



Binary Results Files for PERFORM-3D™

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PERFORM-3D Binary Results Files

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1 Introduction

1.1 Files and File Names

For each analysis, PERFORM-3D writes the analysis results in a number (often a rather large number) of short binary results files. Users can access these files directly, to add post-processing operations that are not included in the PERFORM-3D graphic interface.

It is necessary to write computer code to access the files. This is simple for most of the files, and almost any programming language can be used. Some files are more complex, because the results are compacted.

Most files are binary direct access files, with fixed record lengths. Some are binary sequential files, which can have varying record lengths and must be read sequentially. The files are written by a FORTRAN program.

There is a set of results files for each Analysis Series. The files can be found in the folder for the Analysis Series. This folder also contains ECHO.txt and some other files.

All results files have names that begin with the letter "Z". Other letters identify the result type. For example, a file beginning with "ZC" contains nodal displacements.

An Analysis Series will have several analyses, for gravity load, static push-over, etc. There is a set of results files for each analysis in the series. For example, the files ZC001, ZC002 and ZC003 contain nodal displacement results for the first, second and third analyses in the Analysis Series. Within each series, the analyses are numbered in the order that they are carried out.

For element results there are separate files for each Element Group. The names of these files include the element group number and the analysis number. For example, the files Z001.H005, Z002.H005 and Z003.H005 contain element results for analysis number 5 and the elements in Element Groups 1, 2 and 3.

1.2 Numbering of Nodes, Elements, Nodes, Etc.

In the PERFORM-3D graphic interface, a node is identified by its H1, H2 and V coordinates, not by a node number. The coordinates of a node can be obtained by right-clicking on the node. For analysis, the nodes are also numbered (in the order that they are defined in the graphic interface), and to use the binary results files it is necessary to use node numbers. That is, given the H1, H2, V coordinates of a node, it is necessary to find the corresponding node number.

One way to do this (not necessarily the best way) is to use the ECHO.txt file. This file has a NODE COORDINATES table. Given the coordinates of a node, this table can be searched to find the node number. An alternative (usually better) is to use the binary file ZBC, which, in effect, contains the NODE COORDINATES table. The procedure is described later.

In the graphic interface, elements are divided into element groups. Within any group, an element is identified by its location, not by an element number. For example, for a beam element that has two nodes (Nodes I and J), the element can often be identified by the coordinates of Node I. In some cases it may also be necessary to use the coordinates of Node J. For analysis, the element groups are numbered, and the elements in each group are also numbered. To use the binary results files it is necessary to use these numbers. One way to get an element number (not necessarily the best way) is to use the *ELEMENTS section of the ECHO.txt file. An alternative (usually better) is to use the binary file ZBE, which contains the same information. For a beam element, the steps are essentially as follows.

- (1) Obtain the H1, H2, V coordinates of Node I for the element.
- (2) Find the node number, by searching the NODE COORDINATES table in ECHO.txt or by searching the ZBC binary file.
- (3) Knowing the element group number (the order in which the group is listed in the graphic interface), or else knowing the group description, search either the ELEMENT GROUP table in ECHO.txt or the binary file ZBE, to match the Node I number. Hence get the element number.

Results can also be obtained for drifts and structure sections, both of which are numbered. To get the number for a drift, use the HORIZONTAL DRIFTS table in ECHO.txt, or use the binary file

ZBD, which contains the same information. To get the number for a structure section, use the STRUCTURE SECTION tables in ECHO.txt, or use the binary file ZBS.

1.3 Organization Of This Note

The following sections divide the results files into the following groups.

- (1) Locating nodes, elements, etc.
- (2) Mode shapes and modal properties.
- (3) Nodal displacements, drifts, and nodal velocities and accelerations.
- (4) Structure sections.
- (5) Element results for which the files have simple layouts and are relatively easy to access.
- (6) Element results where the files have more complex layouts and are more difficult to access, because the results are compacted.

This note does not yet cover all of the results files. More files may be covered in the future, usually depending on user requests.

2 Locating Nodes, Elements, Etc.

2.1 Node Coordinates

File name = ZBC

File type = binary direct access. Record length = 24 bytes

One control record, plus one record for each node.

Control record :

No. of nodes (integer*4).

Rest not used.

Record for each node :

H1 coordinate (real*8).

H2 coordinate (real*8).

V coordinate (real*8).

Given the coordinates of a node, search this file to obtain the node number.

2.2 Elements

File name = ZBE

File type = binary sequential.

One control record, plus one set of records for each element group.

Control record :

No. of element groups (integer*4).

Records for each element group :

Record 1 :

No. of elements in group (integer*4).

No. of nodes per element (NNOD) (integer*4).

Element group description (character*40).

Remaining records : one record for each element in the group.

NNOD items.

Item 1 : Node number for Node I (integer*4).

Item 2 (if needed) : Node number for Node J (integer*4).

Item 3 (if needed) : Node number for Node K (integer*4).

Etc.

Given the coordinates of Node I, etc. for an element, and given the Element Group number (or description), search the ZBD file to get the node number(s), then search the ZBE file to get the element number.

2.3 Drifts

File name = ZBD

File type = binary direct access. Record length = 64 bytes

One control record, plus one record for each drift.

Control record :

No. of drifts (integer*4).

Rest not used.

Record for each drift :

Upper, or Node I, number (integer*4).

Lower, or Node J, number (integer*4).

