DOCUMENTATION OF COMPUTER PROGRAM PACKAGE

FOR STRUCTURE / PILE / SOIL

INTERACTION ANALYSIS

Program: SPLICE

Report: MAINTENANCE MANUAL

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Report 8407 - 3

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DOCUMENTATION OF COMPUTER PROGRAM PACKAGE FOR STRUCTURE/PILE/SOIL INTERACTION ANALYSIS

The present report contains the Maintenance Manual for program SPLICE.

The SPLICE package consists of the following independent computer programs :

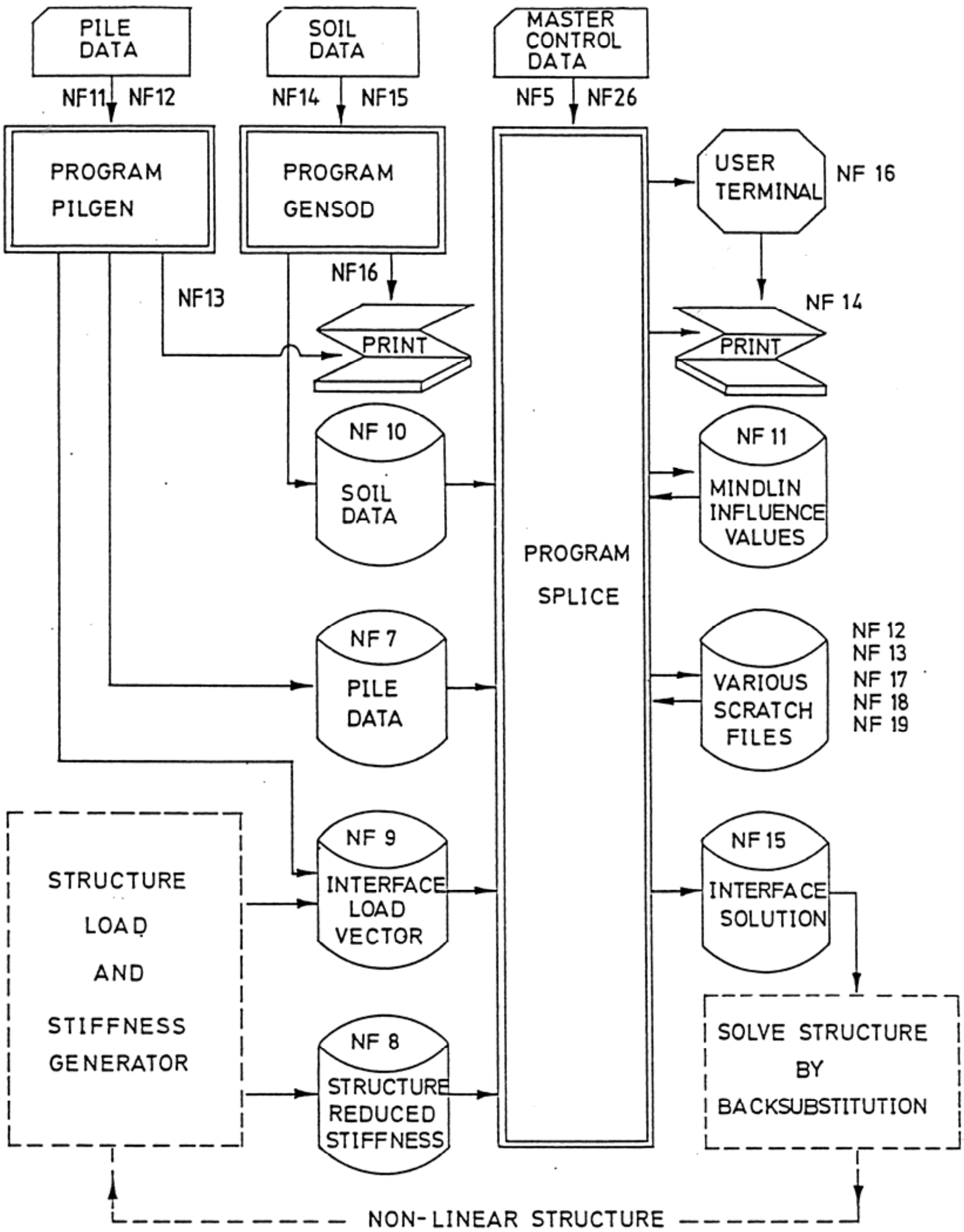
- SPLICE : Solves combined structure/pile/soil system
- GENSOD : Generates soil data needed by SPLICE
- PILGEN : Generates pile data needed by SPLICE

The documentation of the package has been presented in the following reports :

Program	SPLICE	GENSOD	PILGEN
General Description	SPL-GD	GEN-GD	
User's Manual	SPL-UM	GEN-UM	PIL-UM
Maintenance Manual	**SPL-MM**	GEN-MM	
Engineering Documentation	SPL-ED	GEN-ED	

Test examples with complete input/output files have been presented in report SGP-EX.

Program SPLICE was developed as a joint project between Aker Engineering A/S and the Norwegian Geotechnical Institute, with support from the Royal Norwegian Council for Scientific and Industrial Research (NTNF) and Det norske Veritas. Mr. Carl J. Frimann Clausen acted as a consultant to the project group. His report 9302-1 presents the results from a program verification study.



STRUCTURE/PILE/SOIL INTERACTION ANALYSIS
COMPUTER PROGRAM PACKAGE DATA FLOW

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1.0 INTRODUCTION

The present report is part of the documentation of a package of computer programs developed in order to analyze the interaction between a linear superstructure and its non-linear piled foundation system for static loading conditions. The package consists of a soil data generator (GENSOD), a pile data generator (PILGEN) and the program solving the combined structure/pile/soil system (SPLICE).

This report, SPL-MM, presents the maintenance manual for program SPLICE. The report contains information that may be needed for future program corrections and modifications. If the user needs an explanation of the methods used, and the assumptions made for the various calculations, the engineering documentation report SPL-ED should be consulted.

2.0 GENERAL SYSTEM DESCRIPTION

Data flow within the computer program package has been shown on page 0.2. The generator programs GENSOD and PILGEN form a number of data files (NF7, NF8, NF9, NF10) that are input to program SPLICE.

Program SPLICE solves the non-linear problem of structure/pile/soil interaction, and generates a number of output data files (NF11, NF14, NF15, NF16). During the data processing a number of scratch files may be needed (NF12, NF13, NF17,NF18, NF19, NF26).

A detailed description of the contents of the various files has been given or referenced to in Section 4.0, Data File Description.

File opening is carried out at the start of subroutine SPLIC1 at the beginning of program SPLICE.

The present program SPLICE version operates in double precision (8 bytes in each floating point variable).

3.0 GENERAL PROGRAM DESCRIPTION

SPLICE is written in FORTRAN-77 and contains approximately 9500 statements including comments. The program consists of a number of subroutines that use the same common area.

The main program that initiates program execution, is simply:

```
PROGRAM SPLICE
CALL SPLIC1
STOP
END
```

Normal run termination, including identified error conditions, is always through subroutine MSGTIM that terminates by a STOP statement. The present version of SPLICE is intended for use via a satellite user terminal or a PC, see Chapter 4.10 for modifications if program is used in batch mode.

SPLICE calls a few system dependant subroutines related to date, real time and computer time. These calls are done from subroutine MSGTIM, and the call statements may need to be modified if the program is installed on new machines.

The SPLICE common block area has been described in Appendix A. The approximate required size in primary storage for the 32-pile version is:

INTEGER*4	1,200 values
REAL*8	42,500 values

In addition, primary storage must allow local non-dimensioned subroutine variables, format statements and program instructions.

SPLICE uses an out-of-core equation solver based on a Cholesky direct elimination algorithm.

The present program version uses FORTRAN read/write statements for the binary scratch files. These operations are carried out through calls to subroutine SPEED. Experience from earlier SPLICE versions showed that very considerable reduction in required computer time could be obtained by replacing the FORTRAN read/write statements in subroutine SPEED by machine dependent I/O routines.

4.0 DATA FILES DESCRIPTION

SPLICE needs various data files in order to analyze a given problem. They have been indicated on page 0.2. All these files may not be needed within the same run, this is governed by the master control input data.

The following pages present a summary of the different files, with a description of contents and size requirements.

The numerical values of file unit numbers, and the names of the files connected to these units, are as follows:

UNIT	NAME
NF5 = 25	SPLICE.INP
NF7 = 7	PILE.07
NF8 = 8	STRUCT.08
NF9 = 9	LOAD.09
NF10 = 10	SOIL.10
NF11 = 11	MINDL.11
NF12 = 12	SCRATCH.12
NF13 = 13	SCRATCH.13
NF14 = 14	SPLICE.RES
NF15 = 15	INTERF.15
NF16 = 6	Standard output device (users's screen)
NF17 = 17	RESTART.17
NF18 = 18	SCRATCH.18
NF19 = 19	SCRATCH.19
NF26 = 26	SPLICE.TMP

Connection between units and files are established by OPEN statements at the start of subroutine SPLIC1.

In order to reduce the number of I/O files needed to be open at the same time, files are closed after the data needed has been read.

4.1 Master Control Data File, NF5 and NF26

File name : NF5, SPLICE.INP
NF26, SPLICE.TMP

The reader should consult report SPL-UM, Section 3.0, for a complete description of the content of this file.

The user prepares file NF5 (SPLICE.INP). This file is read, and a new file NF26 is generated, which is identical to NF5 except for possible comment lines that may be present in file NF5.

4.2 Pile Data File, NF7

File name : PILE.07

File size is given by:

CHARACTER*80	1
INTEGER*4	$2 + 3 \cdot NP + NP \cdot NN$
REAL*8	$15 \cdot NC + 24 \cdot NP \cdot NN - 3 \cdot NP$

where NP is number of piles, NN number of nodes on each pile and NC is number of different cross sections.

