OTHER START

- [x] LARGE BLACK CLIP
- [ ] MEDIUM BLACK CLIP
- [ ] SMALL BLACK CLIP
- [ ] PAPER RIBBON
- [ ] ELASTIC BAND
- [ ] SPIRAL
- [ ] BINDER
- [ ] THERMAL BIND
- [ ] BOOKLET
- [x] OTHER: Cerlox

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Canada Centre for Mineral and Energy Technology
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Mining Research Laboratories
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Canada

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PCMINTAB USER'S GUIDE

Y.S. Yu and N.A.Toews

c.2?

MRL 88-92(TR)

PCMINTAB USER'S GUIDE - A SOFTWARE PACKAGE FOR DETERMINING THE ELASTIC RESPONSE OF STRATA SURROUNDING TABULAR MINING EXCAVATIONS USING A PERSONAL COMPUTER (PC Version 1.0, 1988)

by

Y.S. Yu and N.A. Toews

Disclaimer

Neither the authors nor the Mining Research Laboratories, Canada Centre for Mineral and Energy Technology, can accept responsibility for the correctness of the results obtained from this software package.

ABSTRACT

PCMINTAB, a software package which was developed based on the displacement discontinuity technique, is described. Its capabilities and limitations for mining applications are summarized. Within the limitations, the software package provide a powerful tool for evaluating stresses and displacements induced by mining in tabular or seam-type orebodies. PCMINTAB was designed to run in a micro computer environment and should prove useful for certain mining applications.

To speed up the process of analysis pre- and post-processors, which are interactive and menu-driven, were incorporated for preparing input data files and interpreting results graphically.

This report provides data input instructions and serves as a user's guide.

Key words: displacement discontinuity, stresses, displacements, closure, rides, off-seam, micro computer

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GUIDE DE L'USAGER DE PCMINTAB - UN LOGICIEL, BASÉ SUR MICRO-ORDINATEUR, PERMETTANT LE CALCUL DES CONTRAINTES ET DÉFORMATIONS CRÉÉES PAR L'EXPLOITATION D'UN GISEMENT TABULAIRE EN MILIEU ÉLASTIQUE (PC version 1.0, 1988)

par
Y.S. Yu* et N.A. Toews*

RÉSUMÉ

Le logiciel PCMINTAB, basé sur la méthode des discontinuités de déplacement, est décrit dans ce rapport. Ses capacités et limitations, pour la simulation de structures minières y sont discutées. Ce puissant outil permet l'évaluation des contraintes et déformations induites par l'exploitation minière d'un gisement tabulaire. PCMINTAB est une version modifiée qui peut être utilisée sur un micro-ordinateur et qui devrait démontrer très rapidement sa qualité à résoudre les problèmes spécifiques à ce type de gisement.

La préparation des fichiers d'entrée des données et l'interprétation des résultats graphiques ont été accélérées par l'addition de pré et post-processeurs interactifs avec menu.

Ce rapport défini le mode d'introduction des données et sert de guide de l'usager.

Mots-clé: discontinuités de déplacement, contraintes, déplacements, convergence, cisaillement, épontes, micro-ordinateur

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FIGURES

INTRODUCTION

PCMINTAB is a software package developed for analyzing pillar extraction scheme in a tabular orebody which is flat - lying or dipping at an angle up to 90° to the horizontal. It is based upon the displacement discontinuity technique, and the mathematical background of this technique has been described in detail [1,2,3].

The program PCMINTAB is a new version of the program MINTAB which was originally developed at Consolidated Golfields Corporation in South Africa by S.L. Crouch and has been extensively modified at the Mining Research Laboratories [4]. It was first modified to run on the departmental main frame computer and then a VAX-11/750 mini computer. Recently, the program MINTAB was further modified to run in a personal computer environment and renamed as PCMINTAB. These modifications include dynamic dimensioning of data arrays, restart capability, arbitrary initial stresses, compressibility of pillars or intact elements, and linear backfill capability; a new procedure to calculate off-seam stresses and displacements was implemented in the companion program OFREEF. Both programs of PCMINTAB and OFREEF were rewritten in accordance with Fortran 77 Standard. In addition, pre- and post-processors have been developed for preparing input data and interpreting output results. The pre- and post-processors, using GSS*GKS software, are interactive, user-friendly, and menu-driven.

This report supplements the previous report MRP/MRL 83-25 [4]. It describes some modifications made to the PCMINTAB program and it also provides data input instructions and serves as a user's guide. A simple example is given for running PCMINTAB on an IBM PC/AT compatible personal computer system.

GENERAL REMARKS

The mathematical formulation upon which PCMINTAB is based have been presented by Starfield and Crouch, and others [2,3]. An effort to derive the mathematical expressions of interest was also conducted independently at MRL, so that the MINTAB or PCMINTAB program would be thoroughly checked to ensure accuracy.

Essentially, this analytical technique deals with extraction of a relatively thin plane deposit which may have any orientation relative to the ground surface. It is assumed that the mine workings are sufficiently deep so that the influence of the surface on stresses and displacements near the mine workings can be neglected. As shown in Fig. 1, the seam or reef (ore-body) with a thickness 't' is dipping at an angle to the horizontal and is located at some distance below the surface. The thickness 't' of the orebody is small compared to its lateral extent and the depth below the surface. Therefore, the seam or reef can be viewed as a simple plane crack of negligible thickness. Figure 2(a) shows the discretization (division into elements or squares) in the

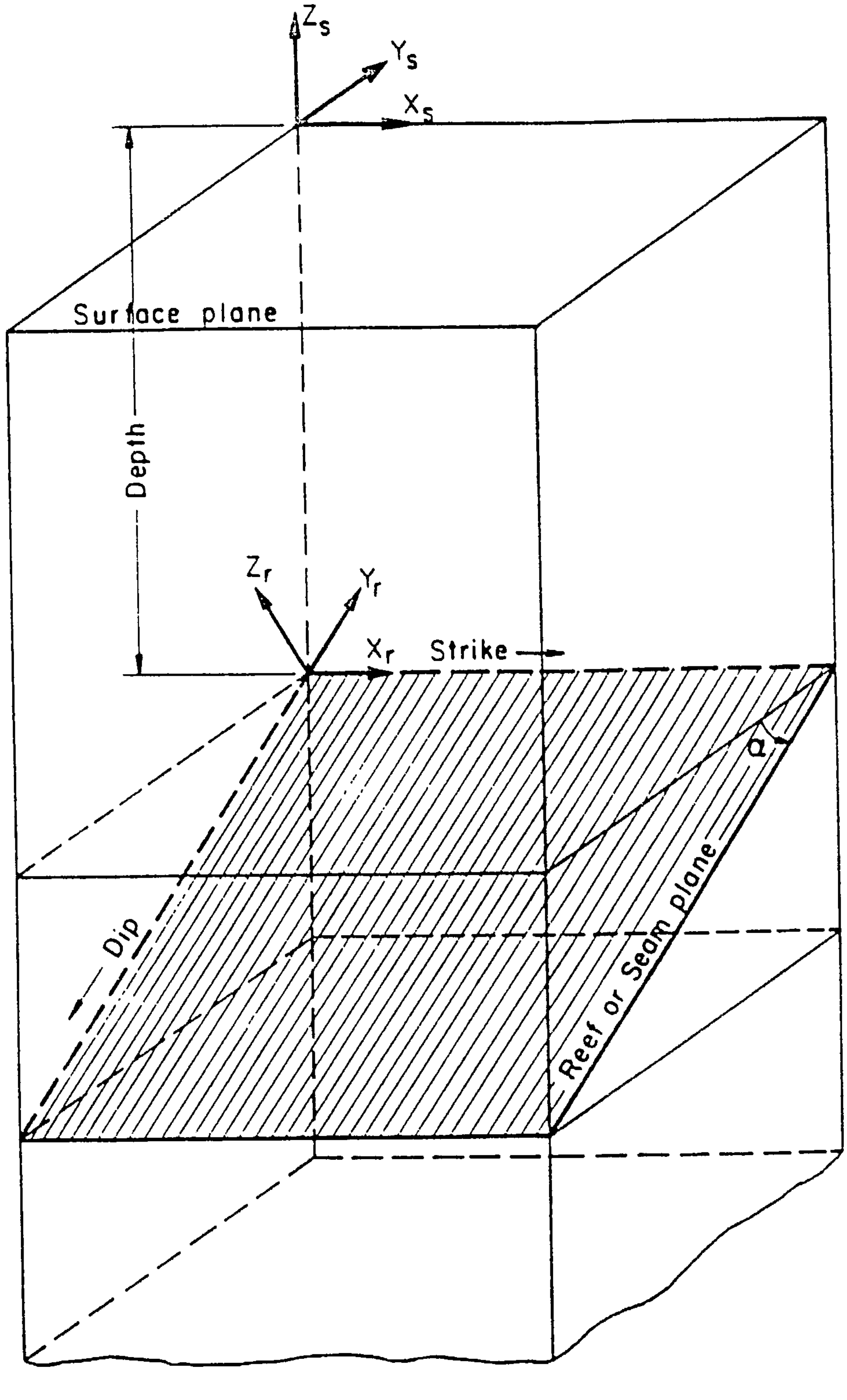


Fig. 1(a) - The coordinate system on surface plane (global) and in the reef or seam plane (local): positive Z_r is directed into the hangingwall and the dip angle is α.

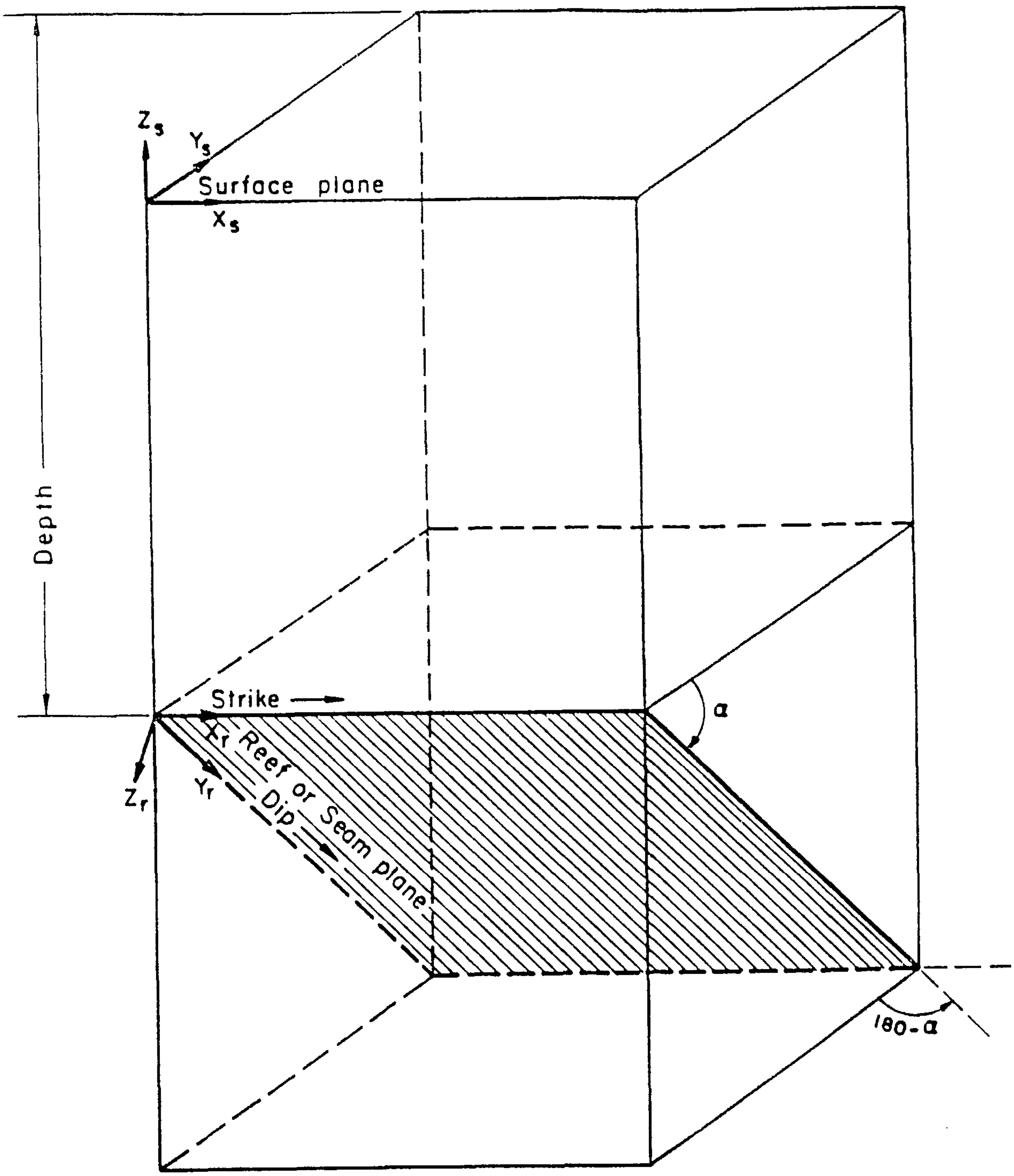


Fig. 1(b) - The coordinate system on surface plane (global) and in the reef or seam plane (local): seam dips away from an observer's eye and positive Z_r is directed into the footwall, the angle (180 - α) is used as the dip angle.