Node K number (integer*4). Zero for a simple drift.

Node L number (integer*4). Zero for a simple drift.

Drift name (character*8).

Drift description (character*40).

The drift names are always "DR1", "DR2", etc.

Given the description for a drift (from the graphic interface), search this file to get the drift number. Alternatively, given the coordinates of the nodes that define the drift, search the ZBC file to get the node numbers, then search the ZBD file to get the drift number.

2.4 Structure Sections

File name = ZBS

File type = binary direct access. Record length = 52 bytes

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One control record, plus one record for each structure section.

Control record :

No. of structure sections (integer*4).

Rest not used.

Record for each structure section :

Number of cut elements (integer*4).

Section name (character*8).

Section description (character*40).

The structure section names are always "SC1", "SC2", etc.

Given the description for a structure section (from the graphic interface), search this file to get the section number. The number of cut elements can act as a check.

3 Mode Shapes and Modal Properties

Modal properties are saved only for the unloaded state (State 000).

Modal properties are normalized to $\phi^T M \phi = 1$, where ϕ = mode shape matrix and M = mass matrix.

File name = ZK000

File type = binary direct access. Record length = 24 bytes

One control record, plus one set of records for each mode shape.

Control record :

- No. of mode shapes (integer*2).
- Total H1 mass, in mass units (real*4).
- Total H2 mass, in mass units (real*4).
- Total V mass, in mass units (real*4).
- Rest not used.

Records for each mode shape :

Record 1 :

- Mode period, seconds (real*4).
- Rest not used.

Record 2 :

- H1 mass participation factor (real*4).
- H2 mass participation factor (real*4).
- V mass participation factor (real*4).
- Rest not used.

Next NNODS records, where NNODS = no. of nodes : mode shape :

- H1 translation, in global displacement units (real*4).
- H2 translation, in global displacement units (real*4).
- V translation, in global displacement units (real*4).
- H1 rotation, in radians (real*4).
- H2 rotation, in radians (real*4).
- H3 rotation, in radians (real*4).

Next NSSEC records, where NSSEC = no. of structure sections :

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H1 force on section, in global force units (real*4).

H2 force, in global force units (real*4).

V force, in global force units (real*4).

H1 moment, in global force and displacement units (real*4).

H2 moment, in global force and displacement units (real*4).

V moment, in global force and displacement units (real*4).

Next NDRFT records, where NDRFT = no. of drifts :

Drift ratio (real*4).

Rest not used.

Repeat for next mode shape.

4 Node Results, Including Drifts

4.1 Drifts

File name = ZDxxx, where xxx = analysis number.

File type = binary direct access.

Record length = 12 bytes (3 REAL*4). Same for static and dynamic analysis.

Item 1 = current drift value.

Item 2 = maximum positive value of this drift to this point

Item 3 = maximum negative value.

The file contains NTIM+1 sets of NDRFT records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NDRFT = no. of drifts.

See *DRIFT : HORIZONTAL DRIFTS in ECHO.txt for drift numbers.

4.2 Node Displacements

File name = ZCxxx, where xxx = analysis number.

File type = binary direct access.

Record length = 24 bytes (6 REAL*4).

Same for static and dynamic.

Items 1-3 = H1, H2, V translations.

Items 4-6 = H1, H2, V rotations.

The file contains NTIM+1 sets of NNODS records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NNODS = no. of nodes.

See *NODE : NODE COORDINATES in ECHO.txt for node numbers.

4.3 Node Velocities and Accelerations

File name = ZLxxx, where xxx = analysis number.

File type = binary direct access. Record length = 24 bytes (6 REAL*4).

Dynamic analyses only

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Items 1-3 = H1, H2, V translational velocities.

Items 4-6 = H1, H2, V translational accelerations.

Rotational velocities and accelerations are not saved.

The file contains $NTIM+1$ sets of NNODS records, where $NTIM$ = no. of time steps (set 1 = state at start of analysis) and NNODS = no. of nodes.

See *NODE : NODE COORDINATES in ECHO.txt for node numbers.

5 Structure Sections

File name = ZFxxx, where xxx = analysis number.

File type = binary direct access.

Record length for static analysis = 36 bytes (6 REAL*4, 6 INTEGER*2).

Record length for dynamic analysis = 60 bytes (6 REAL*4, 6 INTEGER*2, 6 REAL*4).

Items 1-6 = H1, H2, V forces and H1, H2, V moments.

These include P-delta effects (which means, for example, that for static push-over analysis the H shear may be larger than the H load).

For dynamic analysis these are static forces only, not including beta-K damping forces.

Items 7-11 = Shear strength D/C ratios, in parts per thousand (% x 10), for up to 5 performance levels.

These are nonzero only if shear strength capacities have been specified. To get the D/C ratio, convert to REAL and divide by 1000.

Item 12 = 0 (not used).

Items 13-18 (dynamic only) = beta-K forces and moments.

The file contains NTIM+1 sets of NSSEC records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NSSEC = no. of structure sections.

See *SECTION : STRUCTURE SECTION in ECHO.txt for structure section numbers.

6 Element Results – Simple Cases

6.1 Elastic Bar Elements

This includes elements with Elastic Bar, Gap-Hook Bar and Nonlinear Elastic Bar components.

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access. See below for record length.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified. This is the maximum for all components in the model.