The reader should consult report PIL-UM, Chapter 4.2, for a complete description of the content of this file.

The file is generated by program PILGEN.

4.3 Structure Reduced Stiffness Matrix File, NF8

File name : STRUCT.08

This file contains the reduced (condensed) stiffness matrix for the superstructure, if the presence of a superstructure (for example a jacket) was specified.

The file is generated by some program outside the present package, see page 0.2.

The stiffness values are the forces and moments acting upon the superstructure at the fixed support points, when these points are given unit displacements, one freedom at the time.

SPLICE requires that file NF8 has been generated by the following sequence of statements:

```
      CHARACTER*80 TEXT
      DIMENSION NUMHED(32),A(6,192),XYZ(3,32)
      .........
      REWIND NF8
      WRITE(NF8) TEXT,NUMCON
      DO 100 N=1,NUMCON
  100 WRITE(NF8) NUMHED(N),(XYZ(I,N),I=1,3)
      DO 300 N=1,NUMCON
      DO 200 J=1,N
      ..........
      J2=6*J
      J1=J2-5
  200 WRITE(NF8) ((A(I,K),I=1,6),K=J1,J2)
  300 CONTINUE
      REWIND NF8
```

In the above statements the values have the following meaning:

TEXT: Stiffness file label line. Printed by SPLICE for identification purposes.

NUMHED: Pile head numbering sequence corresponding to the sequence in which the superstructure stiffness values are given:
NUMHED(1)=Pile head number connected to superstructure support point 1.
NUMHED(2)=Pile head number connected to superstructure support point 2.
......

A: Superstructure stiffness matrix partition. Each partition contains 6 rows of the matrix. Only the lower triangular half, including the full 6 by 6 submatrix on the leading diagonal, is stored.

NF8: FORTRAN unit number, stiffness matrix file.

NUMCON: Number of structure/pile interface points.

XYZ: Coordinates for the superstructure support points.

The size of the file is (J = NUMCON = Number of jacket support points) :

CHARACTER*80	1
INTEGER*4	1 + J
REAL*8	$3\cdot J + 36\cdot J\cdot(J + 1)/2 = 21\cdot J + 18\cdot J^2$

4.4 Interface Load Vector File, NF9

File name : LOAD.09

The reader should consult report PIL-UM, Chapter 4.3, for a complete description of the content of this file.

The file is generated either by a structure load generator outside the package described in this report, or the file may be generated by program PILGEN, see page 0.2.

Several load vectors may be analyzed in the same run. The user is free to specify if a vector shall have zero as starting point, or the conditions after last analyzed load vector.

The size of the file is (NP = Number of piles, NV = Number of vectors) :

CHARACTER*80	NV
INTEGER*4	NV·(1 + NP)
REAL*8	NV·6·NP

In case of several load vectors in the same run, the vectors follow after each other in the order to be processed. A new label line is read for each vector. See report PIL-UM, Section 4.3.

4.5 Soil Data File, NF10

File name : SOIL.10

The reader should consult report GEN-MM, Section 3.2, for a complete description of the content of this file.

The file is generated by the soil data generator program GENSOD.

The size of this file is given by (N = Number of soil layers):

CHARACTER*80	1
INTEGER*4	2 + 33·N
REAL*8	8 + 599·N (+ 125 in case soil displacements are given)

4.6 Mindlin Interaction Values File, NF11

This file contains the Mindlin interaction values for the different piles and nodes. These values are used to compute pile/soil/pile interaction effects, also referred to as pile group effects, and soil displacements due to specified single point forces.

The values are computed in subroutine MINDL1 in SPLICE, and then stored on file NF11. The user is free to include these interaction effects, or to leave them out. Reference is made to report SPL-UM, Section 3.2. The reader should consult report SPL-ED for theory and justification.

The file is binary and is generated by the following sequence of FORTRAN statements (the actual I/O is done through subroutine SPEED):

```
      DIMENSION IPNT(500),VALINF(3,3,500)
      .......
      REWIND NF11
      DO 900 NP = 1,NPH
      DO 800 ND = 1,MAX
      IF (NUMELP(NP).EQ.0) GO TO 900
      .......
      WRITE(NF11) NP,ND,NUMINF
      IF (NUMINF.EQ.0) GO TO 800
C     WRITE(NF11) (IPNT(J), J=1, NUMINF)
C     WRITE(NF11) (((VALINF(J,K,L),J=1,3),K=1,3),L=1,NUMINF)
      CALL SPEED (.......)
  800 CONTINUE
  900 CONTINUE
```

The above values have the following meaning:

NUMINF: Number of pile elements and single point forces that interact with node ND located at pile NP. This number is computed for each node based on given pile geometry, specified type of interaction (INTER) and interaction distance (DISTIN).

IPNT(NE): Pointer for node ND to element and pile numbers (1 to NE) that interact. For example, if the second element interacting with a node is located on pile 5, and has element number 4, then:

$$IPNT(2) = 100 \cdot 5 + 4 = 504$$

VALINF(3,3,NE): Mindlin interaction values, i.e., displacements {DSP} in global x, y, z directions of a point at location ND due to unit forces {FRC} in global x, y, z directions at location NE :

$$\{DSP\} = [VALINF] \cdot \{FRC\}$$

The size of this file is given by (NP = Number of piles, ND = Number of nodes on each pile, NE = Number of elements interacting with each node) :

INTEGER*4	NP·ND·(1 + NE)
REAL*8	9·NP·ND·NE

4.7 Pile Data Storage Files, NF12 and NF13

These two files are in principle identical, and contain data related to each individual pile stored in common block/PILPRP/, see Appendix A.

One of the files will always contain the latest updated values, this file is within the program referred to as NFIN, since values for next pile to be processed shall be read from this file. After pile processing is done, the new updated values are stored on the other file, referred to as NFOUT.

The files are created in subroutine CRNF12 during program SPLICE initiation. Both files are written here, even if only one is needed, in order to ensure that sufficient disk space is available before further processing is done.

The change between use as read and write files is illustrated below:

```
      NFIN=NF12
      NFOUT=NF13
      DO 100 NP=1,NPH
      READ(NFIN) BUFFER
      ...
      WRITE(NFOUT) BUFFER
  100 CONTINUE
      I=NFIN
      NFIN=NFOUT
      NFOUT=I
      DO 200 NP=1,NPH
      READ(NFIN) BUFFER
      .........
      .........
```

The files are binary and they are generated by the following sequence of FORTRAN statements:

```
      COMMON /PILPRP/ MATND(51),...,D(50),....
      DIMENSION IBUFF(152),BUFF(4822)
      EQUIVALENCE (IBUFF(1),MATND(1)),(BUFF(1),D(1))
      ....
      REWIND NF12
      DO 100 NP=1,NPH
      IF (NUMELP(NP).EQ.0) GO TO 100
      ....
C     WRITE(NF12) IBUFF,BUFF
      CALL SPEED(....,IBUFF,BUFF,...)
 100  CONTINUE
```

It should be noted that common block /PILPRP/ contains both integer and real values. The meaning of the different values in /PILPRP/ is given in Appendix A. The actual reading/writing is carried out by subroutine SPEED.

The size requirements for each of the files NF12 and NF13 are (NP = Number of piles):

INTEGER*4	152·NP
REAL*8	4822·NP

4.8 Print File, NF14

This file is generated by program SPLICE as processing proceeds. The file is formatted for output on a minimum 129 character line printer.

A description of file content is given in report SPL-UM, Chapter 4.1.

4.9 Interface Solution/Pile Solutions, NF15

This file may be used to store the structure/pile interface solution (resulting displacements and forces at all pile heads) and/or the complete pile solutions after a load increment.

The file is generated in subroutine PRT6 if requested by the user. The complete pile solutions part is identical to files NF12 and NF13, Chapter 4.7.

The file is generated by the following sequence of FORTRAN statements in subroutine PRT6 :

```
      DIMENSION DSPHDR(32,6),FRCHDR(32,6)
      CHARACTER*80 TEXTL
      DO 300 NV=1,NUMVEC
      IF (NV.EQ.1) REWIND NF15
      ......
      DO 200 INC=1,NUMINC
      WRITE(NF15) TEXTL,NV,INC
      ......
      DO 50 NP=1,NPH
   50 WRITE(NF15) (DSPHDR(NP,I),FRCHDR(NP,I),I=1,6)
      .....
      DO 100 NP=1,NPH
      IF (NUMELP(NP).EQ.0) GO TO 100
 C    READ(NFIN) IBUFF,BUFF
 C    WRITE(NF15) IBUFF,BUFF
      CALL SPEED (...,NFIN,IBUFF,BUFF,...)
      CALL SPEED (...,NF15,IBUFF,BUFF,...)
  100 CONTINUE
  200 CONTINUE
  300 CONTINUE
```

The above values have the following meaning:

DSPHDR:	Resulting pile head displacements
FRCHDR:	Resulting pile head forces
INC:	Load increment number

NUMINC:	Number of load increments
NV:	Load vector number
NF15:	FORTRAN unit number interface solution file
I:	Counter
NP:	Pile number
NPH:	Number of piles
NUMELP:	Number of pile elements on pile NP
NFIN:	File NF12 or NF13, pile data
IBUFF:	Pile data, integers
BUFF:	Pile data, real values

4.10 User Terminal, NF16

This file is generated by program SPLICE as processing proceeds. The content is displayed at the user's screen. The user may then check that the run develops normally, and in case not, program execution can be terminated manually. The various messages that may be displayed have been described in report SPL-UM, Chapter 4.2.

The file can also be used to obtain different trace values as processing proceeds. Actions required by the user to obtain trace output, and a description of the values displayed, have been presented in Section 8 of the present report.

