1. INTRODUCTION & BACKGROUND

Rapid visual screening of buildings for potential seismic hazards, as described herein, originated in 1988 with the publication of the FEMA 154 Report, Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook.

Written for a broad audience ranging from engineers and building officials to appropriately trained Non professionals, the *Handbook* provided “a sidewalk survey” approach that enabled users to classify surveyed buildings into two categories: those acceptable as to risk to life safety or those that may be seismically hazardous and should be evaluated in more detail by a design professional experienced in seismic design.

Earthquakes and the resultant danger of building collapse or damage are hazards in many parts of the world. In order to provide a tool to evaluate the danger of building collapse or damage due to earthquakes, this manual presents a method whereby buildings can be rapidly identified by "rapid survey" as seismically acceptable or potentially seismically hazardous.

The method generates a score, which results from a quick site inspection of the building, both inside as well as outside, or from a quick inspection of the architectural and structural drawings. The score is related to the degree to which the building is judged to deviate from current seismic requirements.

A high score suggests that the building requires additional study by a professional engineer experienced in seismic design, and a low score indicates that the building is probably adequate. The score is separated into two components, one for the structure, and the other for non-structural components.

1.1 Scope and Purpose

The Rapid Visual Screening method is designed to be implemented without performing any structural calculations. The procedure utilises a damageability grading system that requires the evaluator to

- Check the initial structural lateral load resisting system, and
- Identify building parts that modify the seismic performance expected for this lateral load resisting system with non-structural components.

The inspection, data collection and decision-making process typically occurs at the building site, and is expected to take couple of hours for a building, depending on its size.

The screening is based on Code based Seismic Intensity, Building Type and Damageability Grade as observed in past earthquake.

Although newer buildings in a community may have been properly designed and constructed to resist earthquake forces, there may be many older buildings that pose a threat to life safety or to the community as a whole if subjected to an earthquake. The engineering profession has addressed the problems associated with earthquakes by developing "seismic hazard zones" and design recommendations associated with those zones.

Although the seismic screening procedure presented in this manual applies to buildings of all types, due to budget or other constraints some users may wish to restrict the survey to building types that they consider the most hazardous, such as unreinforced masonry or non-ductile concrete. However, it is recommended, at least initially, that all conventional building types be considered, and that elimination of certain building types is well-documented and supported with both office calculations and field survey data. It is possible that in some cases even buildings designed to modem codes could pose life-safety hazards, particularly with regard to non-structural hazards.

1.2 The nature of earthquakes

In a global sense, earthquakes result from motion between plates jointing the Earth's crust these plates are move by the convective motion of the material in the Earth's mantle, which in turn is move by heat generated at the Earth's core. That is just as heated pot of water, heat from the Earth's core causes material to rise to the Earth's surface. Forces between the arising material and the Earth's crust cause the plates to move. The resulting motions of the plates relative to one another generate earthquakes. Where the plates spread apart, molten material emerges to fill the void.

Generally, the longer a fault the larger the earthquake it can generate. Beyond the main tectonic plates, there are many smaller sub plates, "platelets" and simple blocks of crust which occasionally move and shift due to the "jostling" of their neighbours or the major plates. The existence of these sub-plates means that smaller but still damaging earthquakes are possible almost anywhere, although perhaps with less likelihood. Besides the seismic sources at the tectonic boundaries, such as on the west coast of North and South America, seismic activity can also occur within the tectonic plates due to local faults and local build up of stresses.

Generally, earthquakes are concentrated near faults, and certain faults are more likely than others to produce a large event, but the earthquake-generating process is not understood well enough to predict the exact time of earthquake occurrence. Therefore, communities must be prepared for an earthquake to occur at any time. Four major factors can affect the severity of ground-shaking and thus potential damage data site. These are the size of the earthquake, the type of earthquake, the distance from the source of the earthquake to the site, and the types of soil at the site. Larger earthquakes shake longer and harder, and thus cause more damage.

1.3 Uses of RVS Results

The main uses of this procedure in relation to seismic upgrading of existing buildings are:

- To identify if a particular building requires further evaluation for assessment of its seismic vulnerability.
- To assess the seismic damageability (structural vulnerability) of the building and seismic rehabilitation needs.
- To identify simplified retrofitting requirements for the building (to collapse prevention level) where further evaluations are not considered necessary or not found feasible.

2. EARTHQUAKE BEHAVIOUR OF BUILDINGS

Many different types of damage can occur in buildings. Damage can be divided into two categories: non-structural damage and structural damage, both of which can be hazardous to building occupants. Structural damage means degradation of the building's structural support systems such as the building frames and walls. Non-structural damage refers to any damage that does not affect the integrity of the structural support system. Examples of non-structural damage can be associated with failure of parapets, ornamentations, masonry partitions, heavy equipment, such as elevators, lifelines in critical facilities, etc. The type of damage to be expected is a complex issue that depends, among other factors, on the structural type and age of the building, seismic ground motion, ground conditions, the proximity of the building to neighbouring buildings, condition of