Record length for static analysis = $8 + 6 * \text{MXPFL}$ bytes, *rounded up to next whole multiple of 4* (2 REAL*4, 3*MXPFL INTEGER*2, unused bytes as needed to round up). For example, if MXPFL = 1, record length = 16 bytes (= 14 rounded up); if MXPFL = 2, record length = 20.

Item 1 = current axial force, tension positive.

Item 2 = current axial strain (axial deformation divided by element length).

Next MXPFL items = current strength D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = maximum tension strength D/C ratios to this point.

Next MXPFL items = maximum compression strength D/C ratios.

Record length for dynamic analysis = $12 + 6 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (2 REAL*4, 3*MXPFL INTEGER*2).

Item 1 = current axial force, tension positive.

Item 2 = current axial strain (axial deformation divided by element length).

Item 3 = current beta-K axial force.

Next MXPFL items = current strength D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = maximum tension strength D/C ratios to this point.

Next MXPFL items = maximum compression strength D/C ratios.

Note on D/C Ratios : The strength (force) D/C ratios that are used for performance assessment do not decrease. These are the "maximum" values in the output. Strength D/C ratios are also calculated for the current forces. These are the "current" values. They should not be used for performance assessment, but may be useful for other purposes.

6.2 Inelastic Bar Elements

This includes elements with Nonlinear Bar, Steel Tie and Concrete Strut components:

Record length for static analysis = $8 + 4 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (2 REAL*4, 2*MXPFL INTEGER*2).

Item 1 = current axial force, tension positive (= 0 for a Strain Gage).

Item 2 = current axial strain (axial deformation divided by element length).

Next MXPFL items = tension deformation D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = compression deformation D/C ratios.

Record length for static analysis = $12 + 4 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (3 REAL*4, 2*MXPFL INTEGER*2).

Item 1 = current axial force, tension positive (= 0 for a Strain Gage).

Item 2 = current axial strain (axial deformation divided by element length).

Item 3 = current beta-K axial force.

Next MXPFL items = tension deformation D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = compression deformation D/C ratios.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

Note on D/C Ratios : Deformation D/C ratios never decrease. The deformation D/C ratio is the maximum to the current point in the analysis.

6.3 Deformation Gage Elements

This includes 2-node strain gages, 2-node beam type rotation gages, 4-node rotation gages and 4-node shear strain gages.

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified, for any component. This is the maximum for all components in the model.

Record length = $4 + 4 * \text{MXPFL}$ bytes , rounded up to next whole multiple of 4 (1 REAL*4, 2*MXPFL INTEGER*2).

Item 1 = current deformation (axial strain, beam type rotation, 4-node rotation or shear strain).

Next MXPFL items = positive deformation D/C ratios , in parts per thousand ($\% \times 10$).

Next MXPFL items = negative deformation D/C ratios at current time.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.4 Shear Wall Coupling Beam Element – Special Case - Beam With Two Elastic Beam Segments, One Shear Hinge And No Strength Sections.

For the general case of a coupling beam element see Section 6.1.

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified, for any component. This is the maximum for all components in the model.

Record length = $12 + 4 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (3 REAL*4, 2*MXPFL INTEGER*2).

Item 1 = current hinge force.

Item 2 = current hinge deformation.

Item 2 = energy dissipated in hinge.

Next MXPFL items = positive deformation D/C ratios, in parts per thousand ($\% \times 10$).

Next MXPFL items = negative deformation D/C ratios at current time.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.5 *Frame Element End Forces*

This is for element end forces only. For more detailed results see Section 6.1.

File name = ZyyyFxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

Record length :

44 bytes for a static analysis (11 REAL*4).

68 bytes for a dynamic analysis (17 REAL*4).

Items 1,2 = major plane (3 axis) bending moments at I,J.

Items 3,4 = minor plane (2 axis) bending moments at I,J.

Items 5,6 = major plane (2 axis) shears at I,J.

Items 7,8 = minor plane (3 axis) shears at I,J.

Items 9,10 = axial forces at I,J.

Item 11 = torsional moment.

If a dynamic analysis, beta-K damping forces :

Items 12,13 = major plane (3 axis) bending moments at I,J.

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Items 14,15 = minor plane (2 axis) bending moments at I,J.

Item 16 = axial force.

Item 17 = torsional moment.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.6 Frame Element Bending Deformations

This can be used for drawing the deflected shapes of Frame elements.

File name = ZyyyDxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

Record length :

If N = number of basic components in the compound component,

Record length = $16(N+1)$ bytes ($4(N+1)$ REAL*4).

Each FEMA Beam or FEMA Column component counts as 2 basic components as follows :

For the first FEMA component : a rigid-plastic hinge then an elastic beam segment,

For the second FEMA component : an elastic beam segment then a rigid-plastic hinge.

If the elements in the group do not all have the same number of basic components, the record length is based on the largest value of N. For any element that has a number of basic components that is smaller than the maximum, the results use up only a part of the record.

For N basic components, the number of nodes along the length of the compound component (i.e., along the element length) is N+1. The file contains the transverse displacements (along the element Axis 2 and 3 directions) and bending rotations (about the element Axes 2 and 3) at each node. These are local displacements, relative to the chord from element end I to end J.

There are 4 displacements for each node, as follows.

Displs 1,2 = Translations along Axes 2,3. For the first and last nodes, these are zero (displacements are relative to the chord of the element).
Displs 3,4 = Rotations about Axes 2,3.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.7 Seismic Isolator Elements (Friction Pendulum and Rubber Type)

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified, for any component. This is the maximum for all components in the model.