In case the program is used in batch mode, i.e., there is no user terminal, file NF16 must still be available. Messages will then be generated to this file, and the user may print the file after run termination. In that case subroutine SPLIC1 must be modified, i.e. a file must be assigned to unit NF16 :

```
NF16 = 16
OPEN (NF16,FILE='SPLICE.16')
```

4.11 Re-Start Values, NF17

This file is generated by program SPLICE upon request from the user, and it contains data that may be used as start values for a run, rather than zero which would normally be used. The use of this facility is described in report SPL-UM. The file is written and read from subroutine RSTART.

File NF17 is in principle generated by the following sequence of FORTRAN statements (the actual write statements are broken up to give shorter record length):

```
      COMMON /GLOBAL/ XG(51,100),...
      COMMON /PILPRP/ MATND(51),...
      DIMENSION IBUFF(152),BUFF(4822)
      EQUIVALENCE (IBUFF(1),MATND(1)),(BUFF(1),D(1))
      .......
      REWIND NF17
      REWIND NFIN
      WRITE (NF17) TEXT,NPH,(NUMELP(NP),NP=1,NPH)
      WRITE(NF17) DSPHDR,FRCHDR,FRCPSI
      DO 100 NP=1,NPH
      IF (NUMELP(NP).EQ.0) GO TO 100
      READ(NFIN) IBUFF,BUFF
      WRITE(NF17) DSPRES,DSPINC,SDSP2,FORCER,QPSRES,DSPMAX
  100 CONTINUE
```

The meaning of the different values above has been explained in Appendix A, Common Block Description.

When re-start values are read from file NF17, program checks that number of piles (NPH) and number of elements on each pile (NUMELP(NP) from the pile data file NF7 and the re-start value file NF17 are identical. If not, an error message is printed and run execution terminated.

Re-start values may be fully used (resulting and incremental), or only partly used (incremental only). Consult report SPL-UM, Chapter 3.2, for further details.

The size requirement for file NF17 is (NP = Number of piles):

INTEGER*4	21
REAL*8	15,600 + 1,722 · NP

4.12 Scratch Files NF18 and NF19

These two files are used for storage of interface stiffness values during solution of interface equations.

File NF18 is generated in subroutine BUILD and contains the resulting superstructure and pile stiffness values, with the lower triangular part of the matrix stored.

File NF19 is generated in subroutine SOLVER and contains the lower triangular half of the decomposed coefficient matrix.

The size requirement for each of the files NF18 and FN19 is (J = Number of interface joints) :

REAL*8 $36 \cdot J \cdot (J+1)/2$

5.0 CONTROL FLOW

Main control flow within SPLICE is explained in Section 3.2 of report SPL-GD.

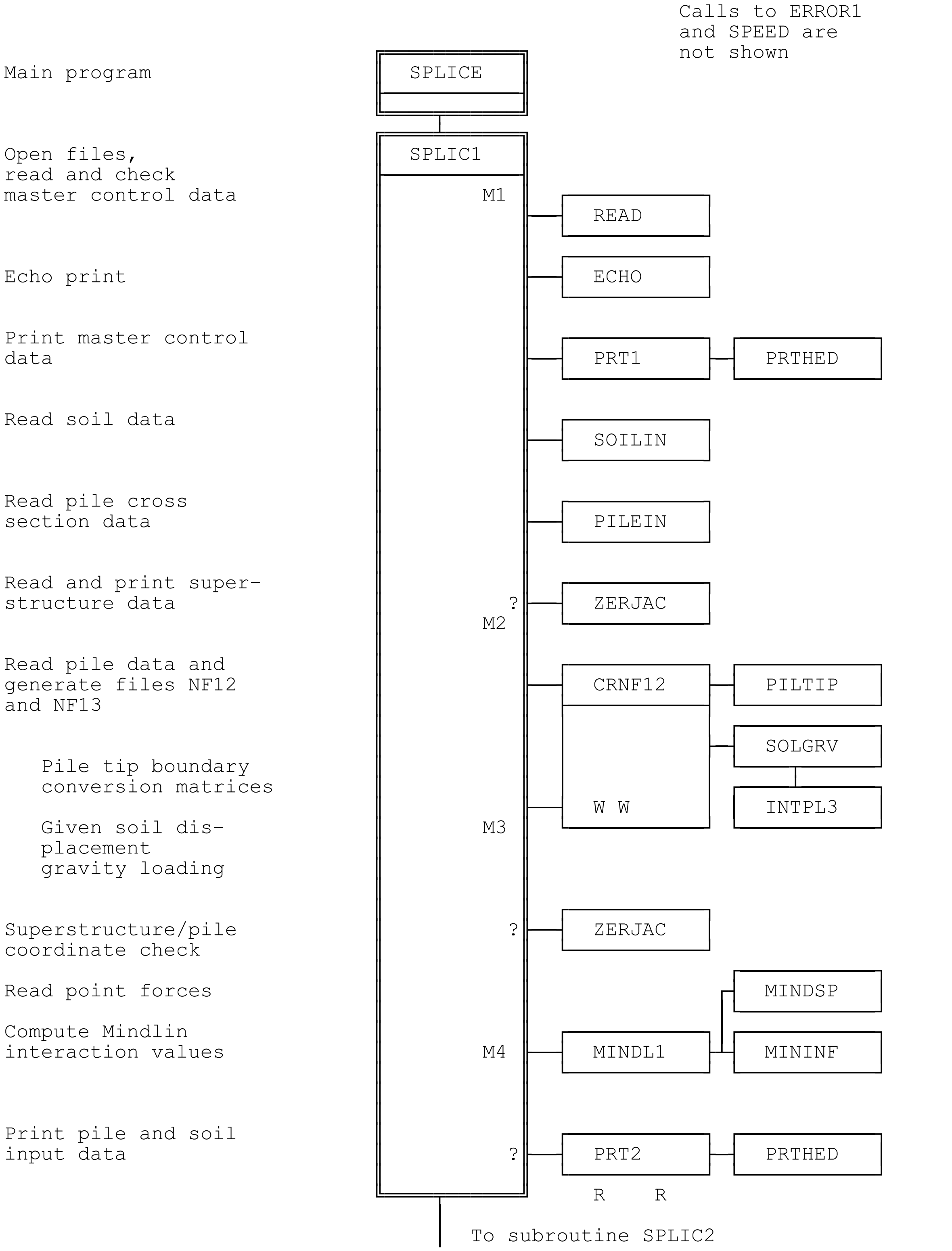
A detailed diagram of control flow through the various SPLICE subroutines has been shown on the following pages. A list of the subroutines and their purpose is given below.

SUBROUTINE	CALLED FROM	PURPOSE
SPLIC1	SPLICE (Main)	Input management.
SPLIC2	SPLIC1	Directs all data processing.
SPLIC3	SPLIC2	Directs updating of resulting values and print of results after each load increment.
READ	SPLIC1 SPLIC2	Reads formatted input files SPLICE.INP and SPLICE.TMP.
ECHO	SPLIC1	Generates re-print of formatted input file SPLICE.INP to formatted output file SPLICE.RES.
LOAD	SPLIC2	Reads load vector data, prints etc.
PRTHED	Several	Prints top identification line on each output page.
PRT1	SPLIC1	Prints master control data to file NF14.
PRT2	SPLIC1	Prints input soil and pile data to file NF14.
PRT3	SPLIC2	Prints load increment data to file NF14.
PRT4	SPLIC2	Prints trace values for given pile head after each iteration to file NF14.
PRT5	SPLIC3	Prints incremental and/or resulting pile head displacements and forces after each load increment to file NF14.
PRT6	SPLIC3	Prints pile head stiffness values to file NF14. Stores interface solution and complete pile solutions on file NF15. Prints pile solutions with depth to file NF14.
ERROR1	Several	Prints error message to files NF14 and NF16.

SUBROUTINE	CALLED FROM	PURPOSE
MSGTIM	Several	Prints various messages related to where program control is and time values to file NF16. This routine terminates run execution.
SOILIN	SPLIC1	Reads soil data from file NF10.
PILEIN	SPLIC1	Reads pile cross section data from file NF7.
CRNF12	SPLIC1	Reads pile data from file NF7, and creates pile data files NF12 and NF13.
SPEED	Several	Input/output of binary files.
PILTIP	CRNF12	Computes pile tip stiffness values and conversion matrices between local and global coordinate systems.
SOLGRV	CRNF12	Computes initially specified soil displacements, if any, of the soil volume surrounding each node. Computes pile element gravity type loading.
INTPL3	SOLGRV	Computes soil displacements by linear interpolation.
MINDL1	SPLIC1	Computes Mindlin interaction (influence) values for all piles and nodes and stores values on file NF11.
MININF or MINDSP	MINDL1	Computes interaction values from Mindlin's formulas.
ZERJAC	SPLIC1	Zeroes resulting interface values.
	LOAD	Reads superstructure data and checks coordinates.
RSTART	LOAD	Reads or writes re-start values on file NF17.
RELDSP	SPLIC2	Computes expected relative displacements pile/soil to be used to find new pile/soil stiffness values.
MINSUM	RELDSP	Computes displacements of the soil volume surrounding a node by summation of Mindlin interaction values times pile element/soil forces.
STIFF	RELDSP	Computes secant stiffnesses axially and laterally between pile and soil to be used for present iteration.

