tr> <tr> <td style="padding-left: 20px;">0</td> <td>Top rebar of mat parallel to x-x axis</td> </tr> <tr> <td style="padding-left: 20px;">1</td> <td>Top rebar of mat parallel to y-y axis.</td> </tr> </table>		<u>Code</u>	<u>Location</u>	0	Top rebar of mat parallel to x-x axis	1	Top rebar of mat parallel to y-y axis.
<u>Code</u>	<u>Location</u>							
0	Top rebar of mat parallel to x-x axis							
1	Top rebar of mat parallel to y-y axis.							
Bar Size (Continued)	Enter the size of the bars placed parallel to the y-y axis.							

COMMAND PARAMETERS (Cont.)

Spacing	Enter the spacing of the bars placed parallel to the y-y axis, in inches.
Bar Size	Enter the size of the bars placed parallel the x-x axis.
Spacing	Enter the spacing of the bars placed parallel to the x-x axis, in inches.
Cover Bottom Default = 15 inches for pile footings = 3 inches for spread footings	Enter the clear distance, in inches, from the bottom of the footing to the bottom layer of reinforcement being defined. See Note 3.

EXAMPLE

Design

For bar size selection, minimum bar size = #6, maximum bar size = #9, and cover - bottom layer = 2.5 in., code:

RNF 6, 9, 2.5

Investigation

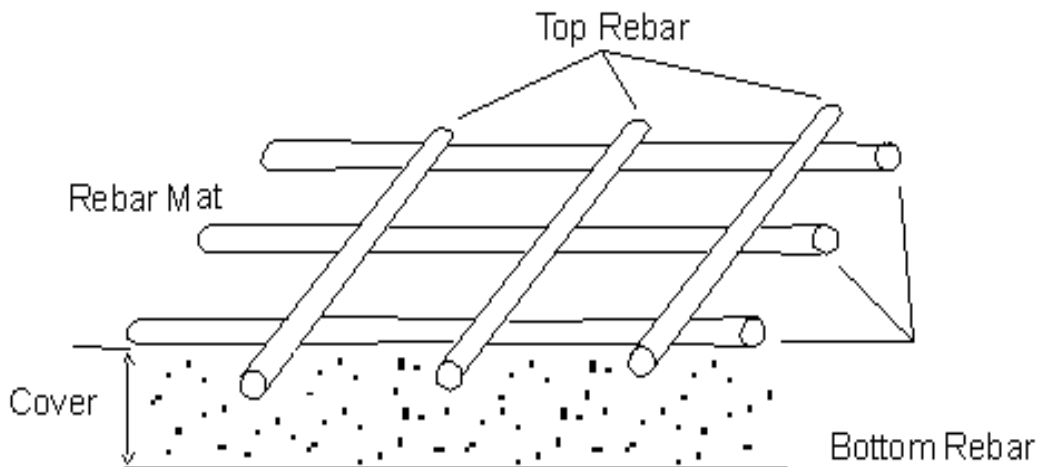
For bar size selection, bottom layer #6 bars @ 6" spacing, bars parallel to the y-y axis, top #5 bars @ 12" spacing parallel to x-x axis, and cover - bottom layer - default = 3 in., code:

RNF 0, 6, 6, 5, 12

For bar size selection, top layer #4 bars @ 12" spacing bars parallel to y-y axis., bottom #4 bars @ 12" spacing parallel to x-x axis., and cover - top layer - default - 2 in., code:

RNF 2, 4, 12, 4, 12

FIGURES



NOTES

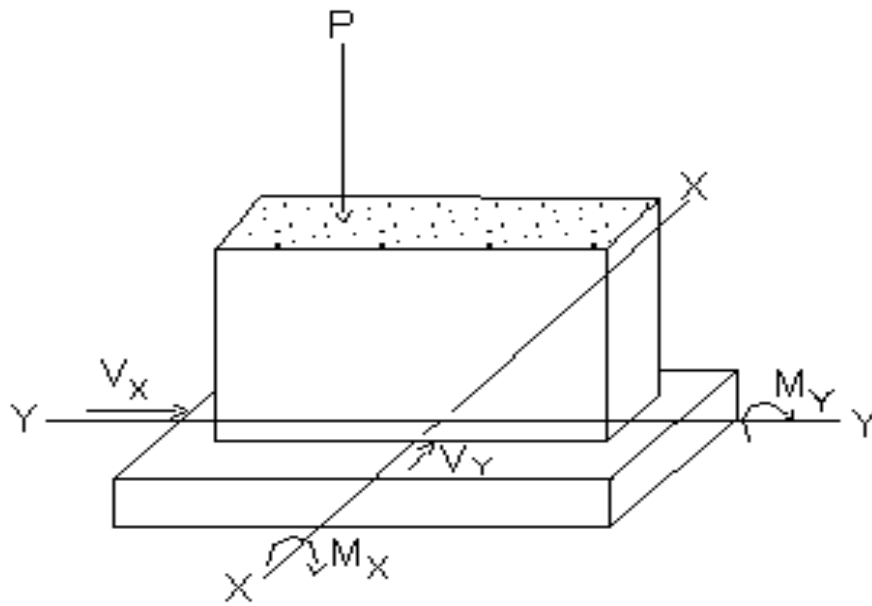
1. The design option will place the reinforcing steel required to resist the maximum of the transverse or longitudinal moment in the bottom row of steel.
2. The program will design the footing depth to carry shear loads based on an effective depth calculated using the bar size input. If the bar size selected by the program to carry moment is larger than the bar size used for shear capacity calculation, the section could be undersigned for shear.
3. For a pile footing, the cover is measured from the bottom of the footing, not from the top of the piles.