Record length = $24 + 12 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4, = $(6 \text{ REAL} * 4, 6 * \text{MXPFL} \text{ INTEGER} * 2)$.

Item 1 = shear force along Axis 2.

Item 2 = shear force along Axis 3.

Item 3 = bearing force.

Item 4 = shear deformation along Axis 2.

Item 5 = shear deformation along Axis 3.

Item 6 = bearing deformation.

Next MXPFL items = total shear deformation D/C ratios, in parts per thousand ($\% \times 10$).

Next MXPFL items = Axis 2 shear deformation D/C ratios.

Next MXPFL items = Axis 3 shear deformation D/C ratios.

Next MXPFL items = bearing force D/C ratios.

Next MXPFL items = bearing tension force D/C ratios.

Next MXPFL items = bearing compression force D/C ratios.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.8 Fluid Damper Element – Overall Results

File name = Zyyy.Fxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

Record length = 32 bytes (8 REAL*4).

Item 1 = axial force. For static push-over, this is the estimated force.

Item 2 = element axial deformation.

Items 3-6 are not used (they may contain garbage – ignore them).

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.9 Fluid Damper Element – Detailed Results

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified, for any component. This is the maximum for all components in the model.

Record length = $20 + 18 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4, = (3 REAL*4, 6*MXPFL INTEGER*2, 2 REAL*4, 3*MXPFL INTEGER*2).

A fluid damper element consists of a fluid damper component in series with an elastic bar component.

Item 1 = axial force in fluid damper component. Zero for static load.

Item 2 = axial deformation of fluid damper component.

Item 3 = axial deformation rate of fluid damper component.

Next MXPFL items = axial deformation D/C ratios for fluid damper, in parts per thousand (% x 10).

Next MXPFL items = maximum tension deformation D/C ratios for fluid damper.

Next MXPFL items = maximum compression deformation D/C ratios for fluid damper.

Next MXPFL items = axial force D/C ratios for fluid damper.

Next MXPFL items = maximum tension force D/C ratios for fluid damper.

Next MXPFL items = maximum compression force D/C ratios for fluid damper.

Next item = axial force in elastic bar component.

Next item = axial deformation of elastic bar component.

Next MXPFL items = axial force D/C ratios for elastic bar, in parts per thousand (% x 10).

Next MXPFL items = maximum tension force D/C ratios for elastic bar.

Next MXPFL items = maximum compression D/C ratios for elastic bar.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.10 Buckling Restrained Brace Element – Overall Results

File name = Zyyy.Fxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

Record length = 8 bytes (2 REAL*4).

Item 1 = axial force in element.

Item 2 = axial deformation of element.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.11 Buckling Restrained Brace Element – Detailed Results

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified, for any component. This is the maximum for all components in the model.

A BRB element consists of a BRB component in series with an elastic bar component.

Static analysis : record length = $12 + 12 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (3 REAL*4, 6*MXPFL INTEGER*2, padding if needed).

Item 1 = axial force, the same in the BRB and elastic bar components.

Item 2 = axial deformation of complete element.

Item 3 = axial deformation of BRB component.

Next MXPFL items = axial deformation D/C ratios for fluid damper, in parts per thousand (% x 10).

Next MXPFL items = maximum tension deformation D/C ratios for BRB component.

Next MXPFL items = maximum compression deformation D/C ratios for BRB component.

Next MXPFL items = accumulated deformation D/C ratios for BRB component.

Next MXPFL items = current axial force D/C ratios for elastic bar.

Next MXPFL items = maximum tension force D/C ratios for elastic bar.

Next MXPFL items = maximum compression force D/C ratios for elastic bar.

Dynamic Analysis : record length = $16 + 12 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (4 REAL*4, 6*MXPFL INTEGER*2, padding if needed).

Item 1 = axial force, the same in the BRB and elastic bar components.

Item 2 = axial deformation of complete element.

Item 3 = axial deformation of BRB component.

Item 4 = beta-K axial force in element.

Next MXPFL items = axial deformation D/C ratios for fluid damper, in parts per thousand (% x 10).

Next MXPFL items = maximum tension deformation D/C ratios for BRB component.

Next MXPFL items = maximum compression deformation D/C ratios for BRB component.

Next MXPFL items = accumulated deformation D/C ratios for BRB component.

Next MXPFL items = current axial force D/C ratios for elastic bar.

Next MXPFL items = maximum tension force D/C ratios for elastic bar.

Next MXPFL items = maximum compression force D/C ratios for elastic bar.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.12 Inelastic Panel Zone Element – Detailed Results

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified, for any component. This is the maximum for all components in the model.

Static analysis : record length = $8 + 4 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (2 REAL*4, 2*MXPFL INTEGER*2, padding if needed).

Item 1 = moment (transmitted from columns to beams).

Item 2 = total deformation, in radians (elastic + plastic shear strain in element).

Next MXPFL items = positive deformation D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = negative deformation D/C ratios.

Binary Results Files

Dynamic analysis : record length = $12 + 4 \times \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (3 REAL*4, 2*MXPFL INTEGER*2, padding if needed).

Item 1 = moment (transmitted from columns to beams).

Item 2 = total deformation, in radians (elastic + plastic shear strain in element).