SUBROUTINE	CALLED FROM	PURPOSE
HEADST(NP,1)	SPLIC2	Computes pile head stiffness matrix and load correction vector for pile NP.
HEADST(NP,2)	SPLIC2	Solves pile NP when pile head displacements are known. Checks for numerical instability.
AXSLV	HEADST	Solves pile axially for given pile tip axial displacement.
TORSLV	HEADST	Solves pile for torsional rotations and moments for given pile tip rotation.
LATSLV	HEADST	Solves pile laterally (two directions) for given pile tip lateral displacements.
INV4	HEADST	Computes the inverse of a 4 by 4 matrix.
CONSTF	HEADST	Converts pile head stiffness matrix and load correction vector from local to global coordinate system.
MULT6	CONSTF RIGID	Multiplies two 6 by 6 matrices, $[C] = [A] \cdot [B]$
RIGID	SPLIC2	Computes resulting stiffness and load correction vector for pile heads that have been rigidly interconnected.
SOLVE1	SPLIC2	Directs building and solving of interface equations. Stores displacement solution and computes pile head forces.
BUILD	SOLVE1	Builds resulting interface stiffness file NF18 and forms resulting interface load vector.
SOLVER	SOLVE1	Equation solver routine.
PRAC10	SOLVER ABMULT	Computes the inner vector product of two vectors.
ABMULT	SPLIC2	Multiplies the stiffness matrix A with the displacement solution B in order to check the solution accuracy.
PROCSS	SPLIC2	Data processing at the end of the iterative loop. Convergence check, second order moments, pile/soil forces.
UPDATE	SPLIC3	Called after convergence criterion has been satisfied. Updates resulting values.

Mi: Call to subroutine MSGTIM(i,....) for terminal messages
Ti: Location for trace message i
R: Read pile data from disk
W: Write pile data on disk



Start of load vector loop

Read load vector data

Zero resulting values

Print load data

Check for re-start values

Start of load increment loop

Read and check load increment data

Print load increment data

Start of iterative loop

Compute pile/soil stiffness values

Include computed soil displacements ?

Find axial and lateral stiffness values

Find torsional stiffness values

Compute pile head stiffnesses and load correction vectors.

Axial

Torsional

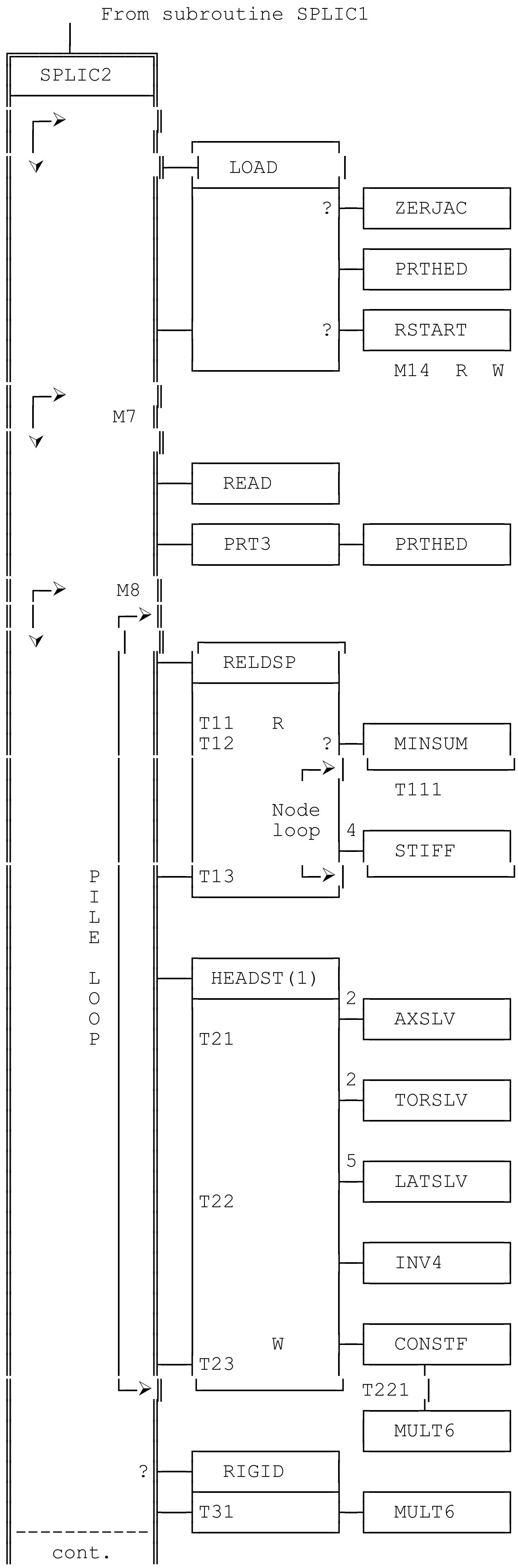
Lateral

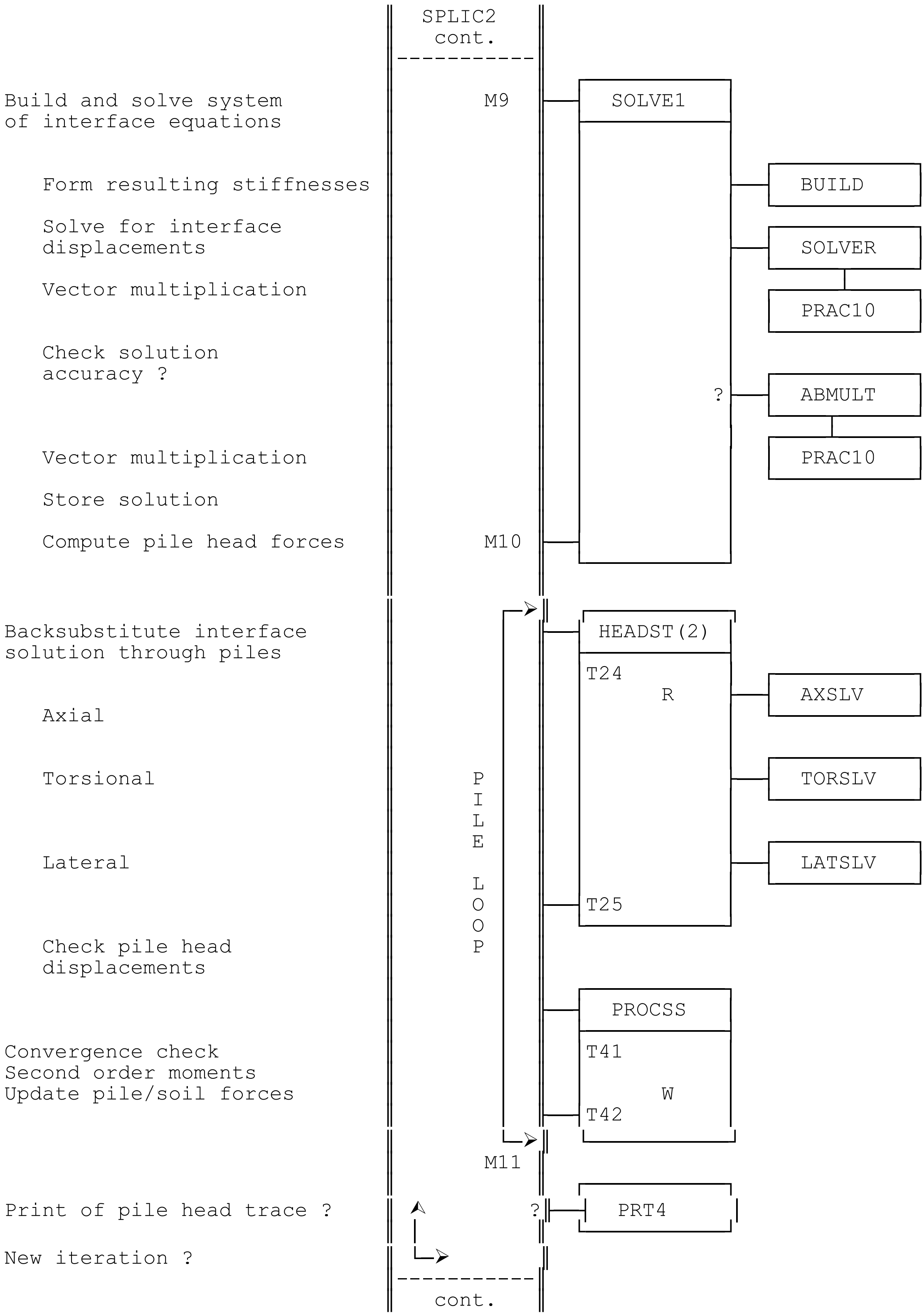
Find coupling tip/head laterally

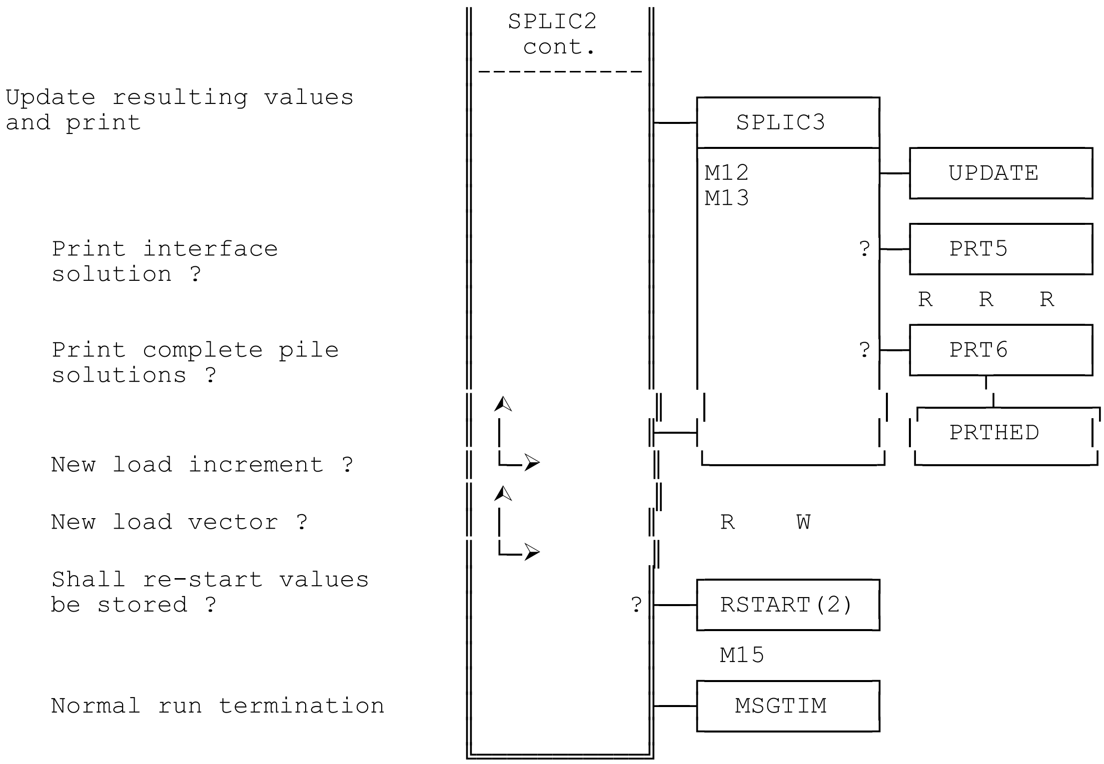
Checks of computed values

Convert local stiffness values to global

Form group center stiffness ?




