

## Zencrack 7.9 - Crack-block Library

### Issue 7.9

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This version of the manual is to be used with Zencrack program version 7.9-1 and Zencrack GUI version 7.9-a. The program version and build date are shown in the banner at the start of every Zencrack output file (i.e. the .rep file). The GUI version is shown in the program Help > About menu. All pages are at “Issue 7.9, Revision 0”.

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## 1. Introduction

Crack-blocks are groups of elements arranged in such a way that they contain a section of crack front. Each crack-block is stored in a unit cube form in a data file that is held in the “crack” directory of the Zencrack installation. Crack-blocks are mapped into element space in the user’s uncracked mesh in order to introduce cracks into an uncracked mesh. Complete crack fronts in a mesh may be defined by one crack-block or a series of connected crack-blocks depending upon the modelling requirements.

The crack-block library contains two types of crack-blocks:

- “Standard” crack-blocks
- “Large” crack-blocks

The standard crack-blocks reduce to a single element on their back faces and merge with the rest of the mesh via shared nodal numbers. The large crack-blocks contain multiple nodes on their back faces and are used with surface-based tying to connect them to the surrounding (dis-similar) mesh. The standard and large crack-blocks contain two topologically different crack-block types:

- Quarter circular crack-blocks
- Through crack-blocks

The quarter circular crack-blocks contain a corner crack in their unit-cube form. The through crack-blocks contain a straight section of crack front in their unit cube form. During the mapping process to place crack-blocks into the user’s mesh, the required crack front can be specified by the user.

Crack-blocks can be connected to one another in a variety of face-to-face or side-to-side orientations. A crack-block can make a face-to-face match with itself if it contains symmetry in its crack plane. This is the case for the majority of crack-blocks. Exceptions to the face-to-face matching exist as pairs of crack-blocks with a and b appended to their names, e.g. s01\_q178x8a and s01\_q178x8b. These crack-blocks have refinement at opposite ends of their crack fronts giving a lack of symmetry in the crack plane.

### 1.1 Crack-block families

The crack-blocks are grouped into “families”. All crack-blocks within each family are compatible with all other family members for side-to-side combinations. The naming convention of the crack-blocks is based on a family reference, the topological type, the number of elements in the crack-block and the number of elements along the crack front section. For example:

l01_q496x8	l01	Large crack-block family 1
	q	Quarter circular crack-block
	496	Total of 496 elements
	x8	8 elements along the crack front
s02_t19x1	s02	Standard crack-block family 2
	t	Through crack-block
	19	Total of 19 elements
	x1	1 element along the crack front

Crack-blocks are referenced on the CRACK FRONT keyword using the crack-block name, e.g. l01\_q496x8, s02\_t19x1.

## 1.2 Updates on crack-blocks faces

During mesh generation Zencrack produces reports in the .rep output file for all crack-block faces that have had boundary conditions, loads or surface definitions updated, e.g.:

```
***INFORMATION : BOUNDARY CONDITION UPDATE FOR CRACK-BLOCK 1, FACE
1, DOF 2
```

```
Fixed displacements of equal magnitude on all four corner nodes
will be updated onto all nodes on the face in the cracked mesh.
```

```
***INFORMATION : CRACK-BLOCK LOADING
LOAD ON FACE 5 OF CRACK-BLOCK 1 HAS BEEN UPDATED
(THIS IS THE CRACK FACE)
```

```
***INFORMATION : CRACK-BLOCK SURFACE
SURFACE ON FACE 6 OF CRACK-BLOCK 1 HAS BEEN UPDATED
```

## 1.3 Standardised face numbering for crack-blocks

The standard numbering for faces 1 to 6 as referenced in the messages above is shown in [Figure 1-1](#). The crack front is always on face 5. Node and element sets for the outer faces of the crack-blocks can be created using the **BLOCK FACES** parameter on the NODE SETS and ELEMENT SETS respectively. For the purposes of set generation, face 5 is split into two parts – one for the open crack face and one for the closed ligament.

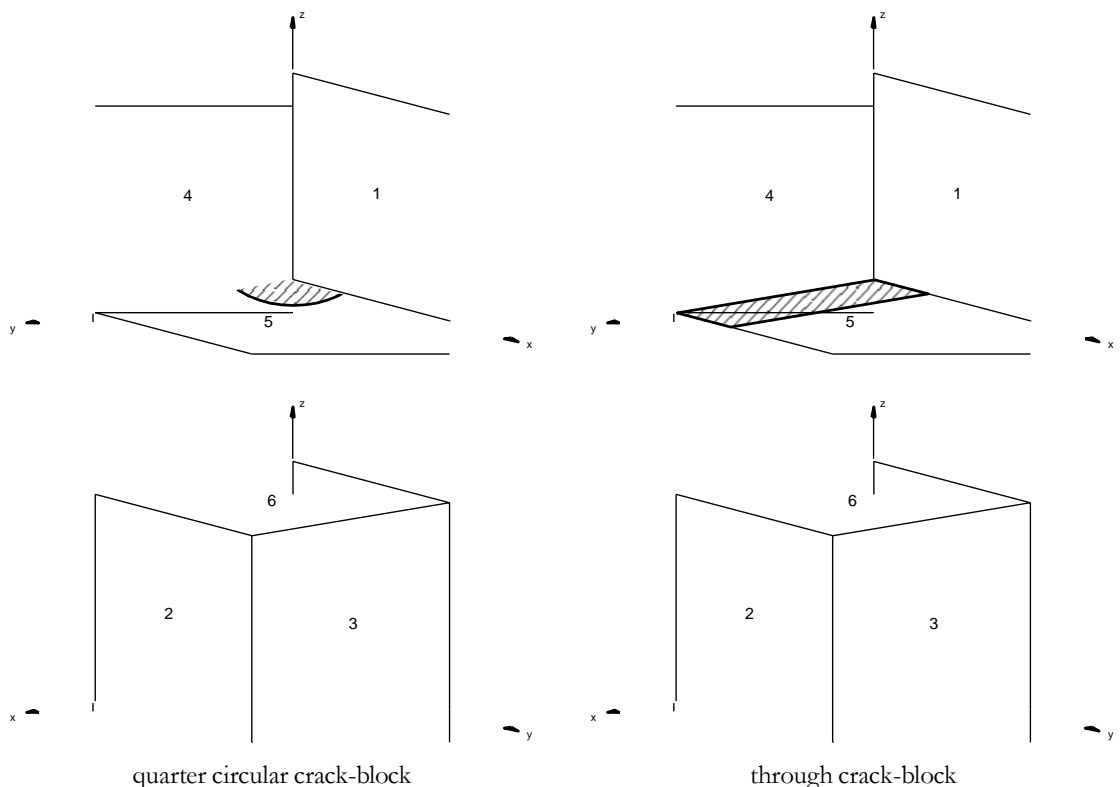


Figure 1-1 – Schematic showing Zencrack face number conventions for crack-blocks



## 1.4 Restrictions

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The following additional points are noted with regard to the crack-blocks:

- Some of the standard crack-blocks, (e.g. s02\_q38x2) have a node at the centre of their upper back face (at the midside of the diagonal edge across the face). This upper face is allowed to connect with a standard element face. Zencrack adds a tying constraint for the centre node to ensure compatibility is maintained.
- Some crack-blocks cannot be used with Ansys version 13 (or earlier) due to a collapsed internal element that is not permitted in these versions of Ansys: s02\_q38x2, s03\_q46x2, s04\_q70x2, s05\_q24x2. All crack-blocks can be used with Ansys 14.0 (or later) due to a change in Ansys.
- If a model contains only large crack-blocks then the following options will have no effect:
  - Boundary shifting
  - Mesh relaxation
- The split set capability requires that the elements connected to the split sets are replaced by standard crack-blocks – the split set capability does not apply for crack fronts consisting of large crack-blocks.
- Crack fronts that are required to take advantage of the BOUNDARY SHIFT, TYPE=TRANSFER option to allow the crack front to move through the mesh should contain only standard through crack-blocks selected from families s02, s03, s04 or s05.

## **2. Crack-block Family Overview**

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This section presents an overview of all the crack-block families with all family members pictured on a single page. Section 3 provides larger images of the individual crack-blocks and additional details for each.

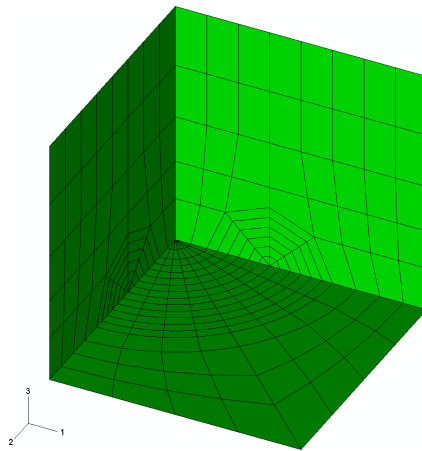
### **2.1 Large crack-blocks**

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There are six large crack-block families available, named l01 to l06, described on the following pages.

Different families are provided to suit different applications. For example, the highly refined l02 and l06 families would be appropriate if very detailed stresses were required from an analysis.

l01



l01\_q496x8

Notes for l01 family:

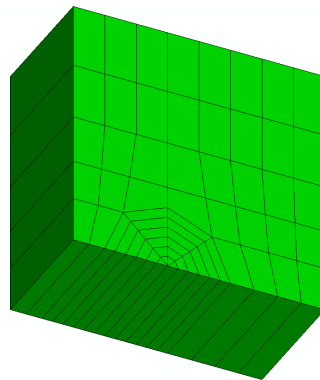
The ideal edge ratio for this family is 0.375.

6 element rings are controlled for mapping purposes.

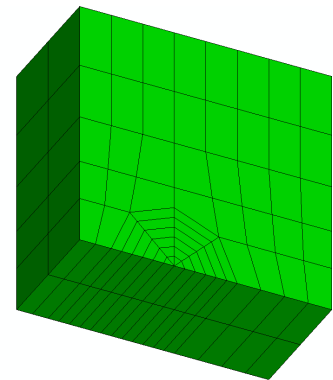
Contour evaluations are possible for up to 6 contours for Abaqus and Ansys.

When using the “enhanced ring control” mapping method (see MAPPING keyword), families l05 and l06 should be used rather than l01 and l02 due to the improved element distribution on the back faces of the crack-blocks.

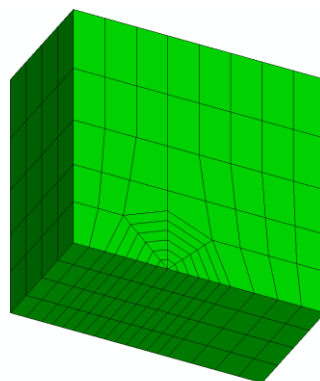
A 2x2x2 refined version of the l01 family is contained in the l02 family, e.g. l02\_q3968x16 is the 2x2x2 refined version of l01\_q496x8.



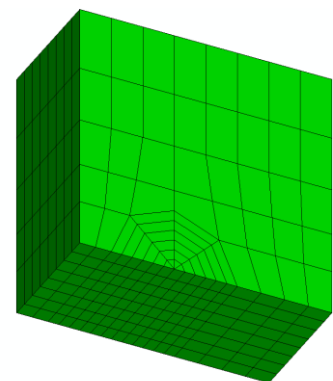
l01\_t062x1



l01\_t124x2



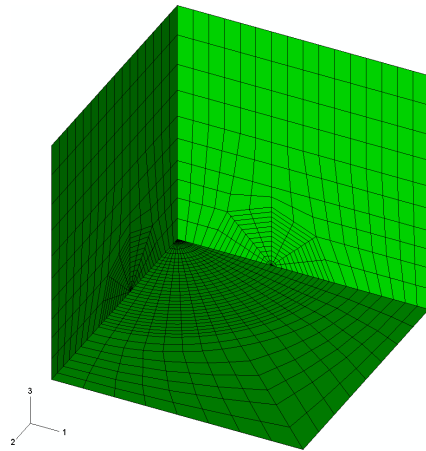
l01\_t248x4



l01\_t496x8

**Figure 2-1 – Crack-block family l01**

102



102\_q3968x16

Notes for 102 family:

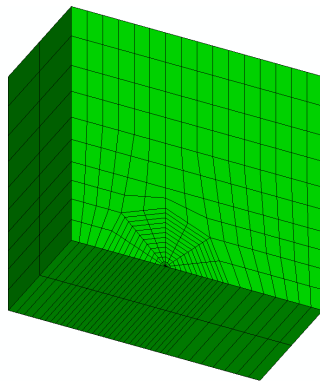
The ideal edge ratio for this family is 0.375.

12 element rings are controlled for mapping purposes.

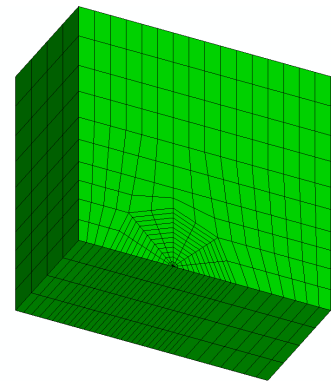
Contour evaluations are possible for up to 12 contours for Abaqus and Ansys.

When using the “enhanced ring control” mapping method (see MAPPING keyword), families 105 and 106 should be used rather than 101 and 102 due to the improved element distribution on the back faces of the crack-blocks.

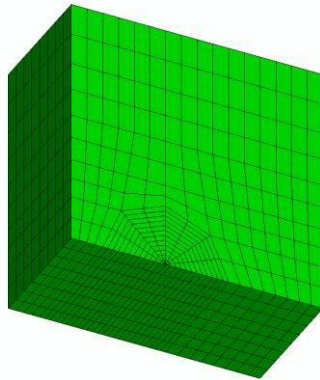
A coarser version of the 102 family is the 101 family, e.g. 102\_q3968x16 is the refined version of 101\_q496x8.



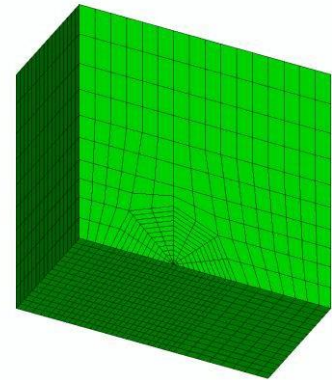
102\_t0496x2



102\_t0992x4



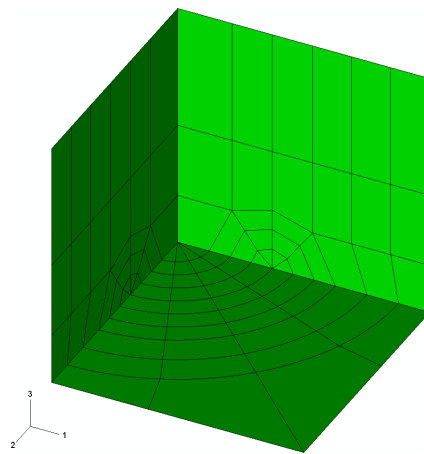
102\_t1984x8



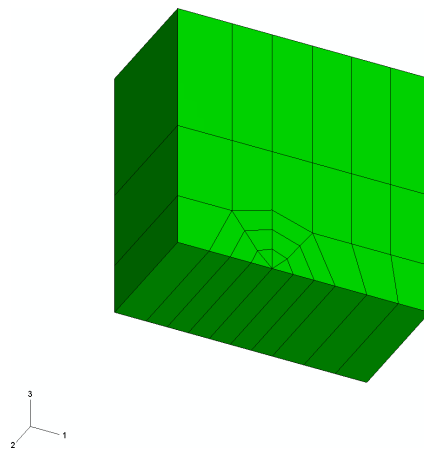
102\_t3968x16

**Figure 2-2 – Crack-block family 102**

103



103\_q112x4



103\_t28x1

Notes for 103 family:

The ideal edge ratio for this family is 0.375.

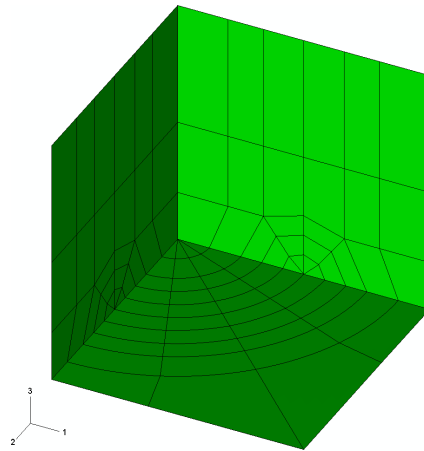
3 element rings are controlled for mapping purposes.

Contour evaluations are possible for up to 3 contours for Abaqus and Ansys.

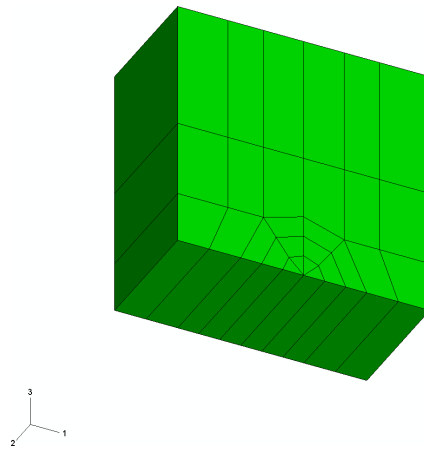
Family 104 is similar to 103 but has a larger ideal edge ratio of 0.5.

**Figure 2-3 – Crack-block family 103**

I04



104\_q112x4



104\_t28x1

Notes for I04 family:

The ideal edge ratio for this family is 0.5.

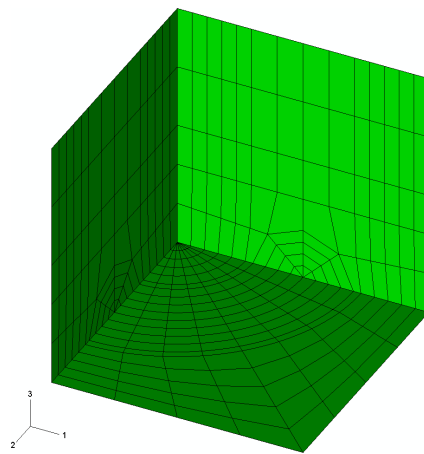
3 element rings are controlled for mapping purposes.

Contour evaluations are possible for up to 3 contours for Abaqus and Ansys.

Family I03 is similar but has a smaller ideal edge ratio of 0.375.

**Figure 2-4 – Crack-block family I04**

I05



105\_q672x8

Notes for I05 family:

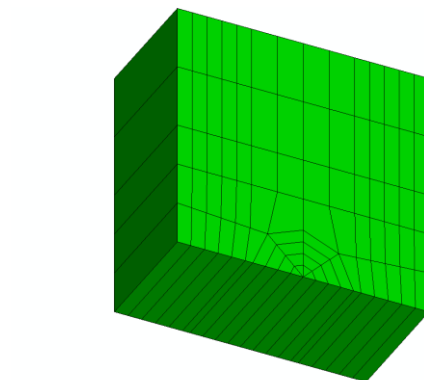
The ideal edge ratio for this family is 0.5.

4 element rings are controlled for mapping purposes.