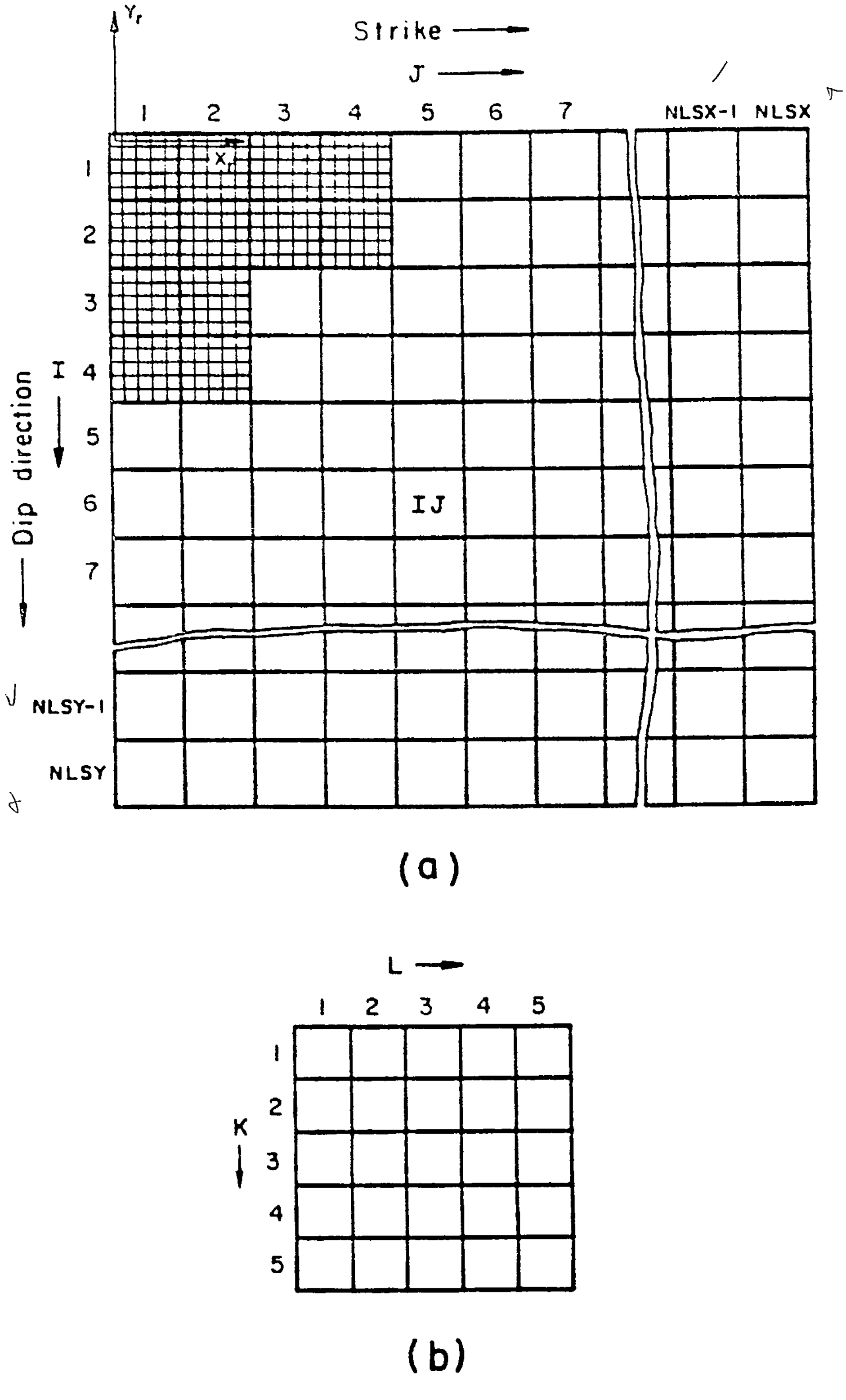


Fig. 2 - Discretization in the mining horizon in the plane $Z_r = 0$. (a) NLSX and NLSY are the maximum number of large squares in X_r and Y_r direction respectively, and (b) a typical large square IJ, is further divided into 5×5 small squares.

mining horizon in the plane $Z_r = 0$. The region of interest in the mining horizon is divided into a number of large squares. A typical large square is identified by its row number I and its column number J as shown in the Fig 2(a). A typical large square is further divided into 5 × 5 small squares as shown in Fig. 2(b). A small square within a given large one is identified by a row number K and a column number L as shown.

As mentioned earlier `PCMINTAB` and its companion program `OFREEF` have been modified and extended as follows:

1. To meet Fortran 77 specifications and enhance its portability between computers.
2. Dynamic dimensioning of `PCMINTAB` data arrays was introduced so that the program memory requirement can be kept to a minimum. The mine grid, at present, is expanded to 6400 elements, i.e., 80 elements in the x-direction and 80 elements in the y-direction. A mine grid of 80 × 80 should be sufficient for most mining applications.
3. The compressibility of pillars or intact elements (unmined portions) have been taken into account and implemented in the present version of the program.
4. A linear backfilled element has also been introduced. The characteristics of a backfill element (small squares) can be stated briefly as follows:
   (a) Freshly placed backfill does not carry any stress until it is compressed by roof and floor closure that accompanies subsequent mining activities. As an illustrated example, the newly placed backfill in stope No. 1, as shown in Fig. 6(p. 33), is stress free until stope No. 2 is excavated (mining step No. 2). Similarly the backfill in the upper portion of stope No. 2 will remain unstressed until the upper portion of the pillar is extracted.
   (b) In the simulation the mining cycle is carried out by backfilling first and followed by excavation if excavating and backfilling are taking place at the same time but in different stopes.
   (c) The stresses transmitted across a backfilled element (small square) will depend upon the closure and ride components that occur at the element after the fill has been stowed in place.

(d) The relationship between the stress and closure or rides for the backfill material is assumed to be linearly elastic. Thus the backfill can be defined by the material constants K_n and K_s,where K_n and K_s are the normal and shear stiffness respectively.

(e) The pore pressure of backfill, if hydraulically placed, has not been taken into account.

5. Arbritrary initial stress fields have been incorporated. The program was modified to accept arbitrary initial stresses. The initial stresses are assumed to be in the form of:

$$\sigma_{xx} = a_{xx} + b_{xx} * z$$
$$\sigma_{yy} = a_{yy} + b_{yy} * z$$
$$\sigma_{zz} = a_{zz} + b_{zz} * z$$
$$\tau_{xy} = a_{xy} + b_{xy} * z$$
$$\tau_{yz} = a_{yz} + b_{yz} * z$$
$$\tau_{xz} = a_{xz} + b_{xz} * z$$

Where $\sigma_{xx}, \sigma_{yy}. \dots . \tau_{xz}$ are the six stress components defining a complete three dimensional stress field in a global co-ordinate system. $a_{xx}, b_{xx}. \dots . a_{xz}, b_{xz}$ are the coefficients relating the stresses to depth (-z) of a point under consideration.

6. A restart capability has been incorporated. This is considered a useful feature in simulating large mine grids with multiple sequences of mining. It allows the user to examine stress and displacement step by step or to modify input data of a particular mining step (sequence) without repeating calculations of the previous mining step(s). In addition, this also removes the restriction in earlier versions that only a maximum of nine mining steps are permitted.

7. Off-seam stress/displacement calculations are separated from the main program. Routines associated with off-seam stress and displacement calculations have been separated from the main program and have been rewritten in accordance with Fortran 77 Standard. It is named as `OFREEF`. Now it stands alone and can be considered as a part of the 'post-processor'. The reason for this is that when additional information for off-seam locations, other than those already specified, is

required, there is no need to rerun the whole PCMINTAB program but only the companion program OFREEF. Thus it reduces computing costs.

8. In the original version of PCMINTAB the numerical solution procedure is not very stable when one attempts to calculate stress and displacement at locations which are very close to the seam plane, i.e., in the immediate area of roof or floor, large errors are observed. In order to correct this situation, rides and closure are no longer assumed to lie only at the centre of an element but to be distributed uniformly over an element. This procedure for off-seam stress and displacement calculations is based on the work of J.P.E. Moris, Chamber of Mines of South Africa [3]. When this is done stresses and displacements calculated at the centre of an element no longer have a singularity, thus it is possible to calculate displacements and stresses anywhere in the rock mass including points located in the seam.

9. The software package was modified to run in a personal computer environment under MS DOS operating system.

10. pre- and post-processors were developed to provide an interactive data entry including data for control parameters, material properties and mining patterns, and to provide graphical representation of results obtained from the execution of the program PCMINTAB.

CAPABILITIES AND LIMITATIONS

The capabilities and limitations of MINTAB can be summarized as follows:

Capabilities:

1. Complex stope-and-pillar or any mining geometries in a tabular orebody can be simulated inexpensively.

2. Any number of mining sequences or steps (extraction/backfill etc.) can be easily modelled.

3. Linear compressibility of pillars, remnants or abutments can be simulated.

4. The seam deposit and the rock mass can have different material properties.

5. Linear behavior of the backfill material can be modelled.

6. Arbitrary three-dimensional initial stress fields can be taken into account.

Limitations:

1. Elastic behavior of orebody and surrounding rocks has to be assumed.
2. The region outside the mine grid is still considered incompressible.
3. Pillar yielding or fracturing cannot be simulated. In addition, support systems such as rock bolts cannot be modelled.
4. The mine must be sufficiently deep so that the ground surface will not influence the results.

Within these limitations, the model provides another means of evaluating stresses and displacements induced by mining a tabular orebody. It is relatively inexpensive to run and should prove useful for certain mining applications.

SIGN CONVENTION AND SYSTEM OF UNITS

The following sign conventions are used in this report:

Displacements U_x, U_y and U_z are positive if they pointed in the positive directions of X_r, Y_r and Z_r axes respectively (Fig. 3(a)).

The rides (D_x, D_y) and closure (D_z) are defined as:

$$D_x = U_x(Z_r = O_-) - U_x(Z_r = O_+)$$
$$D_y = U_y(Z_r = O_-) - U_y(Z_r = O_+)$$
$$D_z = U_z(Z_r = O_-) - U_z(Z_r = O_+)$$

When the dip angle α is less than 90°, i.e., the orebody is dipping toward the observer as shown in Fig. 1(a), $Z_r = O_+$ and $Z_r = O_-$ represent the roof and the floor of a seam respectively; when the orebody is dipping away from the observer's eye and the angle $(180 - \alpha)$ is considered as the dip angle as shown in Fig. 1(b). In this case, $Z_r = O_+$ and $Z_r = O_-$ represent, respectively, the floor and roof of a seam. A positive value of D_z indicates an excavation being closed or compression of the seam material.

It is desirable for mining applications that the convention where compressive stresses are positive be adopted. To achieve this all stresses including shear stresses are reversed in sign. The normal stresses and the shear stress components are shown in Fig. 3(b).

The program will accept any consistent system of units. However, the input and output format is basically designed for the SI system. Therefore, SI units are strongly recommended.

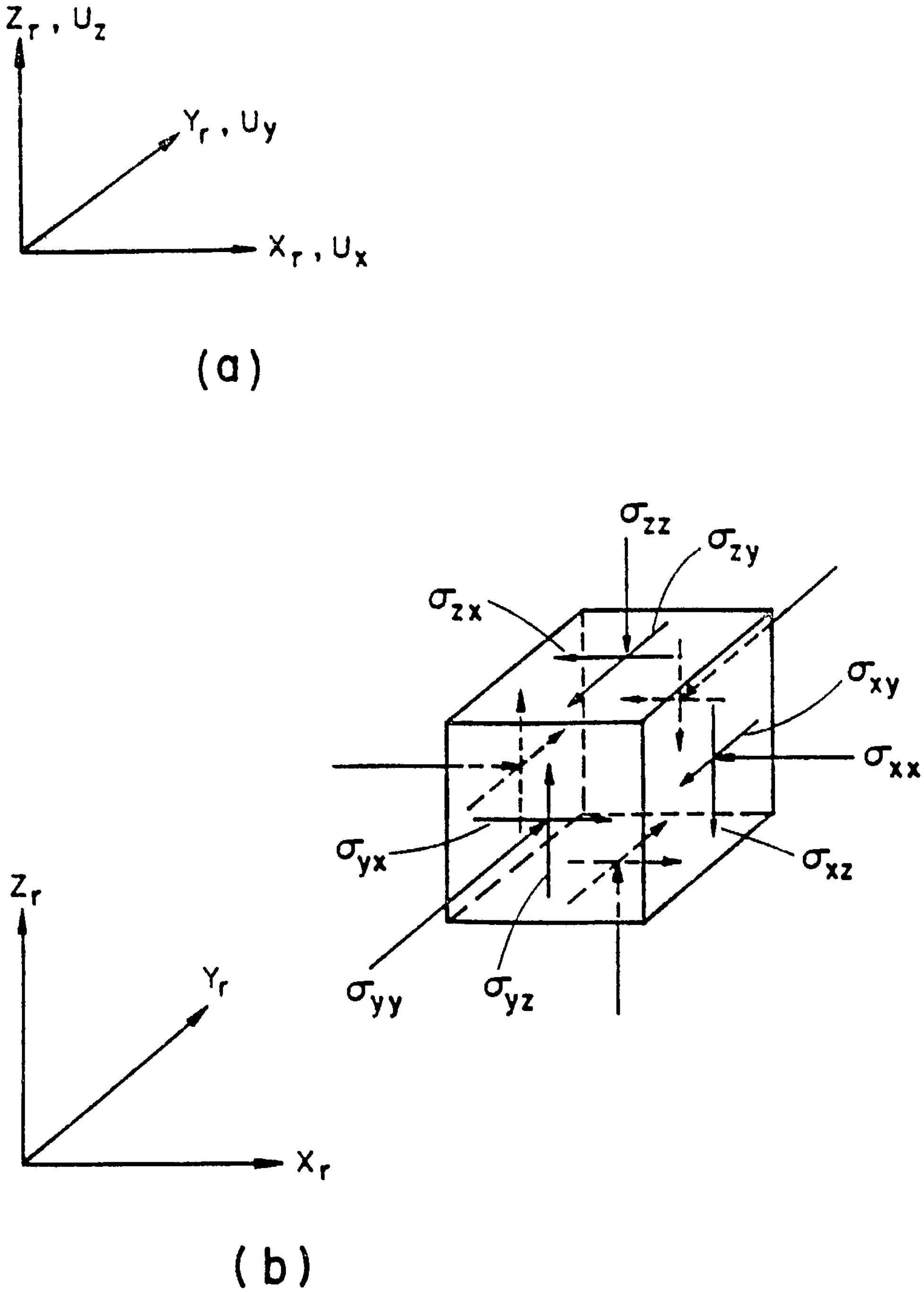


Fig. 3 - Sign convention: (a) Displacement components and (b) stress components.

Modulus of deformation	MPa
Unit weight of rock	MN/m**3
Size of grid elements	m
Stoping thickness	m
Poisson's ratio	dimensionless
Energy released	MJ/m**2
Stresses	MPa
Displacements (rides, closures)	m

COMPUTER MEMORY REQUIREMENTS

If Executable Code is Provided:

The core memory required to run PCMINTAB on a micro computer is approximately 232 Kbytes. The maximum values of these control parameters which defines the size of your mine grid is given below:

NLSX	16
NLSY	16
MAXELR	250
MAXBF	900

where NLSX is the number of large squares in the x - direction and is limited to a maximum of 16. NLSY is the number of large squares in the y - direction and is also limited to 16. MAXELR is the maximum number of elements or squares to be removed in any one mining step after the first one; MAXBF is the maximum number of backfill elements.

If Source Code is Provided:

Necessary storage requirements depend on the problem being analyzed. The storage assigned for a given problem is controlled by the dimension of blank common A and the value assigned to MXDIM as set in the main program (MINTAB). These statements are:

```
COMMON A (n)
MXDIM = n
```

The value of n required for a particular problem may be calculated as follows:

$$n = 100 \times NLSX \times NLSY + 4 \times MAXELR + 3 \times MAXBF$$

where NLSX, NLSY, MAXELR and MAXBF are the same as defined above.

INPUT DATA INSTRUCTIONS

The input data for the PCMINTAB program, is grouped as follows:

1. Problem identification (3 records, for identification only; compulsory).
2. Job control parameters (1 record, compulsory).
3. Mine grid control parameters (1 record, compulsory).
4. Pre-mining stress information (6 records, compulsory).
5. Solution convergence control data (1 record, compulsory).
6. Material properties (2 records, compulsory).
7. Restart file information (1 record, optional).
8. Mining step information (3 records, compulsory).
9. Mining pattern information (including excavation, backfill etc., and print control; variable*).

The details of the input requirements is described in the following tables 1-9.