Item 3 = beta-K damping moment.

Next MXPFL items = positive deformation D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = negative deformation D/C ratios.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

6.13 Elastic Panel Zone Element – Detailed Results

File name = Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access.

MXPFL = maximum number of performance levels for which deformation or strength capacities have been specified, for any component. This is the maximum for all components in the model.

Static analysis : record length = $8 + 6 \times \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (2 REAL*4, 3*MXPFL INTEGER*2, padding if needed).

Item 1 = moment (transmitted from columns to beams).

Item 2 = deformation, in radians (shear strain in element).

Next MXPFL items = current strength D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = maximum positive strength D/C ratios.

Next MXPFL items = maximum negative strength D/C ratios.

Dynamic analysis : record length = $12 + 6 * \text{MXPFL}$ bytes, rounded up to next whole multiple of 4 (3 REAL*4, 3*MXPFL INTEGER*2, padding if needed).

Item 1 = moment (transmitted from columns to beams).

Item 2 = deformation, in radians (shear strain in element).

Item 3 = beta-K damping moment.

Next MXPFL items = current strength D/C ratios, in parts per thousand (% x 10).

Next MXPFL items = maximum positive strength D/C ratios.

Next MXPFL items = maximum negative strength D/C ratios.

NTIM+1 sets of NELEM records, where NTIM = no. of time or load steps (set 1 = state at start of analysis) and NELEM = no. of elements in element group.

7 Element Results – General Case

7.1 Frame Element – Detailed Component Results.

The results are in file *Zyyy.Hxxx*, where *yyy* = element group number and *xxx* = analysis number.

File type = binary direct access. The elements must be of Frame type.

For a static analysis there is one "results record" for each element for the state at the start of the analysis, plus one record for each element for each load step. Total number of records = (number of elements in group) x (no. of load steps +1).

For a dynamic analysis there is one results record for each element for the state at the start of the analysis, plus one record for each element for each time step. Total number of records = (number of elements in group) x (no. of time steps +1).

The data in each results record is compacted, and the details depend on the Basic Components that make up the Frame Compound Component for the element. To get a particular result you must first find (a) the results record length, and (b) the location of the result in the results record.

The results record length is in file *ZG*. This file has one record for each element group. To get the results record length for any element you must know its element group number.

A key to the contents of the results record is in file *ZG03*. This file has one record for each Frame Compound Component. There may be many Frame Compound Components, and a Frame Compound Component can be made up of Basic Components of many types. Usually, several Frame Compound Components will have the same Basic Components, and will differ only in the properties for these basic components. In general, to extract detailed results for an element you must know the Frame Compound Component number for the element. However, the contents key depends only on the basic component types, not their properties. If several (or all) elements in an element group have the same basic component types, they have the same contents key.

FILE ZG. File type = binary sequential.

A sequential file can have a different length for each record. The records must be read sequentially. Each record has an end-of-record marker. If the number of items that is read for any record is smaller than the number of items in the record, the reading program skips to the start of the next record. If the number of items that is read for any record is larger than the number of items in the record, this is an error.

Record 1 (2-byte integer):

 MXPFL = max. number of performance levels for which capacities have been specified.

 The number of levels for some elements may be smaller than this number.

 Next record = results record lengths for Element Group 1 (six 2-byte integers).

 Results record length indicator for ZyyyDxxx file, static analysis.

 Results record length indicator for ZyyyDxxx file, dynamic analysis.

 Results record length indicator for ZyyyFxxx file, static analysis.

 Results record length indicator for ZyyyFxxx file, dynamic analysis.

 Results record length indicator for ZyyyHxxx file, static analysis.

 Results record length indicator for ZyyyHxxx file, dynamic analysis.

 Next record = results record length indicators for Element Group 2 (six 2-byte integers).

 Etc for all element groups.

To get the record length, in bytes, read MXPFL, skip to the element group, read the ZyyyHxxx results record length indicator and multiply by 4 (for a historical reason, the record length indicator is the number of 4-byte words, not the number of bytes).

FILE ZG03. File type = binary sequential.

One set of records for each Frame Compound Component. Each set consists of 8 records.

The first 6 records contain information on the basic components. These records can be skipped, with dummy reads. Records 7 and 8 contain keys to the results records in the ZyyyHxxx file.

Record Contents

1 Number of basic components in compound component (NBC) (2-byte integer).

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- 2 Basic component length types (NBC 2-byte integers).
- 3 Basic component length values (NBC 4-byte reals).
- 4 Basic component types (NBC 2-byte integers).
- 5 Additional data on components (NBC 4-byte reals).
- 6 Additional data on components (NBC 4-byte reals).
- 7 Locations in results record of static analysis results (see below) (32 2-byte integers).
- 8 Locations in results record of dynamic analysis results (see below) (32 2-byte integers).

Each location is the starting byte in the results record of the results for a particular Basic Component type. If a Compound Component has no Basic Components of a given type, the corresponding location is zero.

