Understanding Substantial Damage in the International Building Code, International Existing Building Code, or International Residential Code

This document will help you understand the concept of Substantial Damage (SD) and how to determine if a building meets this criterion. FEMA's Public Assistance Required Minimum Standards Policy found in the Public Assistance Program and Policy Guide, Chapter 2 – Section VII.B.2,[1] requires that projects receiving FEMA assistance for repair or replacement incorporate the natural hazards-related provisions of the most recent edition of the International Code Council's® (ICC®) *International Building Code* (IBC®), *International Existing Building Code*® (IEBC®), and/or *International Residential Code*® (IRC®), known collectively as the I-Codes. The Policy applies to buildings that have received designations of Substantial Structural Damage, Substantial Damage, or are eligible for replacement in accordance with 44 CFR Part 206.226(f).

CONFORMING AND NON-CONFORMING BUILDINGS

Conforming buildings meet a community's current floodplain management requirements and current flood provisions of its building code. Non-conforming buildings do not, usually for one of the following reasons: 1) they were built before flood requirements were adopted, or 2) were built after the first flood requirements were adopted, but before those requirements were subsequently changed. A change in the Flood Insurance Rate Map or floodplain management regulations or building code flood provisions can lead to non-conformance.

Background

Substantial Damage (SD) is a trigger applied to damaged buildings in flood hazard areas[2] that requires those buildings to be brought into compliance or to maintain compliance with: 1) the current community floodplain management regulations, and 2) the flood provisions of the I-Codes. Substantial Damage does not trigger all building code requirements for new construction. The Substantial Damage trigger is activated when damage of any origin is sustained by the structure, whereby the cost of restoring the structure to its before-damage condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial Damage is related to Substantial Improvement (SI). Substantial Improvement is another trigger applied to non-conforming buildings in flood hazard areas and, like Substantial Damage, requires those buildings to maintain or be brought into compliance with the current floodplain management regulations and flood provisions of the I-Codes. The Substantial Improvement trigger is activated when the sum of the improvement costs and the costs of any repairs performed at the same time, equals or exceeds 50 percent of the market value of the building before the improvement or damage occurred.

For building code and floodplain management purposes, Substantial Damage is considered a part of Substantial Improvement, and any costs of repairs, reconstruction, or rehabilitation are combined with any improvement costs into

1 FEMA Public Assistance Program and Policy Guide FP 104-009-2, April 2017.

2 Per the 2015 IBC, a flood hazard area is defined as the greater of the following two areas: The area within a flood plain subject to a 1-percent or greater chance of flooding in any year OR The area designated as a flood hazard area on a community's flood hazard map, or otherwise legally designated.

a single sum – the "work" – and a single SI/SD determination is made. Public Assistance staff may have to break down any SI/SD determination made by local officials to identify the damage repair portion of the work. Figure 1 shows a general flow chart illustrating how local officials typically make SI/SD determinations.