SPLIC2
cont.
Build and solve system of interface equations
M9
SOLVE1
Form resulting stiffnesses
BUILD
Solve for interface displacements
SOLVER
Vector multiplication
PRAC10
Check solution accuracy ?
?
ABMULT
Vector multiplication
PRAC10
Store solution
Compute pile head forces
M10
Backsubstitute interface solution through piles
HEADST(2)
T24
R
Axial
AXSLV
Torsional
TORSLV
PILE LOOP
Lateral
LATSLV
T25
Check pile head displacements
PROCSS
Convergence check
Second order moments
Update pile/soil forces
T41
W
T42
M11
Print of pile head trace ?
?
PRT4
New iteration ?
cont.


SPLIC2
cont.
Update resulting values and print
SPLIC3
M12
M13
UPDATE
Print interface solution ?
?
PRT5
R R R
Print complete pile solutions ?
?
PRT6
PRTHED
New load increment ?
New load vector ?
R W
Shall re-start values be stored ?
?
RSTART(2)
M15
Normal run termination
MSGTIM

6.0 PROGRAM LIMITATIONS

There are a number of limitations on the maximum size of a problem that can be handled by the present version of SPLICE. These limitations are the following:

SOIL
- Maximum number of soil layers is 30.
- For each layer the p-y, t-z and q-z curves can have maximum 23 points, including the origin.
- Four different pile diameters may be used to generate p-y data.
- Known soil displacements can be specified at maximum 25 z-levels.

PILES
- Maximum number of piles is 32, including dummy pile heads, if any.
- Each pile can be divided into maximum 50 elements (51 nodes).
- Maximum number of different cross sections is 40. Circular cross sections only.
- Piles are straight between head and tip.
- Rigidly interconnected pile heads must be at the same z-level.

SUPER-STRUCTURE
- The superstructure, if present, can have maximum 32 interface points between structure and piles.
- The superstructure is linearly elastic.

PILE/SOIL/PILE INTERACTION
- Each pile node can interact with maximum 500 pile elements and single point forces.

SINGLE POINT FORCES	- Maximum 45 single point forces can be specified anywhere within or at the surface of the soil volume.
LOAD VECTORS	- Maximum 75 load vectors in the same run.

7.0 ERROR MESSAGES

Input values and selected computed results are checked for obvious errors at several different locations within SPLICE. Whenever an error condition is identified, an error message is printed to files NF14 and NF16. Most of such error conditions are so severe that program execution is terminated.

A summary of the different error messages that may be generated by SPLICE has been included in report SPL-UM.

8.0 BUILT-IN TRACE OPTIONS

SPLICE has been equipped with a number of trace options that allow the user to obtain various output in addition to the data presented to files NF14 (print file) and NF16 (user terminal).

These options are mainly intended for program testing and error finding purposes. However, the single pile head trace described in Chapter 8.2 may be used for any non-linear run in order to check the convergence development.

All trace options are governed by the master control and load increment input data of file NF5, see report SPL-UM.

8.1 Interface Vector/Matrix Trace

This trace option is initiated if MISC(1) in the Control Section is equal to 2.

Output is to file NF16 (user terminal) and consists of the load vector and the 6 by 6 sub matrix on the leading diagonal of the resulting stiffness matrix (jacket + pile).

Output is printed from subroutine SOLVE1 for each structure/pile interface point.

8.2 Single Pile Head Trace

This trace option is initiated if NPTRC of the load increment line is not zero.

Output is to files NF14 (print file) and NF16 (user terminal) and consists of computed incremental displacements and forces at pile head NPTRC after each iteration. NPTRC can be a real pile or a dummy pile (group center).

File NF14 receives a full set of data:

- Iteration number (IT)
- Six displacements
- Six forces
- Number of pile nodes outside convergence criterion (ICONV)

At file NF16 the following message is printed after each iteration:

```
TRACE OF PILE:  1.1234E-01  1.1234E-01  1.1234E-01
```

where the three numbers are incremental global x, y, z displacements at pile head NPTRC.

The NF14 print is generated in subroutine PRT4, the NF16 print is generated in subroutine SPLIC2.

8.3 Full Pile Head Trace

This trace option is initiated if MISC(7) of the load increment line is equal to 1.

Output is to file NF16 (user terminal) and consists of:

For each pile (real piles and group centers)

- Pile number
- Interface load vector used
- Computed incremental global pile head forces
- Computed incremental global pile head displacements

and for real piles in addition

- Computed incremental local pile head displacements.

The output is generated at the end of subroutine SOLVE1.

8.4 Full Pile Head Stiffness Trace

This trace option is initiated if MISC(8) of the load increment line is equal to 1.

Output is to file NF16 (user terminal) and is related to values used to compute pile head stiffness values and load correction vectors. Computed pile head stiffness matrix is printed prior to symmetry is enforced. After the interface equations have been solved, the corresponding computed pile tip displacements are printed, and the computed pile head forces and displacements after back-substitution up through the piles.

The output is generated in subroutine HEADST. The use of this option may result in considerable output volume to file NF16.

8.5 Control Flow Trace

This trace option is initiated if MISC(9) of the load increment line is equal to 9.

Output is to file NF16 (user terminal) and consists of the following message:

```
TRACE MSG LOC = N1  NP = N2

where   LOC  =  Location number
        NP   =  Pile number
```

The location numbers printed by this trace have been indicated on the control flow diagrams given in Section 5. For example, LOC = 22 is indicated as T22 on these diagrams, and this message is thus printed from subroutine HEADST after subroutine LATSLV has been called.

The use of this trace option would be to check program control flow, or to help find were a problem (for example zero division) occurs.

8.6 Nodal Point Trace

This trace option is initiated if MISC(10) of the load increment line is not zero. The option can be used to check the pile/soil secant stiffness values used for a given node at a given pile.

For example, assume that we want to check node 5 on pile 7.

Input MISC(10) = $100 \cdot 7 + 5 = 705$

After each iteration the following will be printed to file NF16:

```
TRACE OF PILE  =    7    NODE = 5
PILE DISP     -  x,y,z local incremental displacement of node
SOIL DISP     -  x,y,z local incremental soil displacements
STIFFNESS     -  CCCX, CCCY, CCCZ, GSOLZZ
```

CCCX	=	Secant stiffness in direction of maximum relative pile/soil displacement
CCCY	=	Stiffness in direction of zero relative displacement
CCCZ	=	Secant stiffness in axial direction
GSOLZZ	=	Soil shear modulus used to compute pile torsional stiffness.

8.7 Full Element Trace

This trace option is initiated if MISC(11) of the load increment line is not zero. The option is used to generate print of detailed element results from the upward passes done by subroutines AXSLV, TORSLV and LATSLV.

The user is free to select the file unit number to be used, as very large output volumes may be generated by this trace option.

The option is only intended for special checking purposes, and should not be used under normal circumstances.

9.0 FUTURE MODIFICATIONS

During program development it has been attempted to maintain a program structure that easily can be subjected to corrections and modifications.

Common Blocks

All SPLICE subroutines that need the values stored in the common area use identical common statements. These statements are contained in a file called SPLICE.CMN, included into the source code at the time of compilation by:

```
INCLUDE 'SPLICE.CMN'
```

This statement is not part of the FORTRAN-77 standard (ANSI-X3.9-1978) and may need to be changed before the program can be compiled on your computer.

Appendix A contains a listing of file SPLICE.CMN.

Type Declarations

The examples given in report SGP-EX were generated by a Double Precision program version. The above common file contains the following type declarations:

```
IMPLICIT REAL*8 (A-H,O-Z)
IMPLICIT INTEGER*4 (I-N)
```

General purpose subroutines do not need access to the common area. However, they do need a type declaration to avoid mixing of different number types. All such general routines therefore have the above IMPLICIT statements at the top.

Problem Size

The present SPLICE version is limited to 32 piles. In case this shall be changed to say 100 piles, the following modifications are needed:

1. Change all 032 to 100 in common blocks /MCONTR/ and /GLOBAL/.
2. At start of subroutine SPLIC1 change MXXNPH from 32 to 100.

Recompile all routines, link and carry out test runs.

Date, Time and Clock Routines

Subroutine MSGTIM contains a number of calls to system subroutines that give date and time. The DOS subroutines called by the SPLICE PC version are:

```
CALL GETDAT(IYEAR,IMONTH,IDAY)
CALL GETTIM(IHOUR,IMIN,ISEC,ISC100)
```

These calls may need to be changed before the program can run on your computer.

