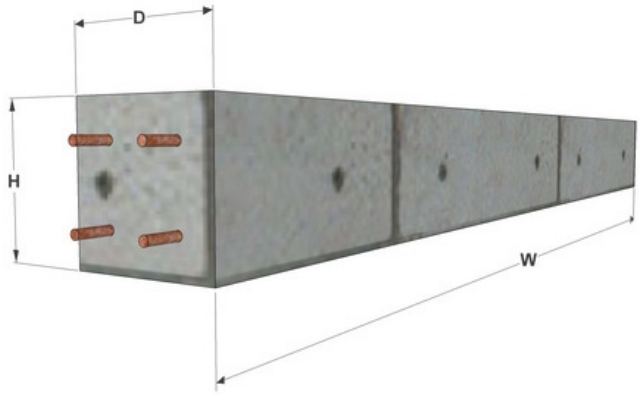
Classification of Building Damage Tutorial

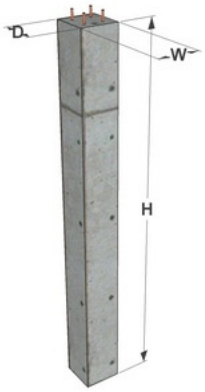
Your task is simple. We ask you to identify and categorize damage to primary elements of reinforced concrete and masonry buildings. This tutorial provides instructions and some basic definitions necessary for this work.

Primary Element Definitions

Before introducing the assessment process itself, it is necessary to define the four primary structural elements you will be asked to assess: beams, columns, slabs, and walls. A description of each is provided below.

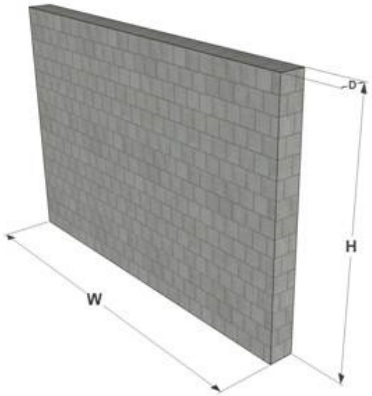


A **beam** is a horizontal element where the width (W) is considerably larger than the depth (D) and height (H).



A **column** is a vertical element where the height (H) is considerably larger than the depth (D) and width (W).

A **slab** is a horizontal element used as a roof or floor where the width (W) and depth (D) are considerably larger than the height (H).



A **wall** is a vertical element used for partitioning where the height (H) and width (W) are considerably larger than the depth (D).

Damage Assessment Process

This portion of the tutorial introduces the five-step assessment process you will be asked to do. These steps are:

1. Determine the building to tag.
2. Identify which elements (beams, columns, slabs, walls) of the building are visible and can be assessed.
3. For each of these visible elements, determine if any of those elements are damaged.
4. For any of the elements identified as damaged, identify the damage pattern.
5. For any of the elements identified as damaged, assess the severity of the damage.

This tutorial will take you through each of these steps, showing the questions you will be asked to answer about each photo, the response options for each question, a definition of the possible responses, and a visual example of each of the possible responses.

Step 1: Determine the building to tag.

Question: Which building needs to be tagged?

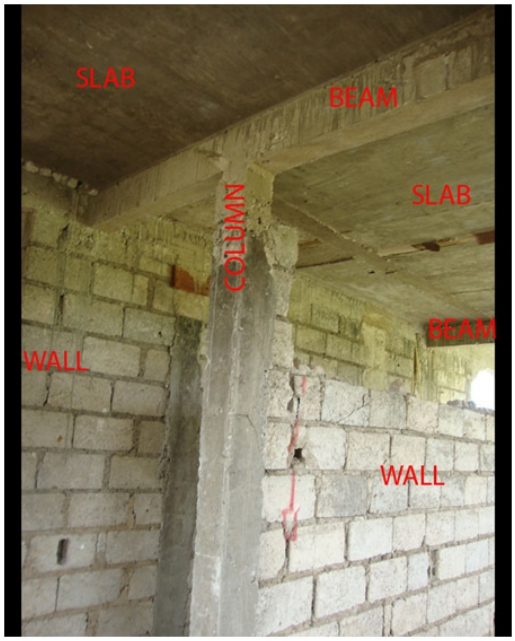
Response Options	Explanation	Examples
Tag entire photo (Picture shows one building in its entirety or just part of it)	Image shows one building in its entirety. or Image zooms in to show only part of a building.	 