790	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	FOOTING-SERVICE		FSV
PURPOSE	<p>This command defines combined service loads to be applied to the footing. This command may be repeated as needed to define up to 25 load cases.</p> <p>When this command is used it must be followed by the FOOTING-ULTIM command for each load case.</p> <p>DO NOT USE THIS COMMAND IF THE FOOTING COMMAND IS PRECEDED IN THE COMMAND SET BY THE PIER COMMAND.</p>		
5 COMMAND PARAMETERS			
P	Enter the axial load, in kips.		
M_x	Enter the moment about the x-x axis, in foot-kips.		
V_x	Enter the shear at the top of the footing that is applied with the moment about the x-x axis, in kips.		
M_y	Enter the moment about the y-y axis, in foot kips.		
V_y	Enter the shear at the top of the footing that is applied with the moment about the y-y axis, in kips.		

EXAMPLE

For service loads: $P = 108.6$ kips., $M_x = 209.7$ ft-kips., $V_x = 10.5$ kips., $M_y = 156.1$ ft-kips., and $V_y = 9.85$ kips, code:

FSV 108.6, 209.7, 10.5, 156.1, 9.85

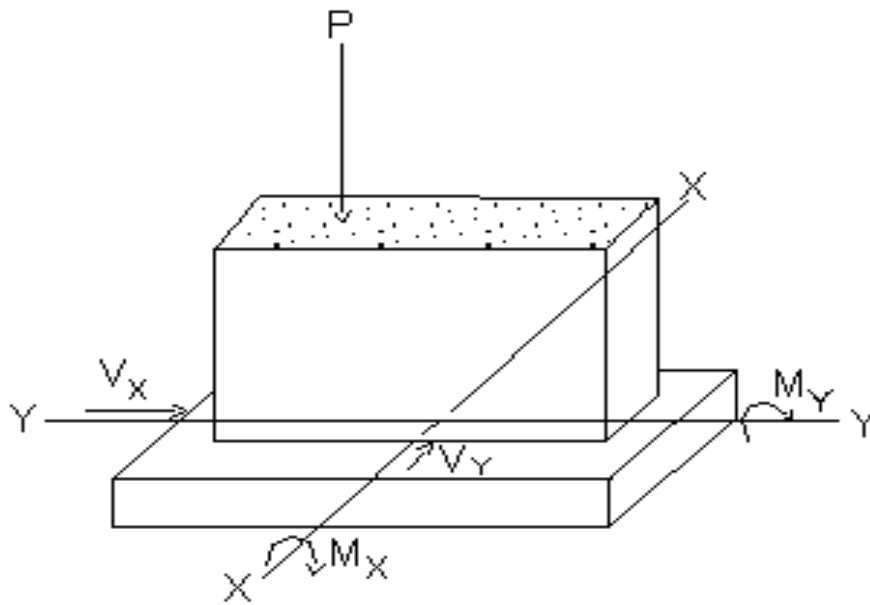
FIGURES**NOTES**

800	BRASS-PIER™	COMMAND DESCRIPTION	
COMMAND NAME	FOOTING-ULTIM		FUL
PURPOSE	<p>This command defines combined ultimate loads to be applied to the footing. This command may be repeated as needed to defined up to 25 load cases.</p> <p>DO NOT USE THIS COMMAND IF THE FOOTING COMMAND IS PRECEDED IN THE COMMAND SET BY THE PIER COMMAND.</p>		
5 COMMAND PARAMETERS			
P	Enter the factored axial load, in kips.		
M _x	Enter the factored moment about the x-x axis, in foot-kips.		
V _x	Enter the factored shear at the top of the footing that is applied with the moment about the x-x axis, in kips.		
M _y	Enter the factored moment about the y-y axis, in foot-kips.		
V _y	Enter the factored shear at the top of the footing that is applied with the moment about the y-y axis, in kips.		

EXAMPLE

For ultimate footing loads: $P = 50.12$ kips., $M_x = 207.6$ ft-kips., $V_x = 21.35$ kips., $M_y = 512.7$ ft-kips., and $V_y = 22.25$ kips., code:

FUL 50.12, 207.6, 21.35, 512.7, 22.25

FIGURES**NOTES**

DESCRIPTION OF OUTPUT

The Footing Design Loads will contain seven maximum load cases used in footing analysis/design process. These seven load cases produce:

1. The maximum soil stress or pile reaction (MAX.P1).
2. The maximum transverse moment in the footing (MAX.MT).
3. The maximum transverse beam shear in the footing (MAX.VT).
4. The maximum peripheral shear in the footing (MAX.VP).
5. The maximum longitudinal moment in the footing (MAX.ML).
6. The maximum longitudinal beam shear in the footing (MAX.VL).
7. The maximum soil or pile uplift (MAX.P3).