* "Variable" in the above means that the number of records in the category is not fixed but is problem dependent.

> o Keybord

> o Arrow → ↕←

→ D:\PCMINTAB\USER>mintab

File : XXX. DAT

Table 1

Variable(s)	Variable Definition or Description	Format
Group 1 - Problem Identification Information Data:		
Line No. 1 - Name of the mine to be studied:		
MINAME	80 characters (20 words) mine name.	20A4
Line No. 2 - Job description:		
JOBDES	A short description of the study (80 characters)	20A4
Line No. 3 - Date information		
DATE	Date (day/month/year) on which this study is being done. A total of 80 characters.	20A4
Remarks:		

Table 2

Group 2 - Job Control Parameters Information (1 record):		
Variable(s)	**Variable Definition or Description**	**Format**
Line No. 1 - Restart and mining step information:		
ISTART	A restart indicator. = 0, implies that this is an initial run. = 1, implies that this is a restart run with restart information to be read from logical file 'RESTART'.	I5
ISTPST	ISTPST is the mining step number residing on the restart file (RESTART), which will provide the starting information for the current run.	I5
ISTPI	ISTPI is the step number of the first mining step in the current run.	I5
ISTPF	ISTPF is the step number of the final mining step in the current run.	I5
Remarks:		

Not tested

0 ✓ Initial RUN [See page 38 for inputs]

1

1

3

Mining lower stope, backfill upper stope

Table 3?

Group 3 - Mine Grid Control Parameters (1 record):

Variable(s)	Variable Definition or Description	Format	
Line No. 1 - Mine Grid Control Parameters:			
NLSX	The number of large squares in x - direction or along the strike direction ($2 \leq NLSX \geq 16$).	I5	5 ✓
NLSY	The number of large squares in y - direction or along the dip direction ($2 \leq NLSY \geq 16$).	I5	10
EW	The width of small square or element in metres.	F10.0	3. m
DEPTH	The depth of the top or first row of the mine grid (samll squires) below ground surface, in metres.	F10.0	350 m
ALF	The dip angle of the seam or orebody in degrees.	F10.0	75°
HO	The stope thickness in metres.	F10.0	2 m

Remarks:

Table 4

Group 4 - Pre-mining or far field stress information: arbitrary three-dimensional in situ stresses can be input. Twelve (12) coefficients are required to define the state of 3-dimensional stresses.

Variable(s)	Variable Definition or Description	Format
Line No. 1 - Coefficients for normal stress σ_{xx}.		
AXX, BXX		2E15.6
Line No. 2 - Coefficients for normal stress σ_{yy}.		
AYY, BYY		2E15.6
Line No. 3 - Coefficients for normal stress σ_{zz}.		
AZZ, BZZ		2E15.6
Line No. 4 - Coefficients for shear stress σ_{xy}.		
AXY, BXY		2E15.6
Line No. 5 - Coefficients for shear stress σ_{xz}.		
AXZ, BXZ		2E15.6
Line No. 6 - Coefficients for shear stress σ_{yz}.		
AYZ, BYZ		2E15.6

Remarks: The definition of these coefficients can be illustrated by the equations, on the following page, representing the initial or far field stresses. (continued over)

0.052
300
174.00.2 8

Table 4 (continued)

Group 4 - Continued.		
Variable(s)	Variable Definition or Description	Format

$$\sigma_{xx} = AXX + BXX \times Z$$
$$\sigma_{yy} = AYY + BYY \times Z$$
$$\sigma_{zz} = AZZ + BZZ \times Z$$
$$\sigma_{xy} = AXY + BXY \times Z$$
$$\sigma_{xz} = AXZ + BXZ \times Z$$
$$\sigma_{yz} = AYZ + BYZ \times Z$$

For example, under a gravitational loading the vertical stress σ_{zz} is due to the weight of overburden and the horizontal stresses, σ_{xx} and σ_{yy} are due to Poisson's effect only. If we assume a depth of 300m, an average density (unit weight) of the overburden is 0.029 MN/m^3, and Poisson's ratio of 0.25, then:

$$\begin{aligned}\sigma_{zz} &= -0.029 \times Z \\ &= -0.029 \times (-300) \\ &= 8.7\ MPa\end{aligned}$$

$$\begin{aligned}\sigma_{xx} = \sigma_{yy} &= \nu/(1-\nu) \times \sigma_{zz} \\ &= 0.25/(1-0.25) \times (0.029) \times Z \\ &= 0.00967 \times (-300) \\ &= 2.9\ MPa\end{aligned}$$

The negative sign is added to Z because it is directed upward in the global coordinates system as positive. Therefore, we have:

$AXX = 0.0, \quad BXX = -0.00967$
$AYY = 0.0, \quad BYY = -0.00967$
$AZZ = 0.0, \quad BZZ = -0.029$
$AXY = 0.0, \quad BXY = 0.0$
$AXZ = 0.0, \quad BXZ = 0.0$
$AYZ = 0.0, \quad BYZ = 0.0$

Table 5

Group 5 - Solution Convergence Control Information:

PCMINTAB program uses an iterative equation solver. This iterative process is controlled by two parameters, IACC and MAXINT.

Variable(s)	Variable Definition or Description	Format
Line No. 1 - Solution convergence data:		
IACC	IACC specifies the convergence criterion. When the unbalanced stress is less than equal to $0.01 \times IACC \times \sigma_{zz}$ the solution is considered to have converged. A value of 1 has yielded reasonable results.	I5
MAXINT	Maximum number of iterations; 10 to 20 iterations should be sufficient for most problems.	
Remarks:		

> EDT ABC.DAT

Mining pattern

>1 Mouse

>1 Printer

Table 6

Group 6 - Material Properties Information (2 records):

Variable(s)	Variable Definition or Description	Format	
Line No. 1 - Modulus and Poisson's ratio:			
E	Modulus of deformation of the rock mass in MPa.	E15.6	7.0E+4
PR	Poisson's ratio.	E15.6	0.25
Line No. 2 - Physical property of pillar and backfill materials:			
STIFFC	Normal stiffness of pillar or intact element in MPa. Default value = E.	E15.6	7.0E+4
STIFFR	Shear stiffness of pillar or intact element in MPa. Default value = E/2 (1 + PR).	E15.6	2.7777E+4
STIFBC	Normal stiffness of backfill materials in MPa.	E15.6	3.5E+2
STIFBR	Shear stiffness of backfill materials in MPa.	E15.6	—0— <Enter> 2 times

Remarks:

Table 7

Group 7 - Restart File Information:

The following record is required only if the current job is a restart run, i.e., ISTART $\neq 0$.

Variable(s)	Variable Definition or Description	Format
Line No. 1 - A description of file:		
FILDES	A 80 characters (20 words) file name allows the user to define the restart file. The information will be saved on the current 'SAVE' File.	20 A4

Remarks:

Table 8

Group 8 - Mining Step Information: For each mining step from ISTPI to ISTPF the following block of information is required.

Variable(s)	Variable Definition or Description	Format
Line No. 1 - Mining step or sub-problem number:		
ISTP	ISTP is the current mining step number.	I5
Line No. 2 - Mining step description:		
STPDES	80 character description of the current mining step.	20A
Line No. 3 - Mining pattern print control information:		
MINPR	Mining pattern print indicator: MINPR = 0, indicates that new mining pattern is not to be printed. MINPR ≠ 0, indicates that the new mining pattern will be printed.	I5

Remarks:

Table 9

Group 9 - Mining Pattern Information: A group of records defining a new mining pattern for the current mining step. This group of records consists of the following sub-groups - 9.1, 9.2, and 9.3:

Variable(s)	Variable Definition or Description	Format
Group 9.1 - Defining the large squares in the y - direction:		
Line No. 1		
LYI, LYF	LYI - LYF inclusive define a sequence of larege squares in the y - direction which are be redefined. LYI is the first row of large square in the sequence, and LYF is the last row of large squares in the sequence. Each large square in the sequence has 5 records associated with it corresponding to 5 rows of small squares. Therefore, a total of $5 \times (LYF - LYI + 1)$ records will follow.	2I5
Line No. 2 to line No. $5 \times (LYF - LYI + 1) + 1$		
PAT ( )	is the mining pattern which defines a maximum of 80 small squares or elements in a row of the mine grid. The mining pattern is designated as follows: - a 'blank' value signifies no changes from the previous pattern. - an 'E' signifies that an excavation of this element is to be implemented. If element is already excavated or mined-out, the 'E' value is treated as a blank. - a 'B' signifies that the element is backfilled in current mining step. If element is already back filled it will be ignored.	80A1

Remarks: (1) The mining pattern can be defined or modified by one or more sub-groups 9.1 as described above.

(2) The value LYI of the current sub-group must be larger than LFY of the previous sub-group.

(3) a blank line or record must be the last entry in this block of records defining the new mining pattern.

INPUT

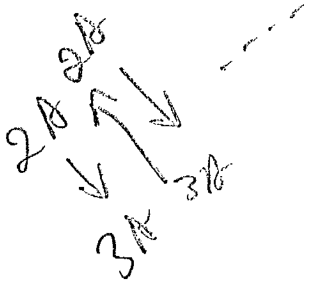


Table 9 (continued)

Group 9 - Continued		
Variable(s)	Variable Definition or Description	Format
Group 9.2 - Output-print control information:		
Line No. 1 : This information controls the printing of in-seam results.		
IPRPC	IPRPC = 0, no in-seam results will be printed. IPRPC < 0, all in-seam results will be printed. IPRPC > 0, a selected print of in-seam results.	I5
ISELPR	ISELPR has meaning only if IPRPC > 0. ISELPR ≠ 0, it takes the print pattern as defined in the previous mining step. If this is a restart run and ISTP = ISTPI, the print pattern will be the same as that of the restart mining step, ISTPI. If this is an initial run and ISTP = ISTPI then previous mining step print pattern is taken to be no print for in-seam results. ISELPR = 0, it takes the print pattern as defined in previous step and modifying it. All remarks for ISELPR ≠ 0 apply here as well.	I5
IPRPP	print-pattern output control. IPRPP = 0, mining step print pattern is not printed. IPRPP ≠ 0, mining step print pattern is printed.	I5
Remarks:		

Table 9 (continued)

Group 9 - Continued		
Variable(s)	Variable Definition or Description	Format
Group 9.3 - Block of records re-defining the print pattern. This block of data is required only if ISELPR $\neq 0$.		
Line No. 1 : This information controls the printing of in-seam results.		
LYI, LYF	LYI - LYF inclusive define a sequence of large squares in the y - direction. LYI is the first row of large square in the sequence, and LYF is the last row of large squares in the sequence. This is followed by $(LYF - LYI + 1)$ records which define the print pattern.	2I5
Line No. 2 to line No. $(LYF - LYI + 1) + 1$		
PAT ( )	This takes a large square as a basic unit for printing in-seam results. The print pattern is designated as follows: - a 'blank' value signifies no changes from the previous pattern. - a 'P' signifies print. - a 'N' signifies no print.	16A1
Remarks: (1) A blank line or record must follow the block of data redefing the print pattern. (2) This ends the input for current mining step. (3) Repeat data Groups 8 and 9 for the next mining steps if required.		

```
D:\> cd \pcmintab

D:\pcmintab> mintab
```

CONTENTS OF FILE - 'SAVE'

The following information is stored on file 'SAVE' on the hard disk after executing the PCMINTAB program. This information will be required either for a restart run or for off-seam stress and displacement calculations. An additional output file , 'POST', is created for plotting purposes, i.e., graphical representation of stresses and displacements. The 'SAVE' file is formatted and its contents are given below in Table 10.

Table 10

Contents of 'SAVE' File	Format
MINAME JOBDES DATE ISTART, ISTPST, ISTPI, ISTPF	20A4 20A4 20A4 4I5
If (ISTART $\neq$ 0) the following four records will be written: FILDES (on restart file) JOBDES (on restart file) DATE (on restart file) STPDES (on restart file)	 20A4 20A4 20A4 20A4
NLSX, NLSY, EW, DEPTH, ALF, HO AXX, BXX, AYY, BYY, AZZ, BZZ AXY, BXY, AYZ, BYZ, AXZ, BXZ IACC, MAXINT E, PR, STIFFC, STIFFR, STIFBC, STIFBR	2I5,4E15.7 6E15.7 6E15.7 2I5 6E15.7
For each mining step the following records are stored:	
ISTP STPDES MINES (NUMLS,5,5) Each large block is stored in 2 records; the first record is formatted as (16I5) and the second record is (9I5). There are NUMLS large blocks where NUMLS = NLSX $\times$ NLSY	I5 20A4
IPRS (NLSY, NLSX) A total of NLSY records; each record is a row (16I5).	
NXTLOC DXYZO (3, NXTLOC -1) A total of (NXTLOC - 1) records; each record is (3E15.7)	I5
MIN,DX,DY,DZ,SIGXX,SIGYY,SIGZZ,SIGXY,SIGYZ,SIGXZ,ENGRRL The above are the in-seam results and are stored in $25 \times NLSX \times NLSY$ blocks with two records in each block. The format is (A1, 3E15.7/7E15.7)	

OFF-REEF STRESS AND DISPLACEMENT CALCULATIONS

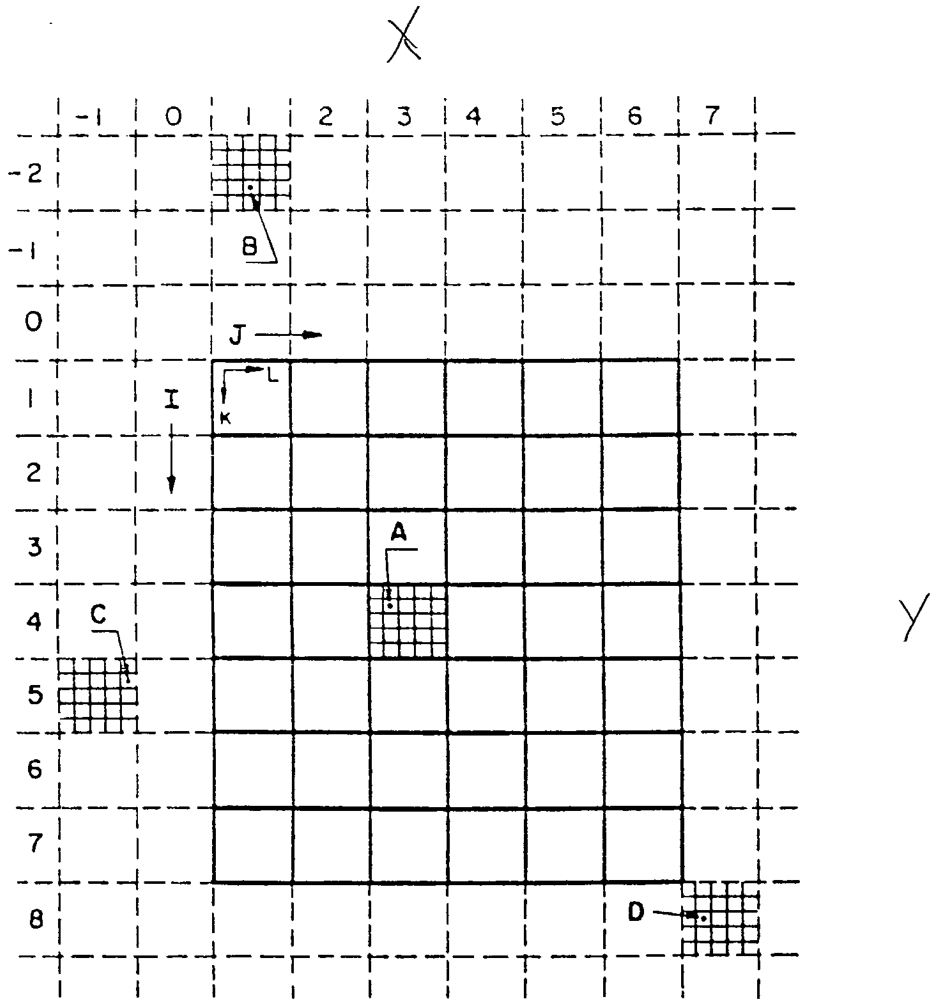
In the earlier versions of PCMINTAB, off-reef stresses and displacements were evaluated together with the in-reef quantities (rides/closure and stresses etc.). If additional information is required for off-reef locations other than those already specified, the PCMINTAB program had to be rerun, which is expensive in terms of computing time. Therefore it is desirable to separate off-reef stress/displacement calculations from the main program and it can be run as a 'post processor'. This companion program, as mentioned earlier, has been modified in accordance with Fortran 77 standard and named as OFREEF. The input data for OFREEF is quite simple. The input instructions for OFREEF and co-ordinate calculations of off-reef points are given in the following sections.