Tag part of photo (Picture shows multiple buildings)	If multiple buildings are present, it will be necessary to tag the building that is the focus of the photo and/or the building that shows the most damage. **In this case it is the building inside the red square.**	
Cannot determine (Picture shows no buildings at all)	Photo does not clearly show a building or part of a building. Such photos cannot be tagged.	

Step 2: Identify which primary elements of the building are visible and can be assessed

Question: What primary elements are visible and can be assessed in this photo? (Select all that apply)

Note: Not all elements will be visible in every photo, but photos can have multiple elements. Please identify all visible elements in the photo including both damaged and undamaged elements if they are visible.

Response Options (select all that apply)	Definition of Elements	Example
COLUMN	Vertical element where the height (H) is considerably larger than the depth (D) and width (W).	
BEAM	Horizontal element where the width (W) is considerably larger than the depth (D) and height (H).	
SLAB	Horizontal element used as a roof or floor where the width (W) and depth (D) are considerably larger than the height (H).	
WALL	Vertical element used for partitioning where the height (H) and width (W) are considerably larger than the depth (D).	
Cannot determine	Photo does not appear to have any of the above elements.	

Step 3: Determine if any of the primary elements are damaged

For every primary element you identified as visible and assessable in Step 2, you will be asked to identify if they are damaged.

Question: Is there damage in (any of) **the beam(s)**?

Question: Is there damage in (any of) **the column(s)**?

Question: Is there damage in (any of) **the slab(s)**?

Question: Is there damage in (any of) **the wall(s)**?

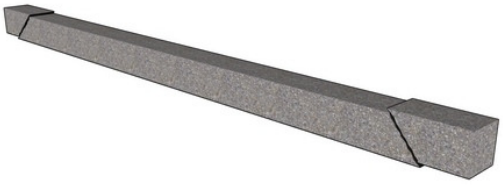
Response Options	Definition of Damage to an Element
NO	No presence of cracks, holes, voids or deformations.
YES	Presence of cracks, holes, voids or other deformations.

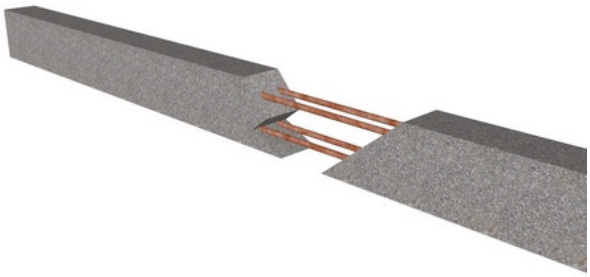
Step 4: Identify the damage pattern

For every primary element you identified as damaged in Step 3, you will be asked to identify the types of damage visible in these elements. Note that more than one damage pattern may be evident in the photo. Please specify all that are present. The types of damage are associated with specific patterns defined in the next pages.

Step 4-1: Beam Damage Pattern

Question: What damage patterns are visible in (any of) the beam(s)? (Select all that apply)

Response Options (select all that apply)	Damage Pattern Definition	Example
FLEXURE	Presence of vertical cracks near the middle of the beam. When severe, beam will appear to sag.	
SHEAR	Presence of horizontal or diagonal cracks in the beam, especially near the ends.	 

CONCRETE LOSS	Concrete has crumbled away creating large voids, exposing steel reinforcing bars inside the beam.	

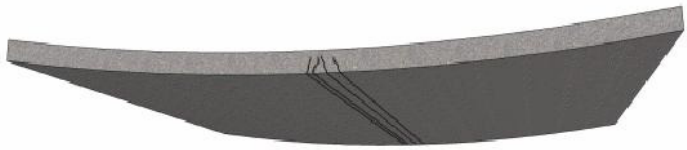
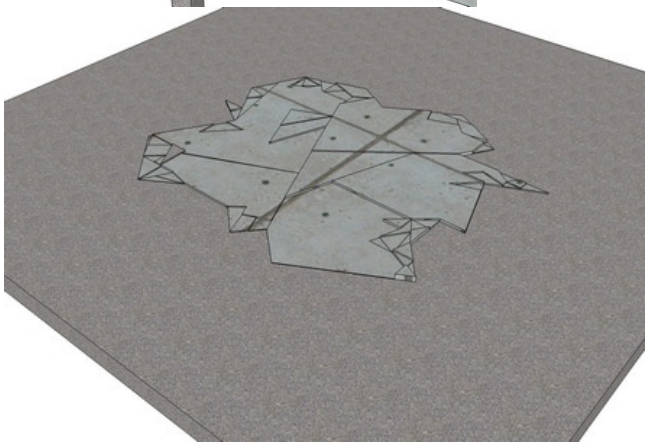
Step 4-2: Column Damage Pattern