Item Location

- 1 P-M2-M3Hinge, Steel Rotation or Curvature Type results.
- 2 P-M2-M3Hinge, Steel Rotation or Curvature Type D/C ratios.
- 3 P-M2-M3Hinge, Concrete Rotation or Curvature Type results.
- 4 P-M2-M3Hinge, Concrete Rotation or Curvature Type D/C ratios.
- 5 V2-V3 Shear Hinge results.
- 6 V2-V3 Shear Hinge D/C ratios.
- 7 Beam or Column Inelastic Fiber Segment results.
- 8 Beam or Column Inelastic Fiber Segment D/C ratios.
- 9 Moment Hinge, Rotation or Curvature Type results.
- 10 Moment Hinge, Rotation or Curvature Type D/C ratios.
- 11 Semi-Rigid Moment Connection results.
- 12 Semi-Rigid Moment Connection D/C ratios.
- 13 Shear Hinge, Displacement or Plastic Strain Type results.
- 14 Shear Hinge, Displacement or Plastic Strain Type D/C ratios.
- 15 FEMA Beam, Steel Type results.
- 16 FEMA Beam, Steel Type D/C ratios.
- 17 FEMA Beam, Concrete Type results.
- 18 FEMA Beam, Concrete Type D/C ratios.
- 19 Not currently used. Always 0.
- 20 P-M2-M3 Strength Section, Steel Type D/C ratios.
- 21 P-M2-M3 Strength Section, Concrete Type D/C ratios.
- 22 V2-V3 Strength Section D/C ratios.
- 23 Moment Strength Section D/C ratios.
- 24 Shear Force Strength Section D/C ratios.
- 25 Axial Force Strength Section D/C ratios.
- 26 Not currently used. Always 0.

- 27 FEMA Column, Steel Type results.
- 28 FEMA Column, Steel Type D/C ratios.
- 29 FEMA Column, Concrete Type results.
- 30 FEMA Column, Concrete Type D/C ratios.
- 31 Semi-Rigid Axial Connection results.
- 32 Semi-Rigid Axial Connection D/C ratios.

FILE Zyyy.Hxxx. File type = binary direct access. Get results record length from file ZG. Get contents key from file ZG03, as above. The available results are listed below.

If a compound component has N basic components of any type, there are N sets of results for that component type at each load or time step. For example, if there are PMM Hinge, Steel Type components at each end of a frame element, there are 6 results values for the first hinge, followed by 6 results values for the second hinge.

D/C ratios are short integers, containing D/C ratios in parts per thousand (i.e., 1000 means D/C ratio = 1.0). Convert to real and divide by 1000 to get D/C ratio. Since the largest value for a short integer is about 32000, the largest D/C ratio is about 32.

P-M2-M3Hinge, Steel Rotation or Curvature Type (24 bytes).

- Bending moment about Axis 2 (real*4)
- Bending moment about Axis 3 (real*4)
- Axial force (real*4)
- Rotation or curvature about Axis 2 (real*4)
- Rotation or curvature about Axis 3 (real*4)
- Axial displacement or strain (real*4)

P-M2-M3Hinge, Steel Rotation or Curvature Type D/C ratios (2 x MXPFL bytes).

- Deformation D/C ratios (MXPFL values, integer*2)

P-M2-M3 Hinge, Concrete Rotation or Curvature Type results (24 bytes).

- Bending moment about Axis 2 (real*4)
- Bending moment about Axis 3 (real*4)
- Axial force (real*4)
- Rotation or curvature about Axis 2 (real*4)
- Rotation or curvature about Axis 3 (real*4)
- Axial displacement or strain (real*4)

P-M2-M3 Hinge, Concrete Rotation or Curvature Type D/C ratios (2 x MXPFL bytes).

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Deformation D/C ratios (MXPFL values, integer*2)
V2-V3 Shear Hinge results (16 bytes).
Shear force along Axis 2 (real*4)
Shear force along Axis 3 (real*4)
Shear displacement along Axis 2 (real*4)
Shear displacement along Axis 3 (real*4)
V3-V3 Shear Hinge D/C ratios (2 x MXPFL bytes).
Deformation D/C ratios (MXPFL values, integer*2)
Beam or Column Inelastic Fiber Segment (24 bytes).
Bending moment about Axis 2 at segment midpoint (real*4)
Bending moment about Axis 3 at segment midpoint (real*4)
Axial force (real*4)
Bending curvature about Axis 2 at segment midpoint (real*4)
Bending curvature about Axis 3 at segment midpoint (real*4)
Axial strain (real*4)
Beam or Column Inelastic Fiber Section D/C ratios (12 x MXPFL bytes).
Steel tension strain D/C ratios (MXPFL values, integer*2)
Steel compression strain D/C ratios (MXPFL values, integer*2)
Concrete tension strain D/C ratios (MXPFL values, integer*2)
Concrete compression D/C ratios (MXPFL values, integer*2)
Positive rotation D/C ratios (MXPFL values, integer*2)
Negative rotation D/C ratios (MXPFL values, integer*2)
Moment Hinge , Rotation or Curvature Type results (8 bytes).
Bending moment (real*4)
Rotation or curvature (real*4)
Moment Hinge , Rotation or Curvature Type D/C ratios (4 x MXPFL bytes).
Positive rotation or curvature D/C ratios (MXPFL values, integer*2)
Negative rotation or curvature D/C ratios (MXPFL values, integer*2)
Semi-Rigid Moment Connection results (8 bytes).
Bending moment (real*4)
Rotation (real*4)
Semi-Rigid Moment Connection D/C ratios (4 x MXPFL bytes).
Positive rotation D/C ratios (MXPFL values, integer*2)
Negative rotation D/C ratios (MXPFL values, integer*2)
Shear Hinge, Displacement or Plastic Strain Type (12 bytes).
Shear force (real*4)
Shear displacement or plastic strain (real*4)
Dissipated energy (real*4)