The soil uplift has no structural meaning since the soil has no tension capacity, but it does give an indication that reinforcement steel may be needed in the top of the footing. The load effect of MAX.P1 and MAX.P3 will be Service Loads. The load effects for the other five load cases will be Service Load or Factored Loads depending on the design option.

For each of the seven load cases, 19 items will be printed. These items are:

1. FG.
The footing (F) which has the imposed loads (used with same designs) and the Group number (G) of the load case is given in these columns.
2. LLID.
The live load case identification for the load case is given in this column. For Groups 2 and 5 this column will be blank.
3. WC.
The wind case in the form I.J. will be given in this column. I is the wind direction and J is the combination number. An R will appear after the wind case if it is reversed.
4. ES.
A E or S in this column indicates Expansion or Shrinkage is included in this load case. Otherwise, this column is blank.
5. C.
A C in this column indicates centrifugal force is included in the load case. If not, the column is left blank.
6. S.
An S in this column indicates stream flow effects are included in the load case.
7. P (kips).
This column contains the axial load on the footing from the column. The soil weight or footing weight is not included. Impact has been removed if given in the input.
8. MT (kip-feet).
MT is the moment, M_{y-y} at the top of the footing about the y-y axis with live load impact removed if given in the input.

9. VT (kips).
VT is the horizontal shear at the top of the footing parallel to the x-x axis with live load impact removed if given in the input.
10. ML (kip-feet).
ML is the moment, M_{x-x} at the top of the footing about the x-x axis with live load impact removed if given in the input.
11. VL (kips).
VL is the horizontal shear at the top of the footing parallel to the y-y axis with live load impact removed if given in the input.
12. P4 (kips or kips/sq. ft.).
P4 is the corner soil pressure or pile reaction where M_{y-y} causes tension and M_{x-x} causes compression.
13. P3 (kips or kips/sq. ft.).
P3 is the corner soil pressure or pile reaction where M_{y-y} and M_{x-x} cause tension.
14. P2 (kips or kips/sq. ft.).
P2 is the corner soil pressure or pile reaction where M_{x-x} causes tension and M_{y-y} causes compression.
15. P1 (kips or kips/sq. ft.).
P1 is the corner soil pressure or pile reaction where M_{y-y} and M_{x-x} cause compression.
NOTE: The P1, P2, P3, and P4 values contain the weight of the soil and footing.
16. MTF (kips-feet/foot).
MTF is the moment in the footing at the face of the column parallel to the y-y axis per foot of footing width.
17. MLF is the moment in the footing at the face of the column parallel to the x-x axis per foot of footing width.
18. VBF (kips/foot).
VBF is the beam shear in the footing in the transverse or longitudinal direction at the critical section (d from the face of the column) per foot of footing width.
19. VPF (kips/foot).
VPF is the peripheral shear in the footing at the critical section (d/2 from the face of the column) per foot of peripheral length.

NOTE: The weight of the soil and footing are considered when computing MTF, VBF, and VPF.
20. LOAD.
This column contains the identification of the maximum load case, i.e., Maximum P1, moment shear, etc.

The footing analysis/design results will consist of the footing size, bar reinforcement steel, and section capabilities.

1. L (feet).
L is the footing length parallel to the y-y axis. In a design problem this is the required length.
2. W (feet).
W is the footing width parallel to the x-x axis. In a design problem this is the required width.
3. T (feet).
T is the thickness of the footing. In a design problem this is the required thickness.
4. P1/PA.
P1/PA is the ratio of the maximum corner soil pressure (or pile reaction) to the allowable soil stress (or pile capacity) under the design option. Under the investigation option, P1/PA is shown as zero.
5. AS. (sq. in.).
AS is the required area of reinforcement steel per square foot.
6. NO.
The total number of rebar is given in this column.
7. SIZE.
The standard bar designation of the selected bar is given in this column.
8. SPAC (inches).
The rebar spacing is given in this column.
9. REBAR DIRECTION.
This column indicates the direction and placement of the rebars.
10. MT (kip-feet/foot).
MT is the moment capacity of the footing per foot of width considering the footing thickness and area of steel.
11. VB (kips/foot).
VB is the beam shear capacity of the footing per foot width considering the footing thickness and steel placement.
12. VP (kips/foot).
VP is the peripheral shear capacity of the footing per foot width considering the footing thickness and steel placement.
13. DS (inches).
DS is the distance from the top of the footing to the centroid of the rebars.
14. FC (kips/sq. in.).
FC is the concrete stress under the Service Load option. Under the Load Factor Option, FC is shown as zero.
15. Number of Piles, B_p and D_p (feet).
If the footing has piles, the number of piles and pile placement data will be given on the next line of output. Refer to the pile placement layouts on pages 12.10 through 12.14.