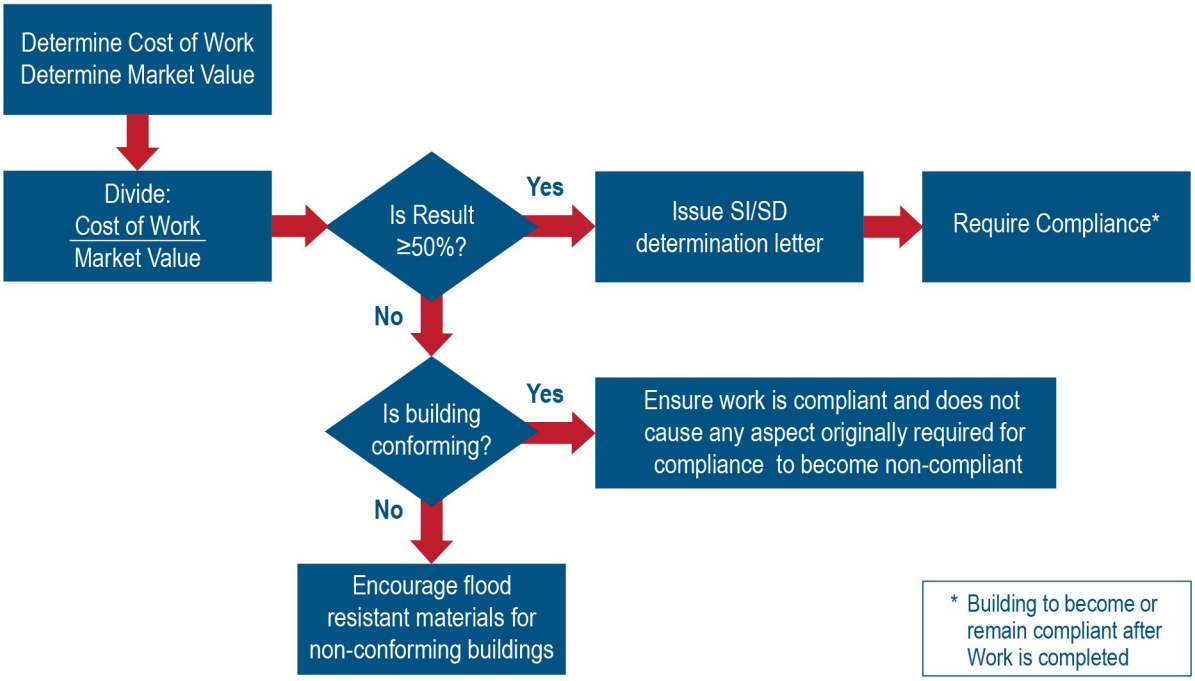

Figure 1. Process for Making SI/SD Determinations (adapted from FEMA P-758, Figure 4-1).

Facilities Subject to SD and SI Requirements

Per the I-Codes, Substantial Damage and Substantial Improvement determinations are made for buildings lying in whole, or in part, within a flood hazard area (FHA) shown on a map adopted by the community. The FHA is almost always the Special Flood Hazard Area (SFHA) shown on a community's Flood Insurance Rate Map (FIRM). Check with the community permitting office to determine the limits of the FHA.

The SI/SD requirements apply to all individual buildings within the SFHA, including residential buildings, non-residential buildings, manufactured homes, and buildings constructed before and after the adoption of floodplain management regulations. The Policy only applies to projects eligible for funding under the Public Assistance Program.

Damage Repair Costs Counted Toward SD

The costs to repair damage used in the determination must include the costs to repair all damage, regardless of origin, including damage caused by flooding, wind, fire, earthquake, and any other cause. In addition, the cost of repairs is the cost to repair a building to its pre-damage condition, even if the owner is not repairing all damage at the same time, or is not repairing all the damage.

According to the NFIP and the I-Codes, certain costs may be excluded from SI/SD determinations:

- Costs of projects required to correct existing health, sanitary, or safety code violations previously cited by the building official and that are the minimum necessary to assure safe living conditions.

- Costs associated with alterations of a historic building provided the alteration will not preclude the building's continued designation as a historic building. See sections 408.3 and 1201.4 of the 2015 IEBC, and section R105.3.1.1 of the 2015 IRC.

Making the SI/SD Determination

Calculating SI/SD requires three separate dollar amount estimates: costs to repair, improvement costs (if any), and the pre-damage or pre-improvement market value of the building. Note that SI/SD determinations use market value, unlike the "50% Rule" determination made by FEMA's Public Assistance program, which uses replacement cost.

Figures 2 and 3 show general flow charts for determining repair/improvement costs and building market values. For additional detail concerning repair costs and market values see FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference*.

Estimating Costs

In general, costs must include materials, labor, site preparation, demolition, compliance with other requirements, exterior and interior finishes, and the costs of utility and service equipment. Building contents are excluded. Communities determine which sources of cost estimates are acceptable, which typically are contractor estimates, and estimates based on building valuation tables. Damage estimates developed using FEMA's Substantial Damage Estimator may be used.