Coordinates of the Off-Seam Stress Points:

Stresses and displacements for points which are located anywhere within the rock mass including points located in the mid plane of the seam can be calculated; the global and surface coordinates (X_s, Y_s, Z_s) of these points or locations have to be specified by the users. Note that the specified point is mapped onto a plane parallel to the mid-plane of seam; imagine that a mine grid is projected onto that plane and then the co-ordinates X_s and Y_s are transferred to the centroid of the nearest small element while Z_s remains unchanged. Figure 4 shows a typical projection of the off-reef points.

If points or locations in relation to the reef coordinate system are desired for stress calculations, it is necessary to know the coordinates in the local (seam) system and then transform them into the global system.

For example, suppose we have a seam dipping at 15°, and the mine grid is composed of 25 x 60 small squares. The depth of seam (measured from ground surface to the first or top row of small squares) is assumed to be 350m and we assume the size of the small square is w = 3 m. Now we wish to know the stresses and displacements at a point A, located at a distance of 10m above the square (perpendicular to the seam and into the hanging wall), say I = 6, J = 5, K = 2, L = 4, where I, J identifies the large squares and K, L identifies the small squares. Let's imagine that the mine grid can be mapped onto a plane passing through the point A and parallel to the seam plane, then the coordinates of A in the local (seam) coordinate system (Fig. 5) can be calculated as follows:



NLSX = 6
NLSY = 7

Specified point	I	J	K	L
A	4	3	2	2
B	-2	1	4	3
C	5	-1	2	5
D	8	7	3	2

I, J define large squares

K, L define small squares

Fig. 4 - Example of specified off seam stress/displacement locations: these points are projected onto a plane parallel to the seam plane; the coordinates (X_s, Y_s) are transferred to the nearest centroid of a small element or square while Z_s remains unchanged.

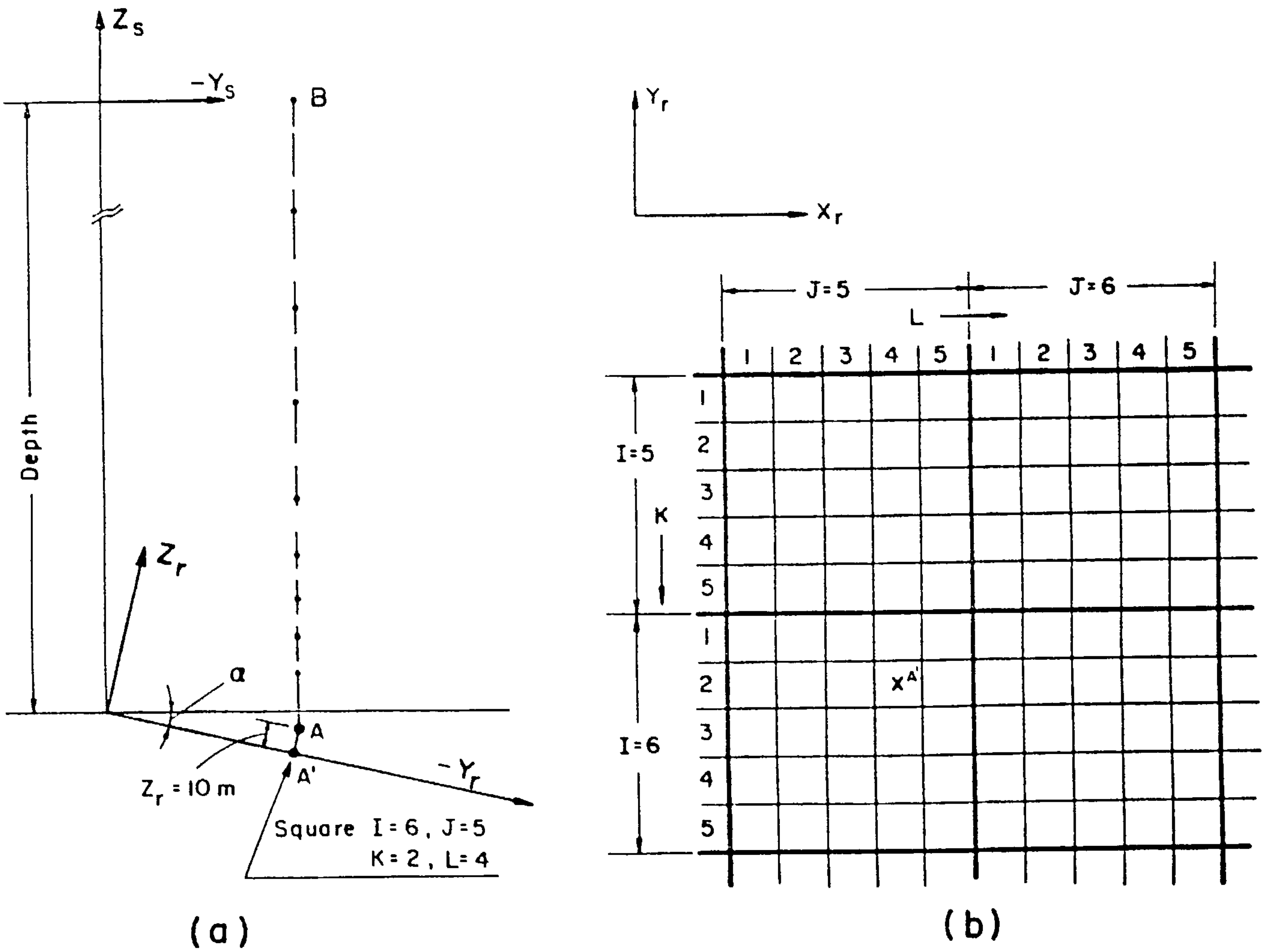


Fig. 5 - Section and plan view showing selected off-seam points:
(a) Y_rZ_r plane, and (b) X_rY_r plane.

$$
\begin{aligned}
X_r &= [5(J-1)+L-1] \times w \\
&= [5 \times (5-1)+4-1] \times 3 \\
&= 69.0m \\
Y_r &= -[5(I-1)+K-1] \times w \\
&= [5 \times 6 \times (6-1)+2-1] \times 3 \\
&= -78.0m \\
Z_r &= 10.0
\end{aligned}
$$

The transformation matrix relating the local (seam) coordinates and the global (surface) coordinates is given as:

$$
\begin{Bmatrix} X_s \\ Y_s \\ Z_s \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & cos\alpha & -sin\alpha \\ 0 & sin\alpha & cos\alpha \end{bmatrix} \begin{Bmatrix} X_r \\ Y_r \\ Z_r \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ -D \end{Bmatrix}
$$

where α = the dip angle of the seam plane in degrees (see Note), and

D = the depth (in meters) measured from the surface to the first or top row of the mine grid (small squares).

Now the global coordinates of point A is thus calculated as:

$$
\begin{aligned}
X_s &= X_r \\
&= 69.0m \\
Y_s &= Y_r cos\alpha - Z_r sin\alpha \\
&= -78.0cos15^\circ - 10.0sin15^\circ \\
&= -77.93m \\
Z_s &= Y_r sin\alpha + Z_r cos\alpha - D \\
&= -78.0sin15^\circ + 10.0cos15^\circ - 350.0 \\
&= -360.53m
\end{aligned}
$$

Note: if the seam is dipping away from the user's eye [Fig. 1(b)], the dip angle is taken as (180 - α) which is greater than 90°.

If stresses along the vertical section AB as shown in Fig. 5 are required, the global coordinates for points along that section can be easily obtained after the coordinates of A are given. It can be easily seen that the values of X_s and Y_s remain constant in the global system while Z_s decreases (absolute value) and reaches 0 at the surface.

Data Input Instructions for OFREEF

The PCMINTAB output (SAVE file) is stored either on a disk file or on floppy diskette when PCMINTAB is executed. This SAVE file has to be attached to run OFREEF. The data required for running OFREEF is quite simple and is described below in Table 11:

Table 11

Group 1 - Control Parameters:		
Variable(s)	Variable Definition or Description	Format
Line No. 1 - Name of the mine to be studied:		
NUMSTP	Number of mining steps to be evaluated.	I5
MAXOR	Maximum number of off-seam stress points to be specified for any mining step.	I5
Group 2 - Coordinates of off-seam stress points		
Line No. 1 - Mining step information:		
ISTP	Current mining step number.	I5
NUMOR	Number of off-seam stress points to be evaluated for current mining step.	I5
Line No. 2 - Global Coordinates		
XOR	X - coordinate in the global system.	E15.7
YOR	Z - coordinate in the global system.	E15.7
ZOR	Z - coordinate in the global system.	E15.7
Remarks:	1. Repeat record Group 2 'NUMSTP' times. 2. If NUMOR is specified as zero (0) for the successive mining steps the off-seam stress/displacement will be calculated at the locations as specified in the previous mining step.	

EXAMPLE PROBLEM

Only a very simple problem will be considered. This example is a hypothetical stope-and-pillar extraction with backfill, and it is used for demonstration purpose only. The sequence of mining for this example is shown in Fig. 6. Four mining steps (stages) were designed; the first three steps were executed in the initial run and the fourth was done by using the restart option. The input information for the first three mining steps is shown in Fig. 7(a), Fig. 7(b) and Fig. 7(c). In addition, off-seam stresses and displacements were evaluated afterward.

Suppose that a 2m thick seam dipping at an angle of 15° to the horizontal has been extracted over a fairly large area. As extraction proceeds down dip, a rib pillar of 9m wide was initially left standing between the 15m wide stopes; the first stope was backfilled prior to the extraction of the second stope. The upper portion of the second stope was backfilled before the pillar was extracted.

The example problem is modelled by using a 20 x 60 grid of small squares or elements to simulate the mining patterns. The deformation modulus $E = 7.0 \times 10^4$ MPa and Poisson's ratio $\nu = 0.25$ were assumed for the rock mass and the orebody (seam).

The initial stress field is assumed as follows:

$$\begin{aligned} \sigma_{zz} &= -\gamma Z \\ &= -0.0270Z \\ \sigma_{xx} &= 1.0\sigma_{zz} \\ &= -0.0270Z \\ \sigma_{yy} &= 1.5\sigma_{zz} \\ &= -0.0405Z \\ \tau_{xy} &= \tau_{yz} \\ &= \tau xz \\ &= 0 \end{aligned}$$

where γ is the unit weight of the rock mass and is taken as $0.027MN/m^3$. Z is the depth below the ground surface; in the global (surface) coordinate Z is directed upward. A negative sign is added to the term γZ so that the compression positive convention is maintained. Note that the unit weight of γ is not required for input but is used only for calculating initial stresses. Values of 3.5×10^2 MPa and 0.0 were assumed, respectively for the normal stiffness and shear stiffness of the backfill material.

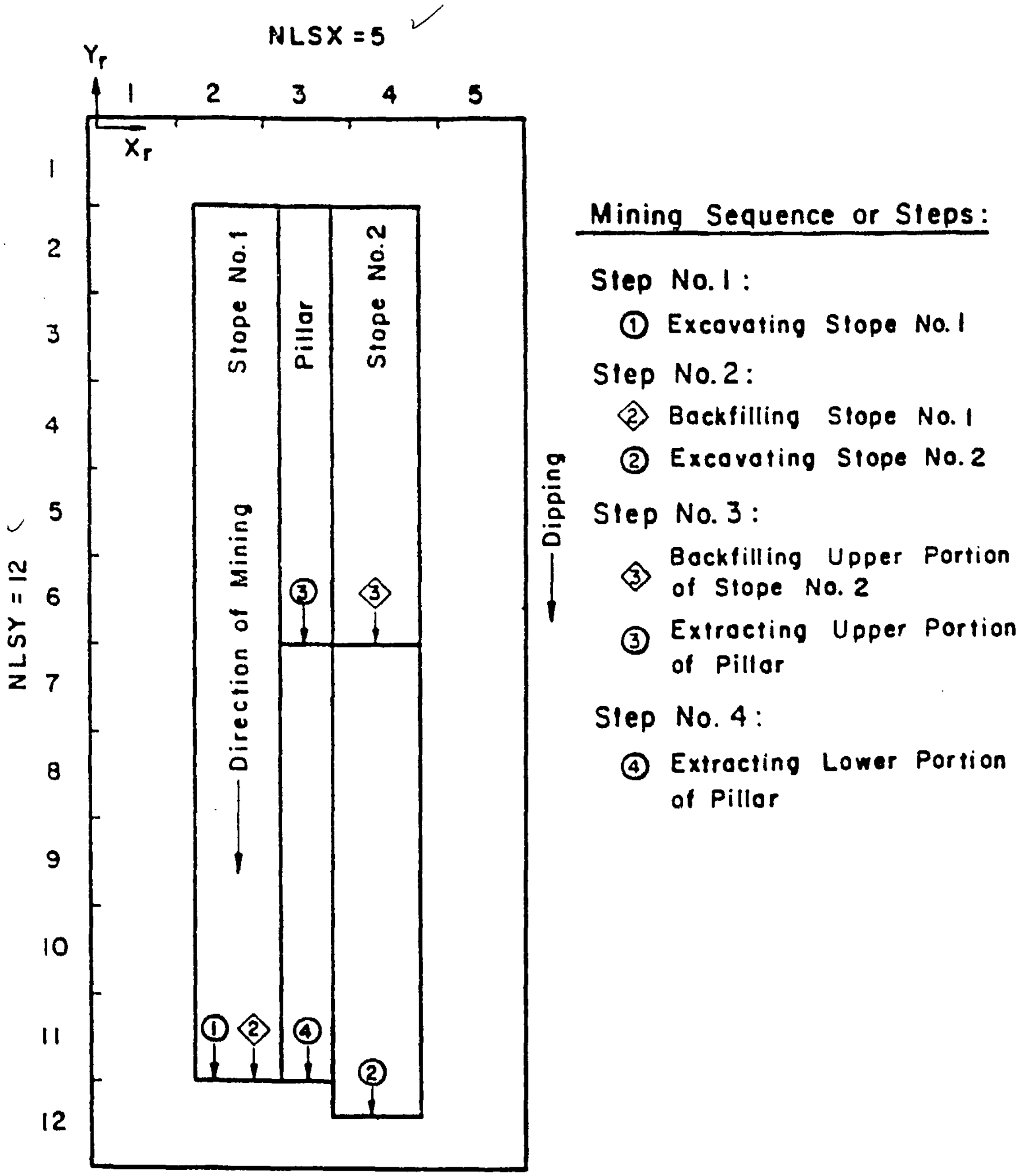


Fig. 6 - Diagram showing the sequence of mining for the example problem

```
        1
   MINING STEP NO. 1
        1
        2     9
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
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           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE
           EEEEE

        1     0     1
        1    10
   NNNNN
   NNNNN
   NNNNN
   NNPNN
   NNPNN
   PPPPP
   NNPNN
   NNPNN
   NNNNN
   NNNNN
```

Fig. 7(a) - Mining step information (Step No. 1)

```
       2
  MINING STEP NO. 2
       1
       2    10
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
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          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
          BBBBB   EEEEE
                  EEEEE
                  EEEEE



       1     1     1
```

Fig. 7(b) - Mining step information (Step No. 2)

```
       3
MINING STEP NO. 3
       1
       2     5
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB
               EEEBBBBB

       1     1     1
```

Fig. 7(c) - Mining step information (Step No. 3)

Figure 8 shows the complete input data for the initial run of the test example. The input data for the restart run is shown in Fig. 9. An example of the input data for off-seam stress and displacement calculations is shown in Fig. 10. A partial output from this example is given in Appendix A.