Future permanent program modifications should be carefully documented. The following Section 10 has been included for this purpose.

10.0 IMPLEMENTED MODIFICATIONS

Permanent modifications included after January 1995 have been described on the following pages. Copies of these pages may be obtained from:

Carl J. Frimann Clausen
Cidex 424 bis
F-06330 Roquefort-les-Pins
France

Telefax: (33) 93 77 19 79

A P P E N D I X A

COMMON BLOCK DESCRIPTION

```
C COMMON FILE FOR SPLICE SUBROUTINES   DOUBLE PRECISION PROGRAM VERSION
C
C DATE         SIGN    LOG OF CORRECTIONS
C -----------  ------  --------------------------------------------
C 17 NOV 1984  CJFC    100 PILE FORTRAN-IV VERSION FOR PRIME COMPUTER
C 16 JUN 1987  CJFC    FORTRAN-77 VERSION FOR WOODSIDE , PERTH
C 19 JUL 1988  CJFC    F77 VERSION FOR THE IBM PC AT , 32 PILES
C 13 NOV 1988  CJFC    SEVERAL MODIFICATIONS DUE TO NEW GENSOD PROGRAM
C 25 NOV 1988  CJFC    SEVERAL MODIFICATIONS DUE TO NEW INPUT FORMAT
C 04 DEC 1988  CJFC    INCLUDE 'NUMI' AND 'NUMR' , VALUES FOR SR/SPEED
C 25 JUL 1989  CJFC    LET ALL TEXT LINES BE CHARACTER*80
C 30 APR 1992  CJFC    STORE PROGRAM VERSION (DATE) IN "DATE"
C 06 AUG 1993  CJFC    KEEP START TIME VALUES FOR PRINT OF TOP LINE
C
C
C     ----------------------------
C     PRESENT SIZE LIMITATIONS ARE
C     ----------------------------
C
C     32  =  NUMBER OF PILES
C     30  =  NUMBER OF SOIL LAYERS
C     25  =  NUMBER OF Z-LEVELS WITH GIVEN SOIL DISPL AND OPEN HOLE DIAM
C      4  =  NUMBER OF DIFFERENT PILE DIAMETERS
C     23  =  NUMBER OF POINTS ON P-Y / T-Z / Q-Z CURVES
C     51  =  NUMBER OF NODAL POINTS ON EACH PILE
C     50  =  NUMBER OF ELEMENTS ON EACH PILE
C     40  =  NUMBER OF DIFFERENT PILE CROSS SECTIONS
C     75  =  NUMBER OF LOAD VECTORS
C     45  =  NUMBER OF GIVEN POINT FORCES
C
      IMPLICIT REAL*8 (A-H,O-Z)
      IMPLICIT INTEGER*4 (I-N)
      CHARACTER*80 TEXT,TEXTL
      CHARACTER*11 DATE
      CHARACTER*3 MOON
C
      COMMON /MXXVAL/ MXXNPH,MXXLAY,MXXDSP,MXXDIA,MXXPTQ,MXXNOD,MXXELM,
     *                MXXCRS,MXXVEC,MXXFRC
C
      COMMON /MCONTR/ NPH,NLPH,JACK,LAYER,NSDSP,NUMVEC,ISTART,ISECM,
     *                INTER,MISC(11),NF5,NF7,NF8,NF9,NF10,NF11,NF12,
     *                NF13,NF14,NF15,NF16,NF17,NF18,NF19,NF26,NUMINC,
     *                IFRC,NNN,MAXIT,IRGD,IPRT1,IPRT2,IPRT3,JECHO,
     *                NPTRC,NUMELP(032),NFIX(032),ICTIP(032),NUMCON,
     *                NUMHED(032),IPAGE,ITOT,NCRS,IERR,NFIN,NFOUT,
     *                ICONV,ITNUM,NINC,ISWINE,ICASE,IWR,NUMI,NUMR,
     *                LDVECT,KEEP,IDSPDP,KZ
C
      COMMON /TXT/ TEXT,TEXTL,DATE,MOON
C
      COMMON /TIME/ JYEAR,JMONTH,JDAY,JHOUR,JMIN,JSEC
C
      COMMON /MISCEL/ PI,DISTIN,QTOT,CONV,QINC,SCOUR,ACCX,ACCY,ACCZ,
     *                ERRMAX,QLAST,CONFRC,CONLTH,EPS,ZERO,ONE,VECMLT,
     *                SOLMLT,FRCMLT
C
      COMMON /SOLPRP/ NPY(4,30),NTZ(4,30),NQZ(4,30),NZRPY(4,30),
     *                NZRTZ(4,30),NZRQZ(4,30),NREV(30),
     *                PYLOAD(23,4,30),PYDISP(23,4,30),TZLOAD(23,4,30),
     *                TZDISP(23,4,30),QZLOAD(23,4,30),QZDISP(23,4,30),
     *                ZLEV(25),SOILD(4,25),ZLAY(30),SPR(10,30),SCRGEN,
     *                DIAPY(4),PYMISC(3,4,30),TZMISC(3,4,30),
     *                QZMISC(3,4,30),ESOL0,ESOL1,POSAVR
C
      COMMON /GLOBAL/ XG(51,032),YG(51,032),ZG(51,032),CONGL(9,032),
     *                CONLG(9,032),HEADK(032,6,6),HEADF(032,6),
     *                FIXLD(032,6),DSPHDI(032,6,2),DSPHDR(032,6),
     *                FRCHDI(032,6,2),FRCHDR(032,6),FRCPSI(032,50,3),
     *                CROSS(40,15),FXC(45),FYC(45),FZC(45),FFX(45),
     *                FFY(45),FFZ(45),SCRPIL(032),COUPL(3,032)
C
      COMMON /VECTOR/ INCVEC(75),KEPVEC(75),FACVEC(3,75)
```

```
C
      COMMON /PILPRP/ MATND(51),ICROSS(50),IDPY(51),
     *                D(50),H(50),TEMP(50),STFTIP(6),
     *                STFND(6,51),EXFNDT(6,51),EXDNDT(6,51),
     *                DSPRES(6,51),DSPMAX(51,3),SINB(51),COSB(51),
     *                QPSRES(4,51),SDSP1(3,51),SDSP2(3,51),GSOLZZ(51),
     *                PTRANS(3,50),SECMOM(51,2),FORCER(2,6,50),
     *                FORCEI(2,6,50),GRAVX(50),GRAVY(50),GRAVZ(50),
     *                CCCX(51),CCCY(51),CCCZ(51),DSPLST(6,51),
     *                AZ(4),PHSTF(6,7),A(4,4),B(4,4),AINV(4,4),AC(4),
     *                BC(4),DSPINC(6,51),AZZ(4),SDSP3(3,51)
C
      COMMON /SCRTCH/ XXX(5400)
```

```
C
C     ---------------------------------------------
C     BELOW FOLLOWS AN EXPLANATION OF THE DIFFERENT
C     VALUES REFERENCED IN THE COMMON BLOCKS ABOVE
C     ---------------------------------------------
C
C
C   COMMON  /MXXVAL/  CONTAINS SIZE LIMITATIONS , VALUES SET IN SR/SPLIC1
C
C   COMMON  /MCONTR/  CONTAINS MASTER CONTROL DATA
C
C   NPH    : NUMBER OF PILES (REAL PILES AND DUMMIES)
C   NLPH   : NUMBER OF PILES WITH GIVEN PILE HEAD LOADING
C   JACK   : CODE FOR PRESENCE OF SUPERSTRUCTURE
C   LAYER  : NUMBER OF SOIL LAYERS
C   NSDSP  : NUMBER OF Z-LEVELS WITH GIVEN SOIL DISPLACEMENTS
C   NUMVEC : NUMBER OF LOAD VECTORS TO BE ANALYZED
C   ISTART : CODE FOR WRITE/READ OF RE-START VALUES
C   ISECM  : CODE FOR INCLUSION OF SECOND ORDER MOMENTS
C   INTER  : CODE FOR PILE/SOIL/PILE INTERACTION (GROUP EFFECTS)
C   MISC   : (11) VARIOUS INTEGERS FOR PROGRAM TESTING/PRINT PURPOSE
C   NF5    : UNIT NUMBER, FORMATTED INPUT DATA FILE
C   NF7    : UNIT NUMBER, PILE INPUT DATA FROM PILE GENERATOR PRGRM
C   NF8    : UNIT NUMBER, SUPERSTRUCTURE STIFFNESS INPUT DATA
C   NF9    : UNIT NUMBER, PILE HEAD LOAD VECTOR(S) INPUT DATA
C   NF10   : UNIT NUMBER, SOIL INPUT DATA FROM SOIL GENERATOR PRGRM
C   NF11   : UNIT NUMBER, MINDLIN INFLUENCE VALUES STORAGE
C   NF12   : UNIT NUMBER, SCRATCH STORAGE FOR PILE DATA /PILPRP/
C   NF13   : UNIT NUMBER, SCRATCH STORAGE FOR PILE DATA /PILPRP/
C   NF14   : UNIT NUMBER, FORMATTED OUTPUT FILE (LINE PRINTER)
C   NF15   : UNIT NUMBER, NON-FORMTTD OUTPUT FILE, INTERFACE DSP ETC
C   NF16   : UNIT NUMBER, FORMATTED OUTPUT FILE, USER'S TERMINAL
C   NF17   : UNIT NUMBER, RE-START VALUES