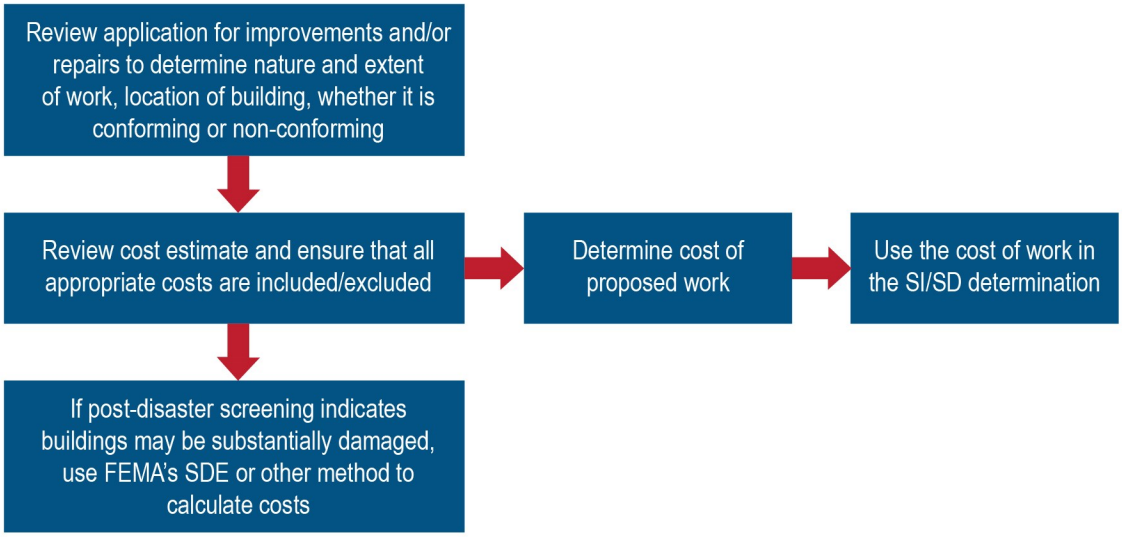

Figure 2. Determining the cost of the work (from FEMA P-758, Figure 4-2)

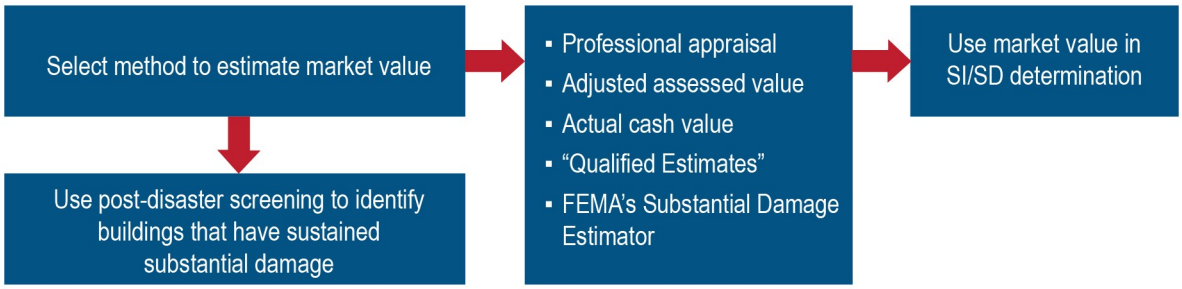

Figure 3. Determining the market value (from FEMA P-758, Figure 4-3)

Estimating Market Value

Communities determine which method is acceptable to estimate market values of buildings and should use this method consistently when estimating building value. The two most common methods are professional property appraisals and property assessments used for determining property taxes. The value of land and accessory structures, and the value of a business occupancy, are not included. Professional property appraisals must be prepared by qualified professional appraisers. Property assessments typically are not used for publicly-owned buildings or unique or complex buildings. When used, property assessment values may need to be adjusted by a factor provided by the assessment authority to better reflect current market value.

ASCE 24

IBC Section 1612 requires buildings and structures in flood hazard areas to be designed and constructed in accordance with the standard ASCE 24, *Flood Resistant Design and Construction*. Thus, when SI/SD determinations are made for buildings within the scope of the IBC, compliance with Section 1612 means compliance with Chapter 5 (Flood Loads) of ASCE 7 and with ASCE 24.

Other Things to Know

Building Codes

Most States and communities that adopt and enforce building codes use the International Codes, sometimes with modifications. The IRC governs one- and two-family dwellings and townhouses up to three stories in height that are subject to certain geographic and hazard intensity limitations specified by the IRC. The IBC governs buildings not governed by the IRC. The IEBC governs work on existing IBC and IRC buildings. All codes require local officials to make SI/SD determinations for proposed improvements and repairs on buildings in FHAs.

When a determination is made that a building has incurred substantial damage or will be substantially improved, the codes require the building to be brought into compliance with the requirements for new construction. The 2015 edition of the IEBC (to be updated in 2018) specifies compliance with IBC Section 1612 or IRC Section R32, whichever is applicable. The requirements are found in IEBC sections that govern additions, alterations, repairs, historic buildings, and moved or relocated buildings.

Section 1302.6 of the 2015 IEBC requires buildings that are relocated or moved into the flood hazard area to meet the requirements of the IBC or IRC, as applicable, even if the buildings are not substantially improved or damaged.