$\sigma_{xx} = a_{xx} + b_{yy}\, y$

$\sigma_{xy} = a_{xy} + b_{xy}\, y$

$\sigma_z = \sigma Z$

$\sigma_x = 1.0\, \sigma_z$

$\sigma_y = 1.0\, \sigma_z$

```
EXAMPLE PROBLEM - A HYPOTHETICAL PILLAR-AND-STOPE MINING WITH BACKFILL
FOR DEMONSTRATION PURPOSE ONLY
OCTOBER 10, 1988
    0    1    1    3
    5    10        3.0         350.0          15.0          2.0
              0.0         -0.02700
              0.0         -0.04050
              0.0         -0.02700
              0.0              0.0
              0.0              0.0
              0.0              0.0
    1    20
         7.0E04             0.25
         7.0E04     2.777777E04          3.5E02              0.0

Mining step information - Step No. 1 (see Fig. 7(a))
Mining step information - Step No. 2 (see Fig. 7(b))
Mining step information - Step No. 3 (see Fig. 7(c))
```

Fig. 8 - Complete input data for the example problem (initial run)

```
EXAMPLE PROBLEM - A HYPOTHETICAL PILLAR-AND-STOPE MINING WITH BACKFILL
FOR DEMONSTRATION PURPOSE ONLY
OCTOBER 10, 1988
    1    3    4    4
    5   10        3.0      350.0       15.0       2.0
            0.0       -0.02700
            0.0       -0.04050
            0.0       -0.02700
            0.0            0.0
            0.0            0.0
            0.0            0.0
    1   20
        7.0E04           0.25
        7.0E04    2.777777E04         3.5E02          0.0
A RESTART RUN - USING INFORMATION OF STEP NO. 3 AND COMPLETING STEP NO. 4
    4
MINING STEP NO. 4
    1
    6    9
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE
           EEE

    1    1    1
```

Fig. 9 - Input data for the example problem (restart run)

```
3       7
1       6
         69.00          -77.93       -370.1879
         69.00          -77.93       -360.5200
         69.00          -77.93       -300.0000
         69.00          -77.93       -200.0000
         69.00          -77.93       -100.0000
         69.00          -77.93          0.0000
2       0
3       7
         69.00          -77.93       -370.1879
         69.00          -77.93       -360.5200
         69.00          -77.93       -300.0000
         69.00          -77.93       -200.0000
         69.00          -77.93       -100.0000
         69.00          -77.93          0.0000
        -18.00         41.3572       -398.5650
```

Fig. 10 - Example input required for off-seam stress/displacement calculations

Use upper case (capital) Lock for mining pattern

GETTING STARTED

PCMINTAB software package consists of the following programs:

(a) **PCMINTAB** - the main module which calculates in-seam stresses, closures, rides and energy release.

(b) **OFREEF** - a companion program which calculates off-seam stresses and displacements after the execution of **PCMINTAB**.

(c) Pre-processor - the pre-processor, which is entirely interactive and menu-driven, prepares and modifies the input data file required by the program **PCMINTAB**.

(d) Post-processor - the post-processor, which is also interactive and menu-driven, interprets and presents the output results of **PCMINTAB** graphically.

Software Requirements:

The main program **PCMINTAB** and the companion programs are compiled and linked with Ryan-McFarland Fortran complier. The pre- and post- processors are compiled under Ryan-McFarland Fortran and linked with GSS*GKS graphic library and Ryan-McFarland Fortran.

GSS*GKS graphic software is required for graphic display. If executable files are provided, users only have to purchase GSS*CGI Device Drivers from Graphic Software System Inc., 9580 SW Gemini Drive, PO Box 900, Beaveton, Oregan 9005. Their telephone number is (503) 641-2200, Fax: (503) 643-8642 and Telex: 499 4839.

To install GSS*CGI drivers, please refer to installation instructions for installing GSS*CGI device drivers supplied by GSS.

Operating System: Operating system has to be MS-DOS 3.3.

Loading **PCMINTAB** Software Package onto Your Personal Computer:

The **PCMINTAB** software package, which resides on several diskettes, was created by the MS-DOS command BACKUP. To load the software package onto your personal computer you simply create a subdirectory named **PCMINTAB** on your hard disk and restore all the files onto this subdirectory. If you did not create the subdirectory the RESTORE command will create one for you automatically. The following commands can be used:

(a) [path]> md **PCMINTAB**

(b) [path]> restore a: [path]:\pcmintab*.*

The path can be either C or D drive depending on whether you have partitioned your hard disk or not. If you have not partitioned it, C is the default drive.

Running PCMINTAB Software Package:

Before you execute the PCMINTAB software package please ensure that:

(a) The GSS*GKS device drivers are properly installed.

(b) The two files, CONFIG.SYS and AUTOEXEC.BAT, are set up properly.

A command procedure called ~~PCTAB~~ MINTAB is written for MS DOS operating system and is used to access these individual modules of the software package. A partial screen menu of this procedure is shown in Fig. 11.

To run the PCMINTAB software you simply execute the ~~PCTAB~~ MINTAB command procedure in your PCMINTAB subdirectory and select the various options of the precedure.

The details concerning the use of the pre- and post-processors are given in Reference [5].

Hardware Requirements:

To run PCMINTAB software package efficiently, an IBM PC/AT compatible computer is required. The minimum desirable configuration of the system is described below in Table 12.

```
*****************************************************************
*                       P C T A B                               *
*                  PCMINTAB PRE-PROCESSOR                       *
*           © 1988 CANMET - VERSION 1.0 (OCT,1988)              *
*****************************************************************
*                 INSTALLATION NOTICE TO USER:                  *
*                                                               *
*        TO INSTALL AND USE THIS APPLICATION, YOU MUST          *
*        FIRST LICENSE THE PROPER GRAPHICS CONTROLLER AND       *
*        DEVICE DRIVER(S) FROM GRAPHIC SOFTWARE SYSTEMS, INC.   *
*                                                               *
*        Contact GSS' Telemarketing Dept. at (503) 641-2200     *
*****************************************************************
*                       M A I N   M E N U                       *
*****************************************************************
*                 1. PRE-PROCESSOR                              *
*                 2. POST-PROCESSOR                             *
*                 3. EXECUTION OF PCMINTAB                      *
*                 4. HELP MENU                                  *
*                 5. EXIT TO OPERATING SYSTEM (DOS)             *
*****************************************************************
```

```
*****************************************************************
*                       P C T A B                               *
*                  PCMINTAB PRE-PROCESSOR                       *
*           © 1988 CANMET - VERSION 1.0 (AUG,1988)              *
*****************************************************************
*        1.   P R E  -  P R O C E S O R   M E N U               *
*****************************************************************
*                                                               *
*           1A.  ENTER/EDIT CONTROL DATA INFORMATION            *
*           1B.  ENTER/EDIT MINE PATTERN INFORMATION            *
*           1C.  ENTER/EDIT PATTERN PRINT-OUT INFORMATION       *
*            4.  HELP MENU                                      *
*            5.  EXIT TO OPERATING SYSTEM (DOS)                 *
*                                                               *
*****************************************************************
```

```
*****************************************************************
*                       P C T A B                               *
*                  PCMINTAB POST-PROCESSOR                      *
*           © 1988 CANMET - VERSION 1.0 (AUG,1988)              *
*****************************************************************
*        2.  P O S T  -  P R O C E S O R   M E N U              *
*****************************************************************
*                                                               *
*           2A.  Colour-fill Contouring Plot                    *
*           2B.  Line Contour Plot (not implemented)            *
*           2C.  X-Y Axis Plot (not implemented)                *
*           2D.  Print Out of PCMINTAB Output File              *
*            4.  Help Menu                                      *
*            5.  Exit To Operating System (DOS)                 *
*                                                               *
*****************************************************************
```

Fig. 11 - A partial PCTAB command procedure

Table 12

Minimum Configuration of the System		
Component	Description	Comments
CPU	Intel 80286 with math coprocessor	
Memory	640 kilobytes (see computer memory requirements)	
Monitor	color monitor with EGA graphic board	
Mass Storage	one 5.25 inch, double density, dual sided floppy diskette drive and a twenty (20) or thirty (30) megabyte hard disk drive	
Printer	HP PaintJet colour printer	
Plotter	HP 7475 A	
Mouse	Microsoft compatible mouse	
Remarks:	It requires a colour printer to display colour-fill contouring of stresses and displacements, etc., and to produce a hard copy.	

IBM PC/AT compaq: 40 MB = MRC

REFERENCES

1. Salamon, M.G.D.; Elastic analysis of displacements and stresses by mining of seam or reef deposits; Journal of the South African Institute Mining and Metallurgy; part 1, vol. 64, pp 128-149, Nov. 1963; part 2, vol 64, pp 147-218, Jan. 1964; part 3, vol. 64, pp 468-500, May 1964; part 4, vol. 65, pp 319-341, Dec. 1964.

2. Starfield, A.M. and Crouch, S.L.; Elastic analysis of single seam extraction; New Horizons in Rock Mechanics; edited by Hardy, H.R. Jr. and Stefanko, R.; ASCE; New York; 1973.

3. Moris, J.P.E.; SHAMIP - a computer program for elastic analysis of large size, tabular, mono-planar, shallow, hard orebodies; Research Report No. 51/75, Mining Operations Laboratory, Chamber of Mines of South Africa; Sept. 1975.

4. Yu, Y.S., Toews, N.A. and Wong, A.S.; MINTAB User's Guide - a mining simulator for determining the elastic response of strata surrounding tabular mining excavations (Version 4.0, 1982); Division Report MRP/MRL 83-25(TR); Mining Research Laboratories, CANMET, Energy, Mines and Resources Canada; March 1983.

5. CANMET Contrat Report; PCTAB User's Manual (Draft Report); CANMET Project No. 4-9147-1; October 1988.

Appendix A
A Partial Output From Example Problem

```
*****************************************************************************************************************************
 MINE :   EXAMPLE PROBLEM - A HYPOTHETICAL PILLAR-AND-STOPE MINING WITH BACKFILL

 JOB DESCRIPTION :    FOR DEMONSTRATION PURPOSE ONLY

 DATE :    OCTOBER 10, 1988

*****************************************************************************************************************************

      I N P U T   P A R A M E T E R S


  RESTART INDICATOR                                       =    0
  MINING STEP ON RESTART FILE USED                        =    1
  INITIAL MINING STEP IN THIS RUN                         =    1
  FINAL MINING STEP IN THIS RUN                           =    3


  NUMBER OF LARGE SQUARES IN X-DIRECTION                  =    5
  NUMBER OF LARGE SQUARES IN Y-DIRECTION                  =   10
  WIDTH OF SMALL GRID ELEMENT IN METERS                   =0.300000E+01
  DEPTH OF THE FIRST ROW OF THE MINE GRID IN METERS       =0.350000E+03
  DIP ANGLE OF THE SEAM PLANE IN DEGREES                  =0.150000E+02
  STOPING THICKNESS IN METERS                             =0.200000E+01


  INSITU STRESSES IN GLOBAL CO-ORDINATES
      SXX = AXX + BXX*Z     AXX =   0.0000000E+00   BXX =  -0.2700000E+00
      SYY = AYY + BYY*Z     AYY =   0.0000000E+00   BYY =  -0.4050000E+00
      SZZ = AZZ + BZZ*Z     AZZ =   0.0000000E+00   BZZ =  -0.2700000E+00      -0.027.
      SXY = AXY + BXY*Z     AXY =   0.0000000E+00   BXY =   0.0000000E+00
      SXZ = AXZ + BXZ*Z     AXZ =   0.0000000E+00   BXZ =   0.0000000E+00
      SYZ = AYZ + BYZ*Z     AYZ =   0.0000000E+00   BYZ =   0.0000000E+00
Solution -  SOLVER CONVERGENCE CONTROL
  PERCENT OF PRIMITIVE STRESS FOR CONVERGENCE CRITERION=    1
  MAXIMUM NUMBER OF ITERATIONS                            =   20


  DEFORMATION MODULUS OF ROCK IN MPA                      =0.700000E+05
  POISSONS RATIO OF ROCK                                  =0.250000E+00
  PILLAR NORMAL STIFFNESS IN MPA                          =0.700000E+05
  PILLAR SHEAR STIFFNESS IN MPA                           =0.277770E+05
  BACKFILL NORMAL STIFFNESS IN MPA                        =0.350000E+03
  BACKFILL SHEAR STIFFNESS IN MPA                         =0.000000E+00
```

```
* * * * * * * * * * MINING STEP NUMBER 1 * * * * * * * * *

     STEP DESCRIPTION
           MINING STEP NO. 1



     MINING PATTERN
        MINING PATTERN IS PRINTED
        THE NUMBER OF ADDITIONAL ELEMENTS EXCAVATED           =  200
        THE NUMBER OF ADDITIONAL BACKFILL ELEMENTS CREATED    =    0
        THE NUMBER OF BACKFILL ELEMENTS EXCAVATED             =    0
```

```
         1    2    3    4    5
        1234512345123451234512345
       1*************************1
       2*************************2
  1    3*************************3   1
       4*************************4
       5*************************5
       1******EEEEE**************1
       2******EEEEE**************2
  2    3******EEEEE**************3   2
       4******EEEEE**************4
       5******EEEEE**************5
       1******EEEEE**************1
       2******EEEEE**************2
  3    3******EEEEE**************3   3
       4******EEEEE**************4
       5******EEEEE**************5
       1******EEEEE**************1
       2******EEEEE**************2
  4    3******EEEEE**************3   4
       4******EEEEE**************4
       5******EEEEE**************5
       1******EEEEE**************1
       2******EEEEE**************2
  5    3******EEEEE**************3   5
       4******EEEEE**************4
       5******EEEEE**************5
       1******EEEEE**************1
       2******EEEEE**************2
  6    3******EEEEE**************3   6
       4******EEEEE**************4
       5******EEEEE**************5
       1******EEEEE**************1
       2******EEEEE**************2
  7    3******EEEEE**************3   7
       4******EEEEE**************4
       5******EEEEE**************5
       1******EEEEE**************1
       2******EEEEE**************2
  8    3******EEEEE**************3   8
       4******EEEEE**************4
       5******EEEEE**************5
       1******EEEEE**************1
       2******EEEEE**************2
  9    3******EEEEE**************3   9
       4******EEEEE**************4
       5******EEEEE**************5
       1*************************1
       2*************************2
 10    3*************************3  10
       4*************************4
       5*************************5
        1234512345123451234512345
         1    2    3    4    5
```

```
THE ABOVE IS THE MINING PATTERN FOR MINING STEP = 1

          LEGEND                                       MARKER
          INTACT                                         *
          EXCAVATED PRIOR TO THIS STEP
          BACKFILLED PRIOR TO THIS STEP                  +
          EXCAVATED THIS STEP                            E
          BACKFILLED THIS STEP                           B


     PRINT PATTERN FOR IN-REEF RESULTS
        PRINT ALL REEF RESULTS
        DO NOT OUTPUT PRINT PATTERN



     SOLVING FOR CLOSURES AND RIDES FOR MINING STEP  1

         ITERATION PROCESS FOR CLOSURES CONVERGED AFTER  9 ITERATIONS.
                   CP TIME=      0.000
         ITERATION PROCESS FOR RIDES CONVERGED AFTER  5 ITERATIONS.
                   CP TIME=      0.000
```