Shear Hinge, Displacement or Plastic Strain Type D/C ratios (4 x MXPFL bytes).
 Positive displacement or strain D/C ratios (MXPFL values, integer*2)
 Negative displacement or strain D/C ratios (MXPFL values, integer*2)
 FEMA Beam, Steel Type results (8 bytes).
 Bending moment (real*4)
 Rotation (real*4)
 FEMA Beam, Steel Type D/C ratios (4 x MXPFL bytes).
 Positive rotation D/C ratios (MXPFL values, integer*2)
 Negative rotation D/C ratios (MXPFL values, integer*2)
 FEMA Beam, Concrete Type results (8 bytes).
 Bending moment (real*4)
 Rotation (real*4)
 FEMA Beam, Concrete Type D/C ratios (4 x MXPFL bytes).
 Positive rotation D/C ratios (MXPFL values, integer*2)
 Negative rotation D/C ratios (MXPFL values, integer*2)
 P-M2-M3 Strength Section, Steel Type D/C ratios (4 x MXPFL bytes).
 Current strength D/C ratios (MXPFL values, integer*2)
 Maximum strength D/C ratios (MXPFL values, integer*2)
 P-M2-M3 Strength Section, Concrete Type D/C ratios (4 x MXPFL bytes).
 Current strength D/C ratios (MXPFL values, integer*2)
 Maximum strength D/C ratios (MXPFL values, integer*2)
 V2-V3 Strength Section D/C ratios (4 x MXPFL bytes).
 Current strength D/C ratios (MXPFL values, integer*2)
 Maximum strength D/C ratios (MXPFL values, integer*2)
 Moment Strength Section D/C ratios (6 x MXPFL bytes).
 Current strength D/C ratios (MXPFL values, integer*2)
 Maximum positive strength D/C ratios (MXPFL values, integer*2)
 Maximum negative strength D/C ratios (MXPFL values, integer*2)
 Shear Force Strength Section, Concrete Type D/C ratios (4 x MXPFL bytes).
 Current strength D/C ratios (MXPFL values, integer*2)
 Maximum strength D/C ratios (MXPFL values, integer*2)
 Axial Force Strength Section, Concrete Type D/C ratios (6 x MXPFL bytes).
 Current strength D/C ratios (MXPFL values, integer*2)
 Maximum positive strength D/C ratios (MXPFL values, integer*2)
 Maximum negative strength D/C ratios (MXPFL values, integer*2)
 FEMA Column, Steel Type results (24 bytes).

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Bending moment about Axis 2 (real*4)
Bending moment about Axis 3 (real*4)
Axial force (real*4)
End rotation about Axis 2 (real*4)
End rotation about Axis3 (real*4)
Axial strain (real*4)
FEMA Column, Steel Type D/C ratios (2 x MXPFL bytes).
Deformation D/C ratios (MXPFL values, integer*2)
FEMA Column, Concrete Type results (24 bytes).
Bending moment about Axis 2 (real*4)
Bending moment about Axis 3 (real*4)
Axial force (real*4)
End rotation about Axis 2 (real*4)
End rotation about Axis3 (real*4)
Axial strain (real*4)
FEMA Column, Concrete Type D/C ratios (2 x MXPFL bytes).
Deformation D/C ratios (MXPFL values, integer*2)
Semi-Rigid Axial Connection results (8 bytes).
Axial force (real*4)
Axial extension (real*4)
Semi-Rigid Axial Connection D/C ratios (4 x MXPFL bytes).
Positive deformation D/C ratios (MXPFL values, integer*2)
Negative deformation D/C ratios (MXPFL values, integer*2)

The steps for getting results values for a particular element are as follows.

Open the ZG file. Knowing the element group, get the record length for that element group.

Open the ZG03 file. Knowing the number of the Frame Compound Component for the element, get the contents key. Often, several compound components will have the same basic components, and hence the same contents key.

Open the ZyyyHxxx file. Knowing the time or load step and the element number in the group, get the results record. Using the contents key and knowing the required result type, get the result location in the record. Hence get the result value.

7.2 *Shear Wall Element – Detailed Component Results.*

The results are in file Zyyy.Hxxx, where yyy = element group number and xxx = analysis number.

File type = binary direct access. The elements must be of Shear Wall type.

For a static analysis there is one record for each element for the state at the start of the analysis, plus one record for each element for each load step. Total number of records = (number of elements in group) x (no. of load steps +1).

For a dynamic analysis there is one record for each element for the state at the start of the analysis, plus one record for each element for each time step. Total number of records = (number of elements in group) x (no. of time steps +1).

The data in each record is compacted, and the details depend on the Basic Components that are used in the Shear Wall Compound Component. To get a particular result you must find (a) the record length for the results, and (b) the location of the result in the record.

The record length is in file ZG. This file has one record for each element group. To get the record length for any element you must know its element group number.

A key to the contents of the record for Shear Wall elements is in file ZG05. This file has one record for each Shear Wall Compound Component. There may be many Shear Wall Compound Components. Usually, all of these components will have the same Basic Components, and will differ only in the properties for these components. In general, to extract the results you must know the Compound Component number. However, the contents key depends only on the basic component types, not their properties. If all elements in an element group have the same basic component types, they all have the same contents key.

FILE ZG. File type = binary sequential.