Besides substantial damage and Substantial Improvement, building codes have other triggers for making existing buildings partially or totally compliant with code provisions for new construction. For the purpose of the Policy, if local regulations or building code requirements trigger a more stringent hazard-resistant upgrade than those required by the I-Codes, or if local regulations or building code requirements call for an upgrade that is not related to reducing disaster risk, FEMA determines the eligibility of the costs to comply with the local requirements based on the criteria in the Policy.

Mitigation Actions Following Less than Substantial Damage

Hazard events provide a natural opportunity for mitigation, and building owners often want to improve the hazard resistance of buildings (see FEMA P-424, P-543, P-577, and P-936 for a discussion of post-disaster mitigation recommendations). In cases where a building is not substantially damaged and where the building code does not require such mitigation actions, the actions will not be eligible for Public Assistance funds. In cases where a building is not

substantially damaged but where the building code does require certain mitigation actions, those actions will likely be eligible for Public Assistance funds. Building owners should know that other hazard mitigation funding sources may exist besides Public Assistance.

Local Requirements

Check community regulations to find out if a community has adopted more restrictive SI/SD requirements than the 50% trigger of the NFIP and the I-Codes. Some communities track damage and improvement costs over a specified period of time ("cumulative" costs) and some communities may have a lower trigger for SI/SD than 50% of building market value. Both of these community requirements would capture more buildings under SI/SD than the NFIP and the I-Codes.

BEST PRACTICES

Besides complying with codes, it is prudent to incorporate applicable best practices give in FEMA P-424, P-543 and P-577. For example, incorporating a secondary roof membrane would be an asset. The purpose of the secondary membrane is to avoid interior water leakage in the event that the roof membrane is punctured by wind-borne debris. A building with a code-minimum roof system is vulnerable to interior leakage caused by roof membrane punctures.

Zone V Buildings Seaward of the Reach of Mean High Tide

Existing buildings seaward of mean high tide line are treated differently than new Zone V buildings. The NFIP and the I-Codes each require new Zone V buildings to be landward of the reach of mean high tide. Existing Zone V buildings seaward of mean high tide are permitted to have substantial damage repaired and to be substantially improved without meeting the landward of mean high tide siting requirement (see ASCE 24-14 section 4.3).

References

ASCE 7-10. *Minimum Design Loads for Buildings and Other Structures*. American Society of Civil Engineers, 2010.

ASCE 24-14. *Flood Resistant Design and Construction.* American Society of Civil Engineers, 2014.

FEMA P-543, *Design Guide for Improving Critical Facility Safety from Flooding and High Winds: Providing Protection to People and Buildings*. FEMA, 2007

FEMA P-577, *Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds: Providing Protection to People and Buildings.* FEMA, 2007.

FEMA P-424, *Design Guide for Improving School Safety in Earthquakes, Floods and High Winds.* FEMA, 2010.

FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference*. FEMA, 2010.

2015 International Building Code. International Code Council, 2014.

2015 International Existing Building Code. International Code Council, 2014.

2015 International Residential Code. International Code Council, 2014.

EXAMPLE — SUBSTANTIAL DAMAGE

The following hypothetical example illustrates determining whether buildings have incurred substantial damage.

Building and Damage Description:

- A two-story school, comprised of four separate buildings, was constructed in 1970, prior to the community's adoption of its first floodplain management regulations and flood hazard map.
- The school lies in an area now shown on the Flood Insurance Rate Map (FIRM) as Flood Zone AE, with a Base Flood Elevation (BFE) approximately 3 feet above grade. The school lies in the windborne debris region identified by the building code.
- Buildings 1, 2, and 3 have a steel frame structure, metal roof deck, concrete floor slabs, and non-load-bearing masonry exterior walls. Building 4 is a one-story metal building system (also known as a pre-engineered metal building – PEMP) with metal siding and roofing. The first floor slabs of all buildings are one foot above grade. Small subgrade areas contain mechanical and electrical equipment servicing school Buildings 1, 2, and 3.
- The four school buildings each sustained damage from high winds during a hurricane. A significant amount of the roof membrane was blown off Buildings 1 and 2. Building 4 lost some of the metal roof panels. Only Building 3 had a secondary roof membrane; it sustained little rainwater penetration into the building when part of the roof covering was blown off. For Buildings 1 and 2, the rainwater penetrated into the interiors and damage was more extensive. Buildings 1 and 2 also sustained collapse of several of the acoustical ceiling boards on the second floor and a few on the first floor. Most of the interior gypsum board partitions on the second floor of Buildings 1 and 2 were damaged by rainwater. Rooftop equipment was blown off Building 1, and a few Building 1 exterior windows were broken by wind-borne debris. Wind-driven rain entered at several of the operable windows in Buildings 1 and 2.
- The school buildings also sustained flood damage from shallow flooding, which reached approximately 18 inches above the first floor in each building. Building 4 sustained damage to a wood gymnasium floor.
- The following first floor items were damaged by floodwater and/or rainwater (the exact source of water has not been determined in all cases): floor coverings (carpet, wood, and vinyl flooring); interior partitions, doors, and ceilings; built-in lockers and bookcases; mechanical and electrical equipment in the subgrade area; contents (desks, furniture, supplies, computer equipment, books, school records); public address system; electrical wiring.
- As part of planned repairs and reconstruction, the school is considering replacing the metal gymnasium building (Building 4) with a new masonry and steel gymnasium building.