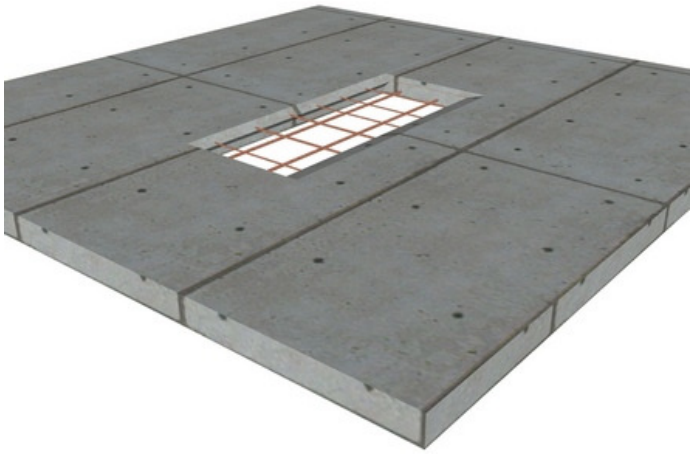
Question: What damage patterns are visible in (any of) the column(s)? (Select all that apply)

Response Options (select all that apply)	Damage Pattern Definition	Example
FLEXURE	Presence of cracking and crumbling of concrete in an hourglass shape near the top or bottom of the column. In extreme cases, steel bars may begin to buckle outwardly as shown in the second image.	 
SHEAR	Presence of diagonal or X-shaped cracking near the top or bottom of the column. Concrete may crumble off in this region.	
CONCRETE LOSS	Concrete has crumbled away creating large voids, exposing steel reinforcing bars inside the beam, which may show a buckled or bowed shape.	

Step 4-3: Slab Damage Pattern

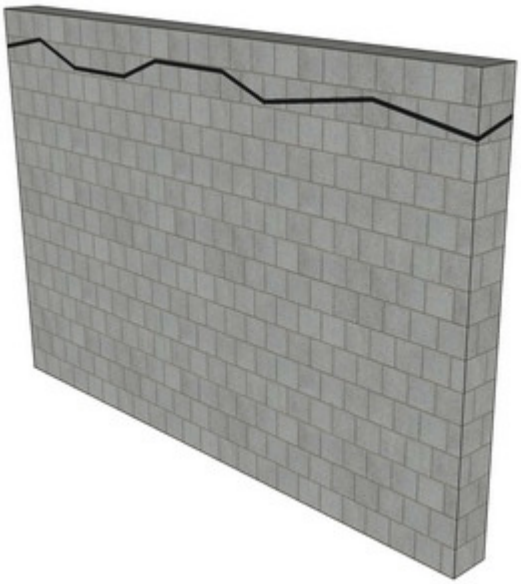
Question: What damage patterns are visible in (any of) the slab(s)? (select all that apply)

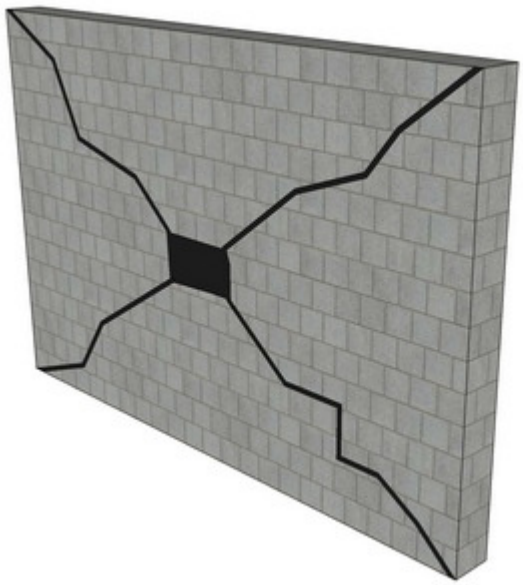
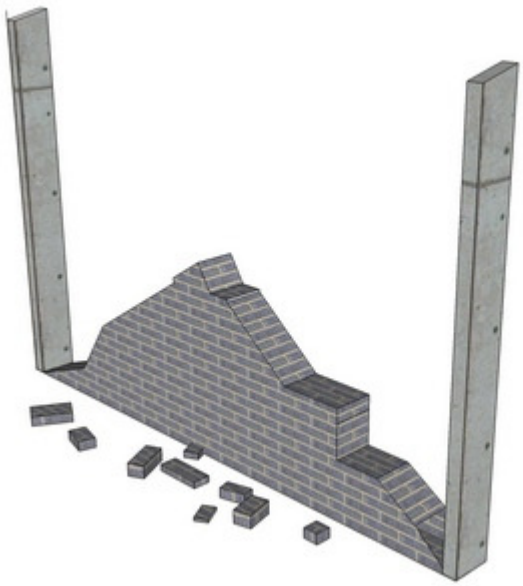
Response Options (select all that apply)	Damage Pattern Definition	Example
FLEXURE	Presence of cracks running the length of the slab when viewed from the top or bottom surface.	
SHEAR	Presence of concentrated cracking forming a rounded pattern on the surface of a slab at the point where a column connects to a slab. In extreme cases, a column "punches" through the slab, as shown in the first image.	 