e.g. 20000000 = 20.E+10 = 20×10^6

RESULTS FOR REEF PLANE (NOTE: I,J LOCATES LARGE SQUARE AND K,L LOCATES SMALL SQUARE.)

12 MPa

K L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL.
I= 1 J= 1											
1 1	*	0.56302E-05	-.18046E-04	0.48925E-04	0.78441E-01	-.12063E+02	0.99378E+02	-.12009E+01	0.95287E+02	0.14037E+03	0.00000E+00
1 2	*	0.66592E-05	-.21154E-04	0.55633E-04	0.92684E-01	-.12107E+02	0.99612E+02	-.13026E+01	0.95421E+02	0.14058E+03	0.00000E+00
1 3	*	0.74620E-05	-.24121E-04	0.61847E-04	0.10387E+00	-.12148E+02	0.99830E+02	-.14279E+01	0.95464E+02	0.14087E+03	0.00000E+00
1 4	*	0.81496E-05	-.27837E-04	0.69101E-04	0.11351E+00	-.12199E+02	0.10008E+03	-.15471E+01	0.95456E+02	0.14126E+03	0.00000E+00
1 5	*	0.84582E-05	-.32647E-04	0.77769E-04	0.11745E+00	-.12266E+02	0.10039E+03	-.16157E+01	0.95402E+02	0.14177E+03	0.00000E+00
2 1	*	0.63780E-05	-.20718E-04	0.55203E-04	0.88958E-01	-.12127E+02	0.99814E+02	-.12743E+01	0.95727E+02	0.14077E+03	0.00000E+00
2 2	*	0.80461E-05	-.25211E-04	0.64919E-04	0.11205E+00	-.12189E+02	0.10015E+03	-.14510E+01	0.95951E+02	0.14106E+03	0.00000E+00
2 3	*	0.95079E-05	-.29765E-04	0.74809E-04	0.13236E+00	-.12253E+02	0.10050E+03	-.16754E+01	0.96083E+02	0.14145E+03	0.00000E+00
2 4	*	0.10973E-04	-.35946E-04	0.87327E-04	0.15298E+00	-.12338E+02	0.10094E+03	-.19295E+01	0.96154E+02	0.14203E+03	0.00000E+00
2 5	*	0.12077E-04	-.44550E-04	0.10347E-03	0.16748E+00	-.12459E+02	0.10150E+03	-.21450E+01	0.96139E+02	0.14289E+03	0.00000E+00
3 1	*	0.69138E-05	-.22205E-04	0.60565E-04	0.96550E-01	-.12174E+02	0.10022E+03	-.13493E+01	0.96213E+02	0.14109E+03	0.00000E+00
3 2	*	0.91393E-05	-.27843E-04	0.73647E-04	0.12743E+00	-.12252E+02	0.10068E+03	-.16069E+01	0.96568E+02	0.14142E+03	0.00000E+00
3 3	*	0.11476E-04	-.34208E-04	0.88789E-04	0.15997E+00	-.12341E+02	0.10121E+03	-.19760E+01	0.96874E+02	0.14191E+03	0.00000E+00
3 4	*	0.14349E-04	-.43764E-04	0.11015E-03	0.19992E+00	-.12473E+02	0.10195E+03	-.24789E+01	0.97158E+02	0.14274E+03	0.00000E+00
3 5	*	0.17507E-04	-.58725E-04	0.14106E-03	0.24011E+00	-.12682E+02	0.10304E+03	-.30627E+01	0.97334E+02	0.14419E+03	0.00000E+00
4 1	*	0.73283E-05	-.23526E-04	0.66375E-04	0.10211E+00	-.12217E+02	0.10064E+03	-.13942E+01	0.96763E+02	0.14136E+03	0.00000E+00
4 2	*	0.10092E-04	-.30359E-04	0.83729E-04	0.14032E+00	-.12311E+02	0.10125E+03	-.17298E+01	0.97322E+02	0.14171E+03	0.00000E+00
4 3	*	0.13495E-04	-.38906E-04	0.10649E-03	0.18750E+00	-.12430E+02	0.10204E+03	-.22734E+01	0.97958E+02	0.14227E+03	0.00000E+00
4 4	*	0.18644E-04	-.53266E-04	0.14296E-03	0.25610E+00	-.12624E+02	0.10332E+03	-.31684E+01	0.98783E+02	0.14336E+03	0.00000E+00
4 5	*	0.26279E-04	-.79749E-04	0.20578E-03	0.34867E+00	-.12977E+02	0.10552E+03	-.46043E+01	0.99745E+02	0.14569E+03	0.00000E+00
5 1	*	0.75809E-05	-.25068E-04	0.73211E-04	0.10562E+00	-.12265E+02	0.10109E+03	-.13803E+01	0.97368E+02	0.14163E+03	0.00000E+00
5 2	*	0.10732E-04	-.33181E-04	0.95943E-04	0.14933E+00	-.12378E+02	0.10189E+03	-.17557E+01	0.98213E+02	0.14198E+03	0.00000E+00
5 3	*	0.15056E-04	-.44155E-04	0.12895E-03	0.20952E+00	-.12530E+02	0.10305E+03	-.24341E+01	0.99380E+02	0.14254E+03	0.00000E+00
5 4	*	0.22774E-04	-.64513E-04	0.18906E-03	0.30646E+00	-.12802E+02	0.10515E+03	-.37381E+01	0.10132E+03	0.14375E+03	0.00000E+00
5 5	*	0.35848E-04	-.10809E-03	0.31807E-03	0.50741E+00	-.13386E+02	0.10965E+03	-.65863E+01	0.10495E+03	0.14687E+03	0.00000E+00
I= 1 J= 2											
1 1	*	0.66917E-05	-.43611E-04	0.98393E-04	0.93158E-01	-.12419E+02	0.10111E+03	-.11706E+01	0.94957E+02	0.14329E+03	0.00000E+00
1 2	*	0.53669E-05	-.49136E-04	0.10772E-03	0.74648E-01	-.12497E+02	0.10144E+03	-.97018E+00	0.94811E+02	0.14393E+03	0.00000E+00
1 3	*	0.32158E-05	-.52957E-04	0.11406E-03	0.44478E-01	-.12550E+02	0.10166E+03	-.59536E+00	0.94676E+02	0.14440E+03	0.00000E+00
1 4	*	0.43144E-06	-.54338E-04	0.11630E-03	0.63556E-02	-.12569E+02	0.10174E+03	-.11054E+00	0.94621E+02	0.14457E+03	0.00000E+00
1 5	*	-.24692E-05	-.52803E-04	0.11376E-03	-.34855E-01	-.12545E+02	0.10165E+03	0.37545E+00	0.94664E+02	0.14439E+03	0.00000E+00
2 1	*	0.10834E-04	-.61414E-04	0.13534E-03	0.15079E+00	-.12694E+02	0.10262E+03	-.18430E+01	0.95721E+02	0.14499E+03	0.00000E+00
2 2	*	0.90965E-05	-.72723E-04	0.15491E-03	0.12640E+00	-.12855E+02	0.10331E+03	-.15905E+01	0.95481E+02	0.14626E+03	0.00000E+00
2 3	*	0.54488E-05	-.80949E-04	0.16893E-03	0.74911E-01	-.12972E+02	0.10380E+03	-.96512E+00	0.95252E+02	0.14722E+03	0.00000E+00
2 4	*	0.45631E-06	-.84040E-04	0.17399E-03	0.70429E-02	-.13013E+02	0.10397E+03	-.11083E+00	0.95160E+02	0.14758E+03	0.00000E+00
2 5	*	-.45933E-05	-.80851E-04	0.16854E-03	-.65223E-01	-.12965E+02	0.10378E+03	0.74339E+00	0.95238E+02	0.14722E+03	0.00000E+00
3 1	*	0.18385E-04	-.87276E-04	0.19723E-03	0.24396E+00	-.13061E+02	0.10500E+03	-.31636E+01	0.97044E+02	0.14743E+03	0.00000E+00
3 2	*	0.16633E-04	-.11435E-03	0.24368E-03	0.21121E+00	-.13372E+02	0.10662E+03	-.28894E+01	0.96651E+02	0.15025E+03	0.00000E+00
3 3	*	0.10063E-04	-.13500E-03	0.27863E-03	0.12214E+00	-.13594E+02	0.10783E+03	-.17352E+01	0.96283E+02	0.15244E+03	0.00000E+00
3 4	*	0.68270E-06	-.14300E-03	0.29140E-03	0.32811E-02	-.13664E+02	0.10828E+03	-.11054E+00	0.96153E+02	0.15323E+03	0.00000E+00
3 5	*	-.88287E-05	-.13596E-03	0.27837E-03	-.11614E+00	-.13562E+02	0.10782E+03	0.15136E+01	0.96267E+02	0.15243E+03	0.00000E+00
4 1	*	0.31852E-04	-.13486E-03	0.32912E-03	0.44860E+00	-.13690E+02	0.10982E+03	-.60972E+01	0.10021E+03	0.15168E+03	0.00000E+00
4 2	*	0.29243E-04	-.19402E-03	0.46972E-03	0.44055E+00	-.14676E+02	0.11476E+03	-.60151E+01	0.99685E+02	0.15962E+03	0.00000E+00
4 3	*	0.16382E-04	-.23466E-03	0.57503E-03	0.25383E+00	-.15382E+02	0.11847E+03	-.34213E+01	0.99477E+02	0.16539E+03	0.00000E+00
4 4	*	-.47721E-06	-.24713E-03	0.61159E-03	0.14773E-01	-.15621E+02	0.11976E+03	-.10962E+00	0.99516E+02	0.16728E+03	0.00000E+00
4 5	*	-.16031E-04	-.22799E-03	0.57411E-03	-.24402E+00	-.15430E+02	0.11846E+03	0.32009E+01	0.99465E+02	0.16538E+03	0.00000E+00
5 1	*	0.62294E-04	-.22009E-03	0.67632E-03	0.87324E+00	-.15110E+02	0.12224E+03	-.14000E+02	0.11161E+03	0.15911E+03	0.00000E+00
5 2	*	0.67599E-04	-.48824E-03	0.14463E-02	0.92664E+00	-.18669E+02	0.14915E+03	-.15159E+02	0.11262E+03	0.19846E+03	0.00000E+00
5 3	*	0.35212E-04	-.62969E-03	0.18964E-02	0.48640E+00	-.20589E+02	0.16490E+03	-.69984E+01	0.11758E+03	0.21713E+03	0.00000E+00
5 4	*	0.16436E-06	-.66907E-03	0.20292E-02	0.97124E-02	-.21140E+02	0.16954E+03	-.10684E+00	0.11945E+03	0.22221E+03	0.00000E+00

RESULTS FOR REEF PLANE (NOTE: I,J LOCATES LARGE SQUARE AND K,L LOCATES SMALL SQUARE.)