C   NF18   : UNIT NUMBER, SCRATCH STORAGE OF RESULTING STIFFNESSES
C   NF19   : UNIT NUMBER, SCRATCH STORAGE FOR EQUATION SOLVER (-L-)
C   NF26   : UNIT NUMBER, INPUT FILE (NF5) WITHOUT COMMENT LINES
C   NUMINC : NUMBER OF LOAD INCREMENTS FOR PRESENT LOAD VECTOR
C   IFRC   : CODE FOR PRESENCE OF SINGLE POINT FORCES
C   NNN    : LOAD INCREMENT NUMBER, DO LOOP
C   MAXIT  : MAXIMUM ALLOWABLE NUMBER OF ITERATIONS
C   IRGD   : CODE FOR PRESENCE OF RIGIDLY CONNECTED PILE HEADS
C   IPRT1  : PRINT OUTPUT CODE, SEE INPUT DATA MANUAL
C   IPRT2  : PRINT OUTPUT CODE, SEE INPUT DATA MANUAL
C   IPRT3  : PRINT OUTPUT CODE, SEE INPUT DATA MANUAL
C   JECHO  : CODE FOR ECHO PRINT OF INPUT DATA (0=NO 1=YES)
C   NPTRC  : PILE HEAD NUMBER TO BE TRACED (PRINTED) DURING ITERATIONS
C   NUMELP : (032) NUMBER OF ELEMENTS ON EACH PILE
C   NFIX   : (032) THE HEAD OF PILE 'N' IS FIXED TO PILE 'NFIX(N)'
C   ICTIP  : (032) PILE TIP BOUNDARY CODE
C   NUMCON : NUMBER OF SUPERSTRUCTURE/PILE INTERFACE JOINTS
C   NUMHED : (032) PILE HEAD NUMBERS CONNECTED TO SUPERSTRUCTURE
C   IPAGE  : PAGE NUMBER PRINTED ON TOP OF EACH NEW PAGE
C   ITOT   : CPU-TIME START VALUE
C   NCRS   : NUMBER OF DIFFERENT PILE CROSS SECTIONS
C   IERR   : ERROR CONDITION CODE
C   NFIN   : UNIT NUMBER, READING OF PILE DATA FILES NF12/NF13
C   NFOUT  : UNIT NUMBER, WRITING OF PILE DATA FILES NF12/NF13
C   ICONV  : NUMBER OF NODES OUTSIDE GIVEN CONVERGENCE CRITERION
C   ITNUM  : ITERATION NUMBER, FIRST = 1
C   NINC   : LOAD INCREMENT NUMBER
C   ISWINE : SWITCH FOR PILE/SOIL/PILE INTERACTION
C   ICASE  : SWITCH FOR PILE/SOIL/PILE INTERACTION CONTROL FLOW
C   IWR    : WRITE/READ INDICATOR TO I/O ROUTINE 'SPEED'
C   NUMI   : NUMBER OF INTEGERS TO BE TRANSFERRED BY ROUTINE 'SPEED'
C   NUMR   : NUMBER OF REALS TO BE TRANSFERRED BY ROUTINE 'SPEED'
C   LDVECT : LOAD VECTOR NUMBER, 1 TO NUMVEC
C   KEEP   : CODE FOR INITIAL START CONDITION FOR A LOAD VECTOR
C   IDSPDP : SINGLE/DOUBLE PRECISION PROGRAM VERSION  1=SP 2=DP
C   KZ     : INTEGER = ZERO, USED IN SUBROUTINE CALLS
C
C   COMMON /TXT/  CONTAINS CHARACTER VALUES
C
C   TEXT   : (C80) TEXT IDENTIFICATION LINE FOR PRESENT RUN
C   TEXTL  : (C80) TEXT IDENTIFICATION LINE FOR PRESENT LOAD VECTOR
C   DATE   : (C11) DATE FOR PRESENT PROGRAM VERSION
C   MOON   : (C3)  MONTH FOR START OF RUN
```

```
C
C   COMMON /TIME/   CONTAINS START TIME VALUES
C
C   JYEAR  : YEAR
C   JMONTH : MONTH
C   JDAY   : DAY
C   JHOUR  : HOUR OF THE DAY
C   JMIN   : MINUTES
C   JSEC   : SECONDS
C
C   COMMON  /MISCEL/  CONTAINS MISCELLANEOUS VALUES
C
C   PI     : 3.141592654
C   DISTIN : MAXIMUM DISTANCE NODE TO ELEMENT IN INTERACTION
C   QTOT   : TOTAL LOAD/DISPL FACTOR FOR PRESENT INCREMENT
C   CONV   : CONVERGENCE CRITERION, DIMENSION LENGTH
C   QINC   : INCREMENTAL LOAD/DISPL FACTOR FOR PRESENT INCRMNT
C   SCOUR  : ELEVATION Z OF SCOUR LINE GIVEN FOR THIS RUN
C   ACCX   : GRAVITY ACCELERATION RATIO IN GLOBAL X DIRECTION
C   ACCY   : GRAVITY ACCELERATION RATIO IN GLOBAL Y DIRECTION
C   ACCZ   : GRAVITY ACCELERATION RATIO IN GLOBAL Z DIRECTION
C   ERRMAX : MAXIMUM ERROR ASSOCIATED WITH EQUATION SOLUTION
C   QLAST  : TOTAL LOAD/DISPL FACTOR FOR LAST LOAD INCREMENT
C   CONFRC : CONVERTION FACTOR FORCE UNITS, SEE INPUT MANUAL
C   CONLTH : CONVERTION FACTOR LENGTH UNITS, SEE INPUT MANUAL
C   EPS    : SMALL VALUE FOR ZERO CHECKS, = 1.0E-6
C   ZERO   : VALUE = 0.00
C   ONE    : VALUE = 1.00
C   VECMLT : MULTIPLIER ON PRESENT LOAD VECTOR VALUES
C   SOLMLT : MULTIPLIER ON GIVEN SOIL DISPL FOR PRESENT LOAD VECTOR
C   FRCMLT : MULTIPLIER ON GIVEN POINT FRCS FOR PRESENT LOAD VECTOR
C
C   COMMON  /SOLPRP/  CONTAINS SOIL DATA VALUES FROM FILE NF10
C
C   NPY    : (4,30) NUMBER OF POINTS ON P-Y CURVES  (4 PILES , 30 LAYERS)
C   NTZ    : (4,30) NUMBER OF POINTS ON T-Z CURVES
C   NQZ    : (4,30) NUMBER OF POINTS ON Q-Z CURVES
C   NZRPY  : (4,30) ORIGO INTERSECTION POINT NUMBER FOR P-Y CURVES
C   NZRTZ  : (4,30) ORIGO INTERSECTION POINT NUMBER FOR T-Z CURVES
C   NZRQZ  : (4,30) ORIGO INTERSECTION POINT NUMBER FOR Q-Z CURVES
C   NREV   : (30) CODE FOR REVERSED LOADING MODEL (0=CLOSED 1=OPEN)
C   PYLOAD : (23,4,30) P-Y LOAD DATA (F/L**2 , 23=POINTS 4=DIAMTRS 30=LAYERS)
C   PYDISP : (23,4,30) P-Y DISP DATA (L , 23=POINTS 4=DIAMTRS 30=LAYERS)
C   TZLOAD : (23,4,30) T-Z LOAD DATA (F/L**2 , 23=POINTS 4=DIAMTRS 30=LAYERS)
C   TZDISP : (23,4,30) T-Z DISP DATA (L , 23=POINTS 4=DIAMTRS 30=LAYERS)
C   QZLOAD : (23,4,30) Q-Z LOAD DATA (F/L**2 , 23=POINTS 4=DIAMTRS 30=LAYERS)
C   QZDISP : (23,4,30) Q-Z DISP DATA (L , 23=POINTS 4=DIAMTRS 30=LAYERS)
C   ZLEV   : (25) Z-LEVELS WHERE SOIL DISPLACEMENTS WERE SPECIFIED
C   SOILD  : (4,25) GIVEN SOIL DISPL (1=X 2=Y 3=Z 4=OPEN HOLE DIAM)
C   ZLAY   : (30) Z-LEVELS AT BOTTOM OF EACH LAYER
C   SPR    : (10,30) GIVEN SOIL LAYER PROPERTIES
C                1 = EFFECTIVE UNIT WEIGHT (F/L**3)
C                2 = ANGLE OF INTERNAL FRICTION (DEGR)
C                3 = UNDRAINED SHEAR STRENGTH (F/L**2)
C                4 = MODULUS OF ELASTICITY (F/L**2)
C                5 = POISSON'S RATIO
C                6 = SHEAR MODULUS (F/L**2)
C             7-10 = 0.0 , NOT USED
C   SCRGEN : SCOUR ASSUMPTION USED BY SOIL DATA GENERATOR PROGRAM
C   DIAPY  : (4) PILE DIAMETERS USED TO GENERATE P-Y DATA
C   PYMISC : (3,4,30) P-Y RELATED DATA, MAX STRESS AND STIFFNESS
C             1 =     MAXIMUM LATERAL STRESS (F/L**2)
C             2 =     INITIAL P-Y SLOPE (F/L**3)
C             3 =     0.0 NOT USED
C   TZMISC : (3,4,30) T-Z RELATED DATA, MAX STRESS AND STIFFNESS
C             1 =     MAXIMUM AXIAL STRESS IN COMPRESSION (F/L**2)
C             2 =     INITIAL T-Z SLOPE (F/L**3)
C             3 =     MAXIMUM AXIAL STRESS IN TENSION (F/L**2)
C   QZMISC : (3,4,30) Q-Z RELATED DATA, MAX STRESS AND STIFFNESS
C             1 =     MAXIMUM PILE TIP STRESS IN COMPRESSION (F/L**2)
C             2 =     INITIAL Q-Z SLOPE (F/L**3)
C             3 =     MAXIMUM PILE TIP STRESS IN TENSION (F/L**2)
C   ESOL0  : SOIL MODULUS FOR MINDLIN INTERACT   E=ESOL0+ESOL1*Z
C   ESOL1  : SOIL MODULUS FOR MINDLIN INTERACT   E=ESOL0+ESOL1*Z