A sequential file can have a different length for each record. The records must be read sequentially. Each record has an end-of-record

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marker. If the number of items that is read for any record is smaller than the number of items in the record, the reading program skips to the start of the next record. If the number of items that is read for any record is larger than the number of items in the record, this is an error.

Record 1 (2-byte integer):

MXPFPL = max. number of performance levels for which capacities have been specified.

The number of levels for some elements may be smaller than this number.

Next record = results record lengths for Element Group 1 (six 2-byte integers).

Results record length indicator for ZyyyDxxx results file, static analysis.

Results record length indicator for ZyyyDxxx results file, dynamic analysis.

Results record length indicator for ZyyyFxxx results file, static analysis.

Results record length indicator for ZyyyFxxx results file, dynamic analysis.

Results record length indicator for ZyyyHxxx results file, static analysis.

Results record length indicator for ZyyyHxxx results file, dynamic analysis.

Next record = results record length indicators for Element Group 2 (six 2-byte integers).

Etc for all element groups.

To get the record length, in bytes, read MXPFPL, skip to the element group, read the ZyyyHxxx record length indicator and multiply by 4 (for a historical reason, the record length indicator is the number of 4-byte words, not the number of bytes).

FILE ZG05. File type = binary sequential.

One set of records for each Shear Wall Compound Component. Each set consists of 2 records, as follows.

Record Contents

1 Locations in results record of static analysis results (see below) (eight 2-byte integers).

- 2 Locations in results record of dynamic analysis results (see below) (eight 2-byte integers).

Each location is the starting byte in the results record of the results for a particular Basic Component type. If a Compound Component has no Basic Components of a given type, the corresponding location is zero.

Item	Location
1	Fiber Wall Section results.
2	Fiber Wall Section D/C ratios.
3	Elastic Wall Section results.
4	Elastic Wall Section D/C ratios.
5	Inelastic Shear Material results.
6	Inelastic Shear Material D/C ratios.
7	Elastic Shear Material results.
8	Elastic Shear Material D/C ratios.

If a Shear Wall Compound Component has, say, no Elastic Wall Sections, the corresponding result locations will be zero.

FILE Zyyy.Hxxx. File type = binary direct access. Get record length from file ZG. Get the contents key from file ZG05.

The available results are as follows. D/C ratios are short integers, containing D/C ratios in parts per thousand (i.e., 1000 means D/C ratio = 1.0). Convert to real and divide by 1000 to get D/C ratio. Since the largest value for a short integer is about 32000, the largest D/C ratio is about 32.

Fiber Wall Section results, static analysis (24 bytes).

Bending moment at element mid-height (real*4)

Axial force (real*4)

Bending curvature at element mid-height (real*4)

Axial strain (real*4)

Max. tension strain in any structural fiber (real*4)

Max. compression strain in any structural fiber (real*4)

Fiber Wall Section D/C ratios, static analysis (8 x MXPFL bytes).

Steel tension steel strain D/C ratios (MXPFL values, integer*2)

Steel compression strain D/C ratios (MXPFL values, integer*2)

Concrete tension steel strain D/C ratios (MXPFL values, integer*2)

Steel compression strain D/C ratios (MXPFL values, integer*2)

Elastic Wall Section results, static analysis (8 bytes).

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Bending moment at element mid-height (real*4)
Axial force (real*4)
Elastic Wall Section D/C ratios, static analysis (8 x MXPFL bytes).
Current tension stress D/C ratios (MXPFL values, integer*2)
Current compression stress D/C ratios (MXPFL values, integer*2)
Max tension stress D/C ratios (MXPFL values, integer*2)
Max compression stress D/C ratios (MXPFL values, integer*2)
Inelastic Shear Material results, static analysis (8 bytes).
Current shear stress (real*4).
Current shear strain (real*4).
Inelastic Shear Material D/C ratios, static analysis (4 x MXPFL bytes).
Positive shear strain D/C ratios (MXPFL values, integer*2)
Negative shear strain D/C ratios (MXPFL values, integer*2)
Elastic Shear Material results, static analysis (4 bytes).
Current shear stress (real*4).
Elastic Shear Material D/C ratios, static analysis (4*MXPFL bytes).
Current shear stress D/C ratios (MXPFL values, integer*2)
Max shear stress D/C ratios (MXPFL values, integer*2)

Fiber Wall Section results, dynamic analysis.
Same as static.
Fiber Wall Section D/C ratios, dynamic analysis.
Same as static.
Elastic Wall Section results, dynamic analysis.
Same as static.
Elastic Wall Section D/C ratios, dynamic analysis.
Same as static.
Inelastic Shear Material results, dynamic analysis.
Same as static.
Inelastic Shear Material D/C ratios, dynamic analysis.
Same as static.
Elastic Shear Material results, dynamic analysis.
Same as static.
Elastic Shear Material D/C ratios, dynamic analysis.
Same as static.

The steps for getting results values for a particular element are as follows.

Open the ZG file. Knowing the element group, get the record length for that element group.

Open the ZG05 file. Knowing the number of the Shear Wall Compound Component for the element, get the contents key. Often, all compound components will have the same basic components, and hence the same contents key, so you can usually use the key for the first compound component.

Open the ZyyyHxxx file. Knowing the time or load step and the element number in the group, get the results record. Using the contents key and knowing the required result type, get the result location in the record. Hence get the result value.