K	L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL
5	5	*	-.34587E-04	-.62678E-03	0.18955E-02	-.47305E+00	-.20585E+02	0.16487E+03	0.67862E+01	0.11756E+03	0.21710E+03	0.00000E+00

I= 1 J= 3

K	L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL
1	1	*	-.69233E-05	-.46011E-04	0.10188E-03	-.96095E-01	-.12452E+02	0.10123E+03	0.13747E+01	0.95009E+02	0.14343E+03	0.00000E+00
1	2	*	-.82389E-05	-.40691E-04	0.92893E-04	-.11440E+00	-.12378E+02	0.10092E+03	0.15699E+01	0.95167E+02	0.14280E+03	0.00000E+00
1	3	*	-.84516E-05	-.35273E-04	0.83238E-04	-.11739E+00	-.12303E+02	0.10058E+03	0.15932E+01	0.95299E+02	0.14216E+03	0.00000E+00
1	4	*	-.80090E-05	-.30391E-04	0.74052E-04	-.11080E+00	-.12235E+02	0.10026E+03	0.15021E+01	0.95362E+02	0.14161E+03	0.00000E+00
1	5	*	-.72063E-05	-.26086E-04	0.65564E-04	-.10036E+00	-.12175E+02	0.99960E+02	0.13647E+01	0.95341E+02	0.14119E+03	0.00000E+00
2	1	*	-.10683E-04	-.69406E-04	0.14882E-03	-.14782E+00	-.12802E+02	0.10309E+03	0.19929E+01	0.95676E+02	0.14574E+03	0.00000E+00
2	2	*	-.12498E-04	-.58295E-04	0.12969E-03	-.17280E+00	-.12648E+02	0.10242E+03	0.22449E+01	0.95932E+02	0.14448E+03	0.00000E+00
2	3	*	-.12237E-04	-.47642E-04	0.11030E-03	-.16944E+00	-.12500E+02	0.10174E+03	0.21603E+01	0.96094E+02	0.14330E+03	0.00000E+00
2	4	*	-.10935E-04	-.38902E-04	0.93326E-04	-.15051E+00	-.12379E+02	0.10115E+03	0.19047E+01	0.96107E+02	0.14240E+03	0.00000E+00
2	5	*	-.92093E-05	-.31903E-04	0.79041E-04	-.12823E+00	-.12282E+02	0.10065E+03	0.16208E+01	0.95988E+02	0.14176E+03	0.00000E+00
3	1	*	-.16849E-04	-.10918E-03	0.23746E-03	-.24800E+00	-.13326E+02	0.10640E+03	0.32916E+01	0.96844E+02	0.14973E+03	0.00000E+00
3	2	*	-.19562E-04	-.84629E-04	0.19175E-03	-.27002E+00	-.12996E+02	0.10480E+03	0.35656E+01	0.97255E+02	0.14692E+03	0.00000E+00
3	3	*	-.17727E-04	-.62655E-04	0.14951E-03	-.24157E+00	-.12716E+02	0.10333E+03	0.31123E+01	0.97371E+02	0.14459E+03	0.00000E+00
3	4	*	-.14429E-04	-.47159E-04	0.11721E-03	-.19611E+00	-.12513E+02	0.10220E+03	0.24712E+01	0.97170E+02	0.14310E+03	0.00000E+00
3	5	*	-.11205E-04	-.36495E-04	0.93514E-04	-.15482E+00	-.12370E+02	0.10137E+03	0.19294E+01	0.96814E+02	0.14221E+03	0.00000E+00
4	1	*	-.32840E-04	-.18414E-03	0.46257E-03	-.44194E+00	-.14678E+02	0.11455E+03	0.64170E+01	0.99880E+02	0.15911E+03	0.00000E+00
4	2	*	-.33093E-04	-.12437E-03	0.32247E-03	-.47926E+00	-.13714E+02	0.10963E+03	0.64984E+01	0.10043E+03	0.15118E+03	0.00000E+00
4	3	*	-.25337E-04	-.81158E-04	0.21557E-03	-.36509E+00	-.13038E+02	0.10587E+03	0.46779E+01	0.99893E+02	0.14608E+03	0.00000E+00
4	4	*	-.18176E-04	-.56034E-04	0.15102E-03	-.25621E+00	-.12670E+02	0.10360E+03	0.31691E+01	0.98867E+02	0.14370E+03	0.00000E+00
4	5	*	-.12995E-04	-.41020E-04	0.11166E-03	-.18308E+00	-.12460E+02	0.10222E+03	0.22283E+01	0.97938E+02	0.14256E+03	0.00000E+00
5	1	*	-.68903E-04	-.48680E-03	0.14401E-02	-.95425E+00	-.18573E+02	0.14888E+03	0.15561E+02	0.11279E+03	0.19788E+03	0.00000E+00
5	2	*	-.64547E-04	-.21912E-03	0.67162E-03	-.89344E+00	-.15029E+02	0.12202E+03	0.14394E+02	0.11181E+03	0.15858E+03	0.00000E+00
5	3	*	-.36151E-04	-.10829E-03	0.32958E-03	-.51297E+00	-.13470E+02	0.11007E+03	0.66585E+01	0.10523E+03	0.14723E+03	0.00000E+00
5	4	*	-.21999E-04	-.66488E-04	0.19819E-03	-.31183E+00	-.12858E+02	0.10547E+03	0.37325E+01	0.10149E+03	0.14408E+03	0.00000E+00
5	5	*	-.14517E-04	-.45980E-04	0.13455E-03	-.20433E+00	-.12561E+02	0.10324E+03	0.23809E+01	0.99403E+02	0.14282E+03	0.00000E+00

I= 1 J= 4

K	L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL
1	1	*	-.57748E-05	-.16081E-04	0.44700E-04	-.80539E-01	-.12037E+02	0.99230E+02	0.10371E+01	0.95645E+02	0.13979E+03	0.00000E+00
1	2	*	-.52783E-05	-.14526E-04	0.42093E-04	-.73593E-01	-.12015E+02	0.99139E+02	0.99335E+00	0.95600E+02	0.13969E+03	0.00000E+00
1	3	*	-.49563E-05	-.13704E-04	0.40568E-04	-.69112E-01	-.12004E+02	0.99085E+02	0.95952E+00	0.95578E+02	0.13964E+03	0.00000E+00
1	4	*	-.47099E-05	-.13097E-04	0.39363E-04	-.65698E-01	-.11995E+02	0.99043E+02	0.93411E+00	0.95554E+02	0.13960E+03	0.00000E+00
1	5	*	-.44416E-05	-.12390E-04	0.37847E-04	-.61975E-01	-.11985E+02	0.98990E+02	0.91867E+00	0.95508E+02	0.13956E+03	0.00000E+00
2	1	*	-.68658E-05	-.19276E-04	0.50717E-04	-.95888E-01	-.12108E+02	0.99657E+02	0.11022E+01	0.96023E+02	0.14024E+03	0.00000E+00
2	2	*	-.61201E-05	-.16929E-04	0.46591E-04	-.85266E-01	-.12075E+02	0.99513E+02	0.10345E+01	0.95937E+02	0.14011E+03	0.00000E+00
2	3	*	-.56347E-05	-.15731E-04	0.44275E-04	-.78535E-01	-.12058E+02	0.99432E+02	0.98365E+00	0.95889E+02	0.14004E+03	0.00000E+00
2	4	*	-.52760E-05	-.14891E-04	0.42543E-04	-.73294E-01	-.12047E+02	0.99371E+02	0.94678E+00	0.95845E+02	0.13999E+03	0.00000E+00
2	5	*	-.48603E-05	-.13921E-04	0.40520E-04	-.67896E-01	-.12033E+02	0.99300E+02	0.92051E+00	0.95781E+02	0.13995E+03	0.00000E+00
3	1	*	-.77106E-05	-.21305E-04	0.55771E-04	-.10807E+00	-.12163E+02	0.10005E+03	0.11837E+01	0.96427E+02	0.14062E+03	0.00000E+00
3	2	*	-.66281E-05	-.18228E-04	0.49732E-04	-.92469E-01	-.12120E+02	0.99840E+02	0.10769E+01	0.96275E+02	0.14046E+03	0.00000E+00
3	3	*	-.59674E-05	-.16676E-04	0.46445E-04	-.83200E-01	-.12098E+02	0.99725E+02	0.10048E+01	0.96188E+02	0.14037E+03	0.00000E+00
3	4	*	-.55051E-05	-.15635E-04	0.44132E-04	-.76367E-01	-.12083E+02	0.99644E+02	0.95620E+00	0.96118E+02	0.14032E+03	0.00000E+00
3	5	*	-.50052E-05	-.14498E-04	0.41704E-04	-.70013E-01	-.12068E+02	0.99558E+02	0.92309E+00	0.96037E+02	0.14027E+03	0.00000E+00
4	1	*	-.84759E-05	-.23376E-04	0.61738E-04	-.11922E+00	-.12213E+02	0.10048E+03	0.12617E+01	0.96908E+02	0.14097E+03	0.00000E+00
4	2	*	-.70728E-05	-.19542E-04	0.53152E-04	-.97398E-01	-.12159E+02	0.10018E+03	0.11092E+01	0.96648E+02	0.14078E+03	0.00000E+00
4	3	*	-.62357E-05	-.17578E-04	0.48649E-04	-.85554E-01	-.12133E+02	0.10002E+03	0.10165E+01	0.96502E+02	0.14069E+03	0.00000E+00
4	4	*	-.56672E-05	-.16305E-04	0.45655E-04	-.77625E-01	-.12116E+02	0.99913E+02	0.95872E+00	0.96398E+02	0.14064E+03	0.00000E+00
4	5	*	-.51088E-05	-.15008E-04	0.42783E-04	-.70701E-01	-.12098E+02	0.99812E+02	0.92197E+00	0.96294E+02	0.14059E+03	0.00000E+00
5	1	*	-.90604E-05	-.25241E-04	0.69676E-04	-.12910E+00	-.12275E+02	0.10097E+03	0.13015E+01	0.97488E+02	0.14132E+03	0.00000E+00
5	2	*	-.71897E-05	-.20593E-04	0.57830E-04	-.10323E+00	-.12208E+02	0.10056E+03	0.11147E+01	0.97069E+02	0.14112E+03	0.00000E+00
5	3	*	-.62337E-05	-.18379E-04	0.51868E-04	-.88862E-01	-.12175E+02	0.10035E+03	0.10106E+01	0.96845E+02	0.14103E+03	0.00000E+00

RESULTS FOR REEF PLANE (NOTE: I,J LOCATES LARGE SQUARE AND K,L LOCATES SMALL SQUARE.)

K L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL.
5 4	*	-.56505E-05	-.16971E-04	0.48086E-04	-.79585E-01	-.12155E+02	0.10022E+03	0.95019E+00	0.96696E+02	0.14098E+03	0.00000E+00
5 5	*	-.51164E-05	-.15522E-04	0.44634E-04	-.71947E-01	-.12135E+02	0.10009E+03	0.91665E+00	0.96564E+02	0.14093E+03	0.00000E+00
I= 1 J= 5											
1 1	*	-.28986E-05	-.70075E-05	0.22020E-04	-.40287E-01	-.11910E+02	0.98436E+02	0.50506E+00	0.95230E+02	0.13901E+03	0.00000E+00
1 2	*	-.26789E-05	-.65792E-05	0.21220E-04	-.37366E-01	-.11904E+02	0.98408E+02	0.49950E+00	0.95198E+02	0.13900E+03	0.00000E+00
1 3	*	-.25973E-05	-.64339E-05	0.20971E-04	-.36230E-01	-.11902E+02	0.98399E+02	0.49860E+00	0.95189E+02	0.13900E+03	0.00000E+00
1 4	*	-.25221E-05	-.62827E-05	0.20701E-04	-.35388E-01	-.11900E+02	0.98390E+02	0.50045E+00	0.95179E+02	0.13899E+03	0.00000E+00
1 5	*	-.23396E-05	-.58588E-05	0.19725E-04	-.32570E-01	-.11894E+02	0.98356E+02	0.50774E+00	0.95139E+02	0.13898E+03	0.00000E+00
2 1	*	-.31966E-05	-.80381E-05	0.23685E-04	-.44357E-01	-.11951E+02	0.98711E+02	0.49941E+00	0.95473E+02	0.13937E+03	0.00000E+00
2 2	*	-.29568E-05	-.74509E-05	0.22642E-04	-.41158E-01	-.11943E+02	0.98674E+02	0.49824E+00	0.95435E+02	0.13936E+03	0.00000E+00
2 3	*	-.28503E-05	-.72440E-05	0.22299E-04	-.39736E-01	-.11940E+02	0.98662E+02	0.49787E+00	0.95422E+02	0.13935E+03	0.00000E+00
2 4	*	-.27359E-05	-.70278E-05	0.21930E-04	-.38359E-01	-.11937E+02	0.98649E+02	0.49863E+00	0.95407E+02	0.13935E+03	0.00000E+00
2 5	*	-.24621E-05	-.64374E-05	0.20681E-04	-.34145E-01	-.11929E+02	0.98606E+02	0.50007E+00	0.95361E+02	0.13933E+03	0.00000E+00
3 1	*	-.32893E-05	-.84479E-05	0.24254E-04	-.45611E-01	-.11983E+02	0.98948E+02	0.49798E+00	0.95694E+02	0.13970E+03	0.00000E+00
3 2	*	-.30367E-05	-.77813E-05	0.23101E-04	-.42240E-01	-.11974E+02	0.98907E+02	0.49734E+00	0.95653E+02	0.13968E+03	0.00000E+00
3 3	*	-.29178E-05	-.75292E-05	0.22696E-04	-.40656E-01	-.11970E+02	0.98893E+02	0.49704E+00	0.95638E+02	0.13967E+03	0.00000E+00
3 4	*	-.27860E-05	-.72699E-05	0.22266E-04	-.39003E-01	-.11967E+02	0.98878E+02	0.49723E+00	0.95622E+02	0.13967E+03	0.00000E+00
3 5	*	-.24861E-05	-.66109E-05	0.20924E-04	-.34418E-01	-.11957E+02	0.98831E+02	0.49755E+00	0.95574E+02	0.13964E+03	0.00000E+00
4 1	*	-.33419E-05	-.87881E-05	0.24709E-04	-.46287E-01	-.12012E+02	0.99180E+02	0.49854E+00	0.95913E+02	0.14002E+03	0.00000E+00
4 2	*	-.30877E-05	-.80633E-05	0.23455E-04	-.42554E-01	-.12002E+02	0.99136E+02	0.49713E+00	0.95870E+02	0.14000E+03	0.00000E+00
4 3	*	-.29583E-05	-.77612E-05	0.22995E-04	-.40864E-01	-.11998E+02	0.99120E+02	0.49643E+00	0.95853E+02	0.13999E+03	0.00000E+00
4 4	*	-.28151E-05	-.74611E-05	0.22516E-04	-.39145E-01	-.11995E+02	0.99103E+02	0.49657E+00	0.95836E+02	0.13998E+03	0.00000E+00
4 5	*	-.25059E-05	-.67510E-05	0.21106E-04	-.34468E-01	-.11984E+02	0.99054E+02	0.49716E+00	0.95787E+02	0.13996E+03	0.00000E+00
5 1	*	-.33602E-05	-.90659E-05	0.25666E-04	-.47885E-01	-.12045E+02	0.99430E+02	0.50244E+00	0.96143E+02	0.14036E+03	0.00000E+00
5 2	*	-.30721E-05	-.82973E-05	0.24215E-04	-.43442E-01	-.12034E+02	0.99380E+02	0.49721E+00	0.96094E+02	0.14033E+03	0.00000E+00
5 3	*	-.29469E-05	-.79950E-05	0.23685E-04	-.41446E-01	-.12029E+02	0.99361E+02	0.49577E+00	0.96075E+02	0.14032E+03	0.00000E+00
5 4	*	-.28155E-05	-.76798E-05	0.23147E-04	-.39519E-01	-.12025E+02	0.99342E+02	0.49621E+00	0.96055E+02	0.14031E+03	0.00000E+00
5 5	*	-.25093E-05	-.69025E-05	0.21594E-04	-.34927E-01	-.12014E+02	0.99288E+02	0.49962E+00	0.96003E+02	0.14029E+03	0.00000E+00
I= 2 J= 1											
1 1	*	0.95848E-05	-.32173E-04	0.10175E-03	0.13359E+00	-.12390E+02	0.10231E+03	-.18735E+01	0.98756E+02	0.14226E+03	0.00000E+00
1 2	*	0.13392E-04	-.43177E-04	0.13505E-03	0.18652E+00	-.12543E+02	0.10348E+03	-.23672E+01	0.99990E+02	0.14277E+03	0.00000E+00
1 3	*	0.18486E-04	-.58630E-04	0.18521E-03	0.25797E+00	-.12758E+02	0.10523E+03	-.31958E+01	0.10182E+03	0.14357E+03	0.00000E+00
1 4	*	0.27570E-04	-.88037E-04	0.28147E-03	0.37141E+00	-.13148E+02	0.10859E+03	-.47146E+01	0.10529E+03	0.14514E+03	0.00000E+00
1 5	*	0.43688E-04	-.15271E-03	0.51653E-03	0.61515E+00	-.14086E+02	0.11685E+03	-.80063E+01	0.11393E+03	0.14889E+03	0.00000E+00
2 1	*	0.92058E-05	-.34193E-04	0.11139E-03	0.12840E+00	-.12445E+02	0.10286E+03	-.17619E+01	0.99512E+02	0.14252E+03	0.00000E+00
2 2	*	0.12889E-04	-.46864E-04	0.15169E-03	0.17963E+00	-.12620E+02	0.10427E+03	-.22223E+01	0.10110E+03	0.14305E+03	0.00000E+00
2 3	*	0.17664E-04	-.65364E-04	0.21501E-03	0.24632E+00	-.12877E+02	0.10649E+03	-.29688E+01	0.10360E+03	0.14388E+03	0.00000E+00
2 4	*	0.25779E-04	-.10223E-03	0.34165E-03	0.34550E+00	-.13359E+02	0.11091E+03	-.42468E+01	0.10853E+03	0.14558E+03	0.00000E+00
2 5	*	0.38250E-04	-.18522E-03	0.66541E-03	0.54016E+00	-.14613E+02	0.12229E+03	-.65853E+01	0.12107E+03	0.15011E+03	0.00000E+00
3 1	*	0.83077E-05	-.35646E-04	0.11919E-03	0.11601E+00	-.12491E+02	0.10335E+03	-.15720E+01	0.10019E+03	0.14277E+03	0.00000E+00
3 2	*	0.11483E-04	-.49701E-04	0.16535E-03	0.16018E+00	-.12686E+02	0.10497E+03	-.19463E+01	0.10208E+03	0.14331E+03	0.00000E+00
3 3	*	0.15383E-04	-.70907E-04	0.23956E-03	0.21485E+00	-.12980E+02	0.10757E+03	-.25263E+01	0.10509E+03	0.14419E+03	0.00000E+00
3 4	*	0.21683E-04	-.11415E-03	0.38963E-03	0.28834E+00	-.13543E+02	0.11281E+03	-.34356E+01	0.11100E+03	0.14614E+03	0.00000E+00
3 5	*	0.30076E-04	-.21109E-03	0.77225E-03	0.42046E+00	-.15051E+02	0.12625E+03	-.48692E+01	0.12566E+03	0.15165E+03	0.00000E+00
4 1	*	0.71136E-05	-.36918E-04	0.12532E-03	0.99085E-01	-.12534E+02	0.10379E+03	-.13208E+01	0.10077E+03	0.14303E+03	0.00000E+00
4 2	*	0.96131E-05	-.52199E-04	0.17599E-03	0.13367E+00	-.12744E+02	0.10556E+03	-.15834E+01	0.10287E+03	0.14359E+03	0.00000E+00
4 3	*	0.12524E-04	-.75721E-04	0.25828E-03	0.17400E+00	-.13068E+02	0.10844E+03	-.19786E+01	0.10623E+03	0.14455E+03	0.00000E+00
4 4	*	0.17168E-04	-.12403E-03	0.42454E-03	0.22259E+00	-.13694E+02	0.11424E+03	-.25657E+01	0.11274E+03	0.14674E+03	0.00000E+00
4 5	*	0.22557E-04	-.23121E-03	0.84377E-03	0.31035E+00	-.15372E+02	0.12897E+03	-.34269E+01	0.12855E+03	0.15304E+03	0.00000E+00
5 1	*	0.58513E-05	-.38211E-04	0.13016E-03	0.81473E-01	-.12580E+02	0.10417E+03	-.10332E+01	0.10122E+03	0.14335E+03	0.00000E+00
5 2	*	0.76505E-05	-.54478E-04	0.18416E-03	0.10628E+00	-.12806E+02	0.10606E+03	-.11708E+01	0.10347E+03	0.14394E+03	0.00000E+00