C   POSAVR : AVERAGE POISSON'S RATIO FOR MINDLIN INFLUENCE VALUES
```

```
C
C   COMMON  /GLOBAL/  CONTAINS PILE GEOMETRY, STIFFNESSES ETC.
C                     GLOBAL COORDINATES
C                     DIMENSION (6) MEANS X-Y-Z-XX-YY-ZZ
C
C   XG     : (51,032) PILE NODE X-COORDINATES
C   YG     : (51,032) PILE NODE Y-COORDINATES
C   ZG     : (51,032) PILE NODE Z-COORDINATES
C   CONGL  : (9,032) CONVERTION MATRICES GLOBAL TO LOCAL
C   CONLG  : (9,032) CONVERTION MATRICES LOCAL TO GLOBAL
C   HEADK  : (032,6,6) PILE HEAD STIFFNESS MATRICES
C   HEADF  : (032,6) PILE HEAD CORRECTED LOAD VECTOR
C   FIXLD  : (032,6) GIVEN FIXED PILE HEAD LOAD VECTOR
C   DSPHDI : (032,6,2) INCREMENTAL PILE HEAD DISPL  1=GLOBAL 2=LOCAL
C   DSPHDR : (032,6) RESULTING PILE HEAD DISPLACEMENTS
C   FRCHDI : (032,6,2) INCREMENTAL PILE HEAD FORCES  1=GLOBAL 2=LOCAL
C   FRCHDR : (032,6) RESULTING PILE HEAD FORCES
C   FRCPSI : (032,50,3) INCRM FORCES FROM PILE ELEMENTS TO SOIL
C   CROSS  : (40,15) GIVEN CROSS SECTION PROPERTIES
C                1 = OUTER DIAMETER (L)
C                2 = WALL THICKNESS (L)
C                3 = WALL CROSS SECTION AREA (L**2)
C                4 = SECTION MODULUS (L**3)
C                5 = AXIAL STIFFNESS, EA (F)
C                6 = SHEAR STIFFNESS, GA (F)
C                7 = BENDING STIFFNESS, EI (F*L**2)
C                8 = TORSIONAL STIFFNESS, GIP (F*L**2)
C                9 = PILE WALL UNIT WEIGHT (F/L**3)
C               10 = UNIT WEIGHT OF FLUID INSIDE PILE (F/L**3)
C               11 = PILE WALL MATERIAL TEMP EXPANSION COEFFICIENT (1/DGR.CNT)
C               12 = PILE WALL MATERIAL YIELD STRESS (F/L**2)
C               13 = PILE WALL MATERIAL MODULUS OF ELASTICITY (F/L**2)
C               14 = PILE WALL MATERIAL SHEAR MODULUS (F/L**2)
C               15 = NOT USED
C   FXC    : (45) SINGLE POINT FORCES, X-COORDINATE
C   FYC    : (45) SINGLE POINT FORCES, Y-COORDINATE
C   FZC    : (45) SINGLE POINT FORCES, Z-COORDINATE
C   FFX    : (45) SINGLE POINT FORCES, X-FORCE COMPONENT
C   FFY    : (45) SINGLE POINT FORCES, Y-FORCE COMPONENT
C   FFZ    : (45) SINGLE POINT FORCES, Z-FORCE COMPONENT
C   SCRPIL : (032) LOCAL SCOUR VALUES FOR EACH INDIVIDUAL PILE
C   COUPL  : (3,032) APPROX PILE HEAD/TIP COUPLING VALUES
C             1 =    AXIAL   (DSPTIP/DSPHEAD)
C             2 =    TORSION (DSPTIP/DSPHEAD)
C             3 =    LATERAL (DSPTIP/DSPHEAD)
C
C   COMMON  /VECTOR/  CONTROL VALUES FOR EACH VECTOR READ FROM INPUT
C                     FILE NF5/NF26 AT START OF RUN
C
C   INCVEC : (75) NUMBER OF LOAD INCREMENTS TO BE USED
C   KEPVEC : (75) START CODE "KEEP"
C   FACVEC : (3,75) MULTIPLIERS "VECMLT" , "SOLMLT" AND "FRCMLT"
C
C   COMMON  /PILPRP/  VARIOUS PILE VALUES. STORED ON FILES NF12-13
C                     ALL VALUES ARE IN LOCAL PILE COORDINATES
C                     DIMENSION (6) MEANS LOCAL X-Y-Z-XX-YY-ZZ
C
C   MATND  : (51) PILE NODE SOIL MATERIAL IDENTIFICATION
C   ICROSS : (50) PILE ELEMENT CROSS SECTION IDENTIFICATION
C   IDPY   : (51) PILE NODE P-Y DIAMETER IDENTIFICATION (1 TO 4)
C   D      : (50) PILE ELEMENT OUTER DIAMETER
C   H      : (50) PILE ELEMENT HEIGHT (LENGTH)
C   TEMP   : (50) PILE ELEMENT FREE TEMPERATURE STRAIN
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C   STFTIP : (6) PILE TIP STIFFNESS VALUES
C
C                FRCX  = S1 00 00 00 S4 00 * DSPX
C                FRCY  = 00 S1 00 S5 00 00 * DSPY
C                FRCZ  = 00 00 S2 00 00 00 * DSPZ
C                MOMXX = 00 S5 00 S3 00 00 * ROTXX
C                MOMYY = S4 00 00 00 S3 00 * ROTYY
C                MOMZZ = 00 00 00 00 00 S6 * ROTZZ
C
C   STFND  : (6,51) SPRING STIFFNESSES BETWEEN NODE AND FIXD SUPPORT
C   EXFNDT : (6,51) GIVEN FORCES/MOMENTS ACTING AT NODE
C   EXDNDT : (6,51) GIVEN SPRING SUPPORT DISPL OR SOIL DISPL
C   DSPRES : (6,51) NODE RESULTING DISPLACEMENTS
C   DSPMAX : (51,3) MAX REL DISPL EVER (1,2) MAX ELEMENT STRESS (3)
C   SINB   : (51) SIN(B), B IS ANGLE FROM X-LOC TO MAX DISPL DIRECT
C   COSB   : (51) COS(B), B IS ANGLE FROM X-LOC TO MAX DISPL DIRECT
C   QPSRES : (4,51) RESULTING LOAD/STRESS BETWEEN NODE AND SOIL
C             1 =   LOCAL-X LOAD (F/L)
C             2 =   LOCAL-Y LOAD (F/L)
C             3 =   LOCAL-Z LOAD (F/L)
C             4 =   TORSIONAL STRESS (F/L**2)
C   SDSP1  : (3,51) INITIALLY GIVEN SOIL DISPLACEMENT VALUES
C   SDSP2  : (3,51) COMPUTED RESULTING SOIL DISPLACEMENT VALUES
C   GSOLZZ : (51) SOIL SHEAR MODULUS FOR TORSIONAL STIFFNESS
C   PTRANS : (3,50) INCREMENTAL FORCES TRANSFERRED FROM PILE TO SOIL
C   SECMOM : (51,2) SECOND ORDER INCREMENTAL MOMENTS  1=XXL 2=YYL
C   FORCER : (2,6,50) RESULTING ELEMENT FORCES  1=TOP 2=BOTTOM
C   FORCEI : (2,6,50) INCREMENT ELEMENT FORCES  1=TOP 2=BOTTOM
C   GRAVX  : (50) PILE ELEMENT TOTAL GRAVITY LOADING, LOCAL X-DIRECT
C   GRAVY  : (50) PILE ELEMENT TOTAL GRAVITY LOADING, LOCAL Y-DIRECT
C   GRAVZ  : (50) PILE ELEMENT TOTAL GRAVITY LOADING, LOCAL Z-DIRECT
C   CCCX   : (51) NODE/SOIL SPRING STIFNS, MAX DISP DIRECT F/L**2
C   CCCY   : (51) NODE/SOIL SPRING STIFNS, MIN DISP DIRECT F/L**2
C   CCCZ   : (51) NODE/SOIL SPRING STIFNS, AXL DISP DIRECT F/L**2
C   DSPLST : (6,51) LAST INCREMENTAL DISPLACEMENT SOLUTION
C   AZ     : (4) VECTOR RELATING AXIAL HEAD FRC AND DSP TO TIP DSP
C   PHSTF  : (6,7) PILE HEAD LOCAL STIFNS MATRIX (6*6) AND LOAD C.V.
C   A      : (4,4) MATRIX RELATING HEAD LATERAL DISP TO TIP DISP
C   B      : (4,4) MATRIX RELATING HEAD LATERAL FORC TO TIP DISP
C   AINV   : (4,4) A-MATRIX INVERTED
C   AC     : (4) LATERAL PILE HEAD DISPLS FOR ZERO TIP DISPL
C   BC     : (4) LATERAL PILE HEAD FORCES FOR ZERO TIP DISPL
C   DSPINC : (6,51) INCREMENTAL PILE NODE DISPLACEMENTS
C   AZZ    : (4) VECTOR RELATING TORSION HEAD MOM AND FRC TO TIP ROT
C   SDSP3  : (3,51) INCREMENTAL SOIL DISPLACEMENTS AROUND NODE
C
C   COMMON  /SCRTCH/  CONTAINS AREA FOR SCRATCH STORAGE
C                     USED BY EQUATION SOLVER AND INTERACTION ROUTINES
C
C   XXX    : (5400) SCRATCH STORAGE AREA
C
C
C     *************************
C     END OF SPLICE*COMMON FILE
C     *************************
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