Figure 4. View of damaged school. Four buildings are numbered. Red arrows indicate areas where the roof membrane (Buildings 1-3) or metal roof panels (Building 4) blew off.

Determine if the school buildings were substantially damaged.

Building 1
Pre-damage market value = V1

Post-storm work:

- Clean-up – $
- ***Replace roof system as required by building code – $***
- ***Replace rooftop equipment – $***
- ***Repair second floor interior water damage – $***
- ***Repair first floor interior water damage – $***
- ***Replace broken windows with impact-resistant windows (per building code requirement) – $***
- ***Replace built-in lockers and bookcases – $***
- Replace desks and furniture – $
- Replace supplies and books – $
- Replace computer equipment – $
- ***Replace public address system – $***
- ***Replace damaged wiring – $***
- ***Repair/replace damaged mechanical and electrical equipment in subgrade area – $***

Cost of work included in SD calculation (in ***bold*** above) / pre-damage market value = D1 / V1 = 64%.
Building 1 is substantially damaged.

Building 2
Pre-damage market value = V2

Post-storm work:

- Clean-up – $
- ***Replace roof system as required by building code – $***
- ***Replace rooftop equipment – $***
- ***Repair second floor interior water damage – $***
- ***Repair first floor interior water damage – $***
- ***Replace built-in lockers and bookcases – $***
- Replace desks and furniture – $
- Replace supplies and books – $
- Replace computer equipment – $
- ***Replace public address system – $***
- ***Replace damaged wiring – $***
- ***Repair/replace damaged mechanical and electrical equipment in subgrade area – $***

Cost of work included in SD calculation (in ***bold*** above) / pre-damage market value = D2 / V2 = 58%.
Building 2 is substantially damaged.

Possible Building Improvement

- Replace unbroken windows with impact-resistant windows (this work is not required by the building code, but it is appropriate mitigation work, particularly considering that the unbroken windows are susceptible to wind-driven rain infiltration)

Building 3
Pre-damage market value = V3

Post-storm work:

- Clean-up – $
- ***Repair the damaged roof area*** (The building code allows the remainder of the roof to remain as is. A post-damage investigation found that the undamaged roof area is not vulnerable to future wind damage, and that it has several more years of useful service life) – $
- ***Repair first floor interior water damage – $***
- Replace desks and furniture – $
- Replace supplies and books – $
- Replace computer equipment – $
- ***Replace damaged wiring – $***
- ***Repair/replace damaged mechanical and electrical equipment in subgrade area – $***

Cost of work included in SD calculation (in ***bold*** above) / pre-damage market value = D3 / V3 = 37%. Building 3 is not substantially damaged.

Building 4
Pre-damage market value = V4

Post-storm work:

- ***Repair the damaged roof panels – $***
- Clean-up – $
- ***Replace gymnasium wood floor – $***
- ***Replace damaged wiring – $***

If Building 4 is repaired: Cost of work included in SD Calculation (in ***bold*** above) / pre-damage market value = D4 / V4 = 47%. Building 4 is not substantially damaged.

Possible Building Improvement, I4:

- The building code allows the remainder of the roof to remain as is. A post-damage investigation found that the undamaged roof area is vulnerable to future wind damage. Hence, if the building is not demolished, as a best practice, all of the metal roof should be replaced. – $
- If Building 4 is repaired and the entire metal roof is replaced, the cost of work / pre-damage market value = (D4 + I4)/V4 = 53%. Building 4 would be a Substantial Improvement.

Possible Building Replacement:

- Demolish existing building
- Expand foundation
- Construct new gymnasium building

If Building 4 is demolished and replaced with a new building, the work is classified as new construction, irrespective of the cost. PA would reimburse the school for the eligible repair costs for the damaged building.