RESULTS FOR REEF PLANE (NOTE: I,J LOCATES LARGE SQUARE AND K,L LOCATES SMALL SQUARE.)

K	L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL.
5	3	*	0.96319E-05	-.79657E-04	0.27191E-03	0.13351E+00	-.13155E+02	0.10914E+03	-.13891E+01	0.10706E+03	0.14496E+03	0.00000E+00
5	4	*	0.12787E-04	-.13104E-03	0.44857E-03	0.16583E+00	-.13832E+02	0.11530E+03	-.17236E+01	0.11394E+03	0.14733E+03	0.00000E+00
5	5	*	0.16785E-04	-.24227E-03	0.89006E-03	0.21528E+00	-.15672E+02	0.13083E+03	-.22395E+01	0.13044E+03	0.15413E+03	0.00000E+00

I= 2 J= 2

K	L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL.
1	1	*	0.82020E-04	-.39220E-03	0.15260E-02	0.11572E+01	-.17427E+02	0.15213E+03	-.17062E+02	0.15169E+03	0.16406E+03	0.00000E+00
1	2	E	0.20412E-03	-.30574E-02	0.19790E-01	-.51206E-02	-.18354E-01	0.15545E-01	-.18628E+02	0.17251E+02	0.70320E+02	0.00000E+00
1	3	E	0.12126E-03	-.37377E-02	0.24579E-01	-.24809E-01	0.25167E-01	0.14782E-01	-.87780E+01	0.22807E+02	0.64763E+02	0.00000E+00
1	4	E	0.32750E-06	-.39122E-02	0.25833E-01	0.12934E-01	0.29199E-02	-.25066E-01	-.10445E+00	0.23878E+02	0.63632E+02	0.00000E+00
1	5	E	-.11713E-03	-.37308E-02	0.24573E-01	0.38312E-02	-.11065E-01	-.21923E-01	0.85641E+01	0.22773E+02	0.64741E+02	0.00000E+00
2	1	*	0.62684E-04	-.52133E-03	0.20699E-02	0.89426E+00	-.19165E+02	0.17138E+03	-.10891E+02	0.17291E+03	0.17191E+03	0.00000E+00
2	2	E	0.16287E-03	-.39207E-02	0.25186E-01	-.10227E-01	-.20480E-01	0.42972E-01	-.11681E+02	0.92460E+01	0.78558E+02	0.00000E+00
2	3	E	0.10905E-03	-.49216E-02	0.32186E-01	-.44436E-01	0.24263E-01	-.32598E-01	-.64034E+01	0.14033E+02	0.73658E+02	0.00000E+00
2	4	E	-.21148E-05	-.51846E-02	0.34076E-01	0.44681E-01	0.79234E-02	-.24518E-01	-.10795E+00	0.15480E+02	0.72223E+02	0.00000E+00
2	5	E	-.10176E-03	-.49134E-02	0.32169E-01	-.84328E-02	-.15920E-01	0.49785E-01	0.61817E+01	0.14093E+02	0.73721E+02	0.00000E+00
3	1	*	0.44402E-04	-.60646E-03	0.23817E-02	0.64644E+00	-.20331E+02	0.18253E+03	-.69702E+01	0.18386E+03	0.17788E+03	0.00000E+00
3	2	E	0.11700E-03	-.43854E-02	0.27848E-01	-.15605E-01	-.25914E-01	0.38278E-01	-.72795E+01	0.56227E+01	0.82367E+02	0.00000E+00
3	3	E	0.81791E-04	-.55774E-02	0.36005E-01	-.47289E-01	0.14238E-01	-.54847E-01	-.41740E+01	0.86398E+01	0.79210E+02	0.00000E+00
3	4	E	-.22174E-05	-.58997E-02	0.38261E-01	0.46862E-01	-.95331E-02	0.59160E-01	-.11276E+00	0.98059E+01	0.78215E+02	0.00000E+00
3	5	E	-.73847E-04	-.55703E-02	0.35991E-01	-.96609E-02	-.11248E-01	-.28983E-01	0.39511E+01	0.86654E+01	0.79223E+02	0.00000E+00
4	1	*	0.30527E-04	-.66320E-03	0.25693E-02	0.45624E+00	-.21115E+02	0.18934E+03	-.44261E+01	0.19022E+03	0.18191E+03	0.00000E+00
4	2	E	0.81605E-04	-.46744E-02	0.29372E-01	-.15981E-01	-.15295E-01	0.42339E-02	-.45452E+01	0.35052E+01	0.84625E+02	0.00000E+00
4	3	E	0.58300E-04	-.59824E-02	0.38171E-01	-.43988E-01	0.13825E-01	-.26368E-01	-.26361E+01	0.54276E+01	0.82657E+02	0.00000E+00
4	4	E	-.20687E-05	-.63408E-02	0.40644E-01	0.44677E-01	-.37066E-02	0.24421E-01	-.11514E+00	0.61763E+01	0.81984E+02	0.00000E+00
4	5	E	-.51445E-04	-.59772E-02	0.38157E-01	-.51019E-03	0.30388E-02	0.21130E-02	0.24111E+01	0.54458E+01	0.82681E+02	0.00000E+00
5	1	*	0.20275E-04	-.70232E-03	0.26879E-02	0.32006E+00	-.21671E+02	0.19371E+03	-.26635E+01	0.19428E+03	0.18459E+03	0.00000E+00
5	2	E	0.57136E-04	-.48710E-02	0.30334E-01	-.18597E-01	-.85526E-02	-.51271E-01	-.27705E+01	0.21672E+01	0.86072E+02	0.00000E+00
5	3	E	0.42048E-04	-.62542E-02	0.39517E-01	-.47971E-01	0.14305E-01	0.36528E-01	-.15957E+01	0.35450E+01	0.84826E+02	0.00000E+00
5	4	E	-.25483E-05	-.66368E-02	0.42126E-01	0.50156E-01	-.48809E-01	0.18520E-02	-.11546E+00	0.40046E+01	0.84314E+02	0.00000E+00
5	5	E	-.34255E-04	-.62549E-02	0.39509E-01	-.73022E-02	0.65129E-01	-.15520E-01	0.13682E+01	0.35015E+01	0.84791E+02	0.00000E+00

I= 2 J= 3

K	L	CODE	DX	DY	DZ	SIGXZ	SIGYZ	SIGZZ	SIGXY	SIGXX	SIGYY	ENERGY REL.
1	1	E	-.20671E-03	-.30507E-02	0.19757E-01	-.34441E-02	0.22463E-01	0.34360E-01	0.19030E+02	0.17649E+02	0.69950E+02	0.00000E+00
1	2	*	-.85559E-04	-.39128E-03	0.15187E-02	-.11651E+01	-.17357E+02	0.15191E+03	0.17458E+02	0.15187E+03	0.16354E+03	0.00000E+00
1	3	*	-.44777E-04	-.15686E-03	0.53176E-03	-.62477E+00	-.14161E+02	0.11737E+03	0.81972E+01	0.11422E+03	0.14937E+03	0.00000E+00
1	4	*	-.27316E-04	-.90195E-04	0.29167E-03	-.38168E+00	-.13218E+02	0.10896E+03	0.48017E+01	0.10543E+03	0.14556E+03	0.00000E+00
1	5	*	-.18149E-04	-.60421E-04	0.19058E-03	-.25620E+00	-.12794E+02	0.10542E+03	0.32137E+01	0.10177E+03	0.14391E+03	0.00000E+00
2	1	E	-.16369E-03	-.39112E-02	0.25155E-01	-.12322E-01	0.66950E-02	-.28485E-01	0.12085E+02	0.95925E+01	0.78104E+02	0.00000E+00
2	2	*	-.66655E-04	-.51949E-03	0.20637E-02	-.89599E+00	-.19105E+02	0.17114E+03	0.11295E+02	0.17308E+03	0.17136E+03	0.00000E+00
2	3	*	-.39248E-04	-.19312E-03	0.68415E-03	-.54855E+00	-.14672E+02	0.12290E+03	0.67466E+01	0.12153E+03	0.15055E+03	0.00000E+00
2	4	*	-.25431E-04	-.10443E-03	0.35368E-03	-.35467E+00	-.13439E+02	0.11134E+03	0.43108E+01	0.10877E+03	0.14598E+03	0.00000E+00
2	5	*	-.17251E-04	-.67110E-04	0.22118E-03	-.24400E+00	-.12915E+02	0.10671E+03	0.29699E+01	0.10361E+03	0.14419E+03	0.00000E+00
3	1	E	-.11694E-03	-.43732E-02	0.27812E-01	-.14178E-01	-.15177E-01	0.11979E-01	0.76894E+01	0.60067E+01	0.81943E+02	0.00000E+00
3	2	*	-.48779E-04	-.60398E-03	0.23742E-02	-.64163E+00	-.20275E+02	0.18230E+03	0.73767E+01	0.18403E+03	0.17735E+03	0.00000E+00
3	3	*	-.30489E-04	-.22262E-03	0.79283E-03	-.42916E+00	-.15092E+02	0.12695E+03	0.49714E+01	0.12628E+03	0.15208E+03	0.00000E+00
3	4	*	-.20983E-04	-.11665E-03	0.40285E-03	-.29556E+00	-.13631E+02	0.11329E+03	0.34582E+01	0.11135E+03	0.14652E+03	0.00000E+00
3	5	*	-.14807E-04	-.72667E-04	0.24622E-03	-.21186E+00	-.13020E+02	0.10781E+03	0.24969E+01	0.10515E+03	0.14449E+03	0.00000E+00
4	1	E	-.81657E-04	-.46587E-02	0.29332E-01	-.14569E-01	-.30283E-01	0.15159E-01	0.49595E+01	0.39252E+01	0.84221E+02	0.00000E+00
4	2	*	-.35161E-04	-.66002E-03	0.25638E-02	-.44814E+00	-.21064E+02	0.18907E+03	0.48363E+01	0.19037E+03	0.18136E+03	0.00000E+00
4	3	*	-.22327E-04	-.24493E-03	0.86714E-03	-.31787E+00	-.15411E+02	0.12972E+03	0.34490E+01	0.12927E+03	0.15344E+03	0.00000E+00
4	4	*	-.15940E-04	-.12682E-03	0.43928E-03	-.22857E+00	-.13789E+02	0.11477E+03	0.25322E+01	0.11317E+03	0.14711E+03	0.00000E+00
4	5	*	-.11722E-04	-.77653E-04	0.26561E-03	-.17034E+00	-.13109E+02	0.10870E+03	0.19080E+01	0.10633E+03	0.14484E+03	0.00000E+00
5	1	E	-.56835E-04	-.48511E-02	0.30290E-01	-.16041E-01	-.64569E-01	-.39107E-03	0.31888E+01	0.26252E+01	0.85690E+02	0.00000E+00

Corrections required to "PCMINTAB User's Guide"
Division Report MRL 88-92 (TR)

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