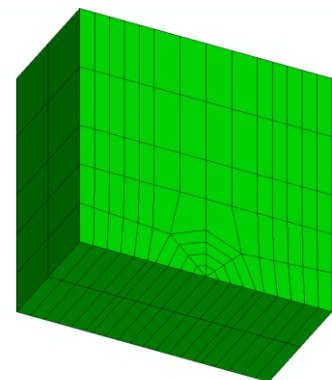
Contour evaluations are possible for up to 6 contours for Abaqus and Ansys.

When using the “enhanced ring control” mapping method (see MAPPING keyword), families I05 and I06 should be used rather than I01 and I02 due to the improved element distribution on the back faces of the crack-blocks.

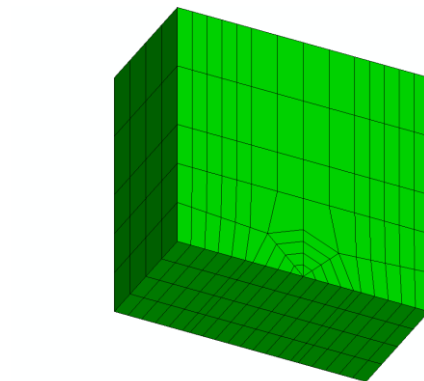
A 2x2x2 refined version of the I05 family is contained in the I06 family, e.g. I06\_q5376x16 is the refined version of I05\_q672x8.



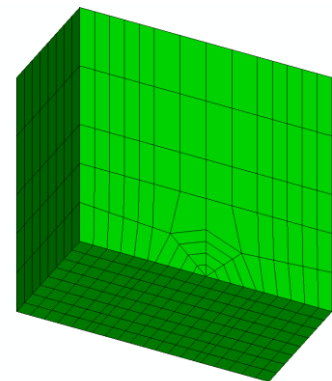
105\_t084x1



105\_t168x2



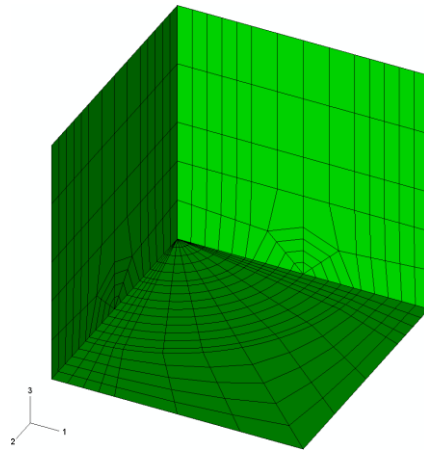
105\_t336x4



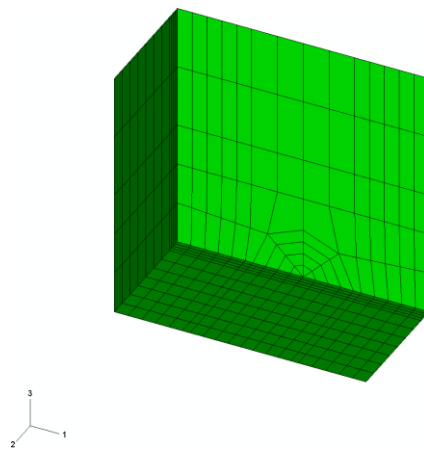
105\_t672x8

**Figure 2-5 – Crack-block family I05**

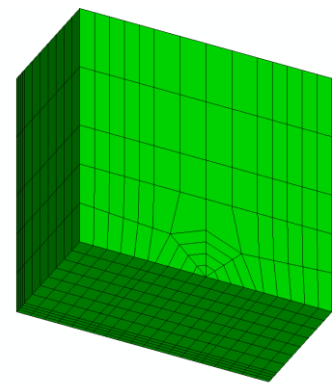
These crack-blocks are extensions to the I05 family with additional sub-divisions along part of the crack front.



I05\_q1176x14



I05\_t924x11a



I05\_t924x11b

**Figure 2-6 – Crack-block family I05 (extensions)**



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