CONCRETE LOSS	Concrete has crumbled away creating large voids, possibly exposing steel reinforcing bars inside the slab.	

Step 4-4: Wall Damage Pattern

Question: What damage patterns are visible in (any of) the wall(s)? (select all that apply)

Response Options (select all that apply)	**Damage Pattern Definition**	**Example**
SLIDING SHEAR	Presence of **horizontal** cracking along the top or bottom of the wall.	

DIAGONAL SHEAR	Presence of **diagonal** cracks, often forming an x-pattern across the wall.	
OUT-OF-PLANE	Crumbling of wall materials leaving large gaps or voids in the wall.	

Step 5: Assess the Damage Severity

For every primary element you identified as damaged in Step 3, you will be asked to assess the severity of the damage. Note that more than one damage pattern may be evident for that element type, so assess the worst pattern you observe. Note that this is a subjective assessment.

Question: What is the severity of the worst damage pattern in (any of) the **beam(s)**?

Question: What is the severity of the worst damage pattern in (any of) the **column(s)**?

Question: What is the severity of the worst damage pattern in (any of) the **slab(s)**?

Question: What is the severity of the worst damage pattern in (any of) the **wall(s)**?

Response Options	Definition
Yellow	Damage is moderate.
Red	Damage is severe.

Examples of Coded Building Damages

Example 1

- Which building needs to be tagged?
  Tag entire photo (Picture shows one building in its entirety or just part of it)
- Which of the building's primary element(s) (beam, column, slab, wall) is/ are visible and can be assessed in the photo?
  Column
- Is there damage in (any of) the beam(s), column(s), slab(s), wall(s)?
  Column - Yes
- What damage patterns are visible in (any of) the beam(s), column(s), slab(s), wall(s)?
  Column – Concrete Loss
- What is the severity of the worst damage pattern in (any of) the beam(s), column(s), slab(s), wall(s)?
  Column - Red

Examples of Coded Building Damages

Example 2

- Which building needs to be tagged?
  Tag entire photo (Picture shows one building in its entirety or just part of it)
- Which of the building's primary element(s) (beam, column, slab, wall) is/ are visible and can be assessed in the photo?
  Beam, Column, Slab, Wall
- Is there damage in (any of) the beam(s), column(s), slab(s), wall(s)?
  Column - Yes
  Wall - Yes
- What damage patterns are visible in (any of) the beam(s), column(s), slab(s), wall(s)?
  Column - Shear
  Wall - Diagonal Shear, Out-of-Plane
- What is the severity of the worst damage pattern in (any of) the beam(s), column(s), slab(s), wall(s)?
  Column - Yellow
  Wall - Red

Examples of Coded Building Damages

Example 3

- Which building needs to be tagged?
  Tag part of photo (Picture shows multiple buildings)
- Which of the building's primary element(s) (beam, column, slab, wall) is/ are visible and can be assessed in the photo?
  Beam, Column, Wall
- Is there damage in (any of) the beam(s), column(s), slab(s), wall(s)?
  Beam - Yes
  Wall - Yes
- What damage patterns are visible in (any of) the beam(s), column(s), slab(s), wall(s)?
  Beam – Concrete Loss
  Wall - Out-of-Plane
- What is the severity of the worst damage pattern in (any of) the beam(s), column(s), slab(s), wall(s)?
  Beam - Yellow
  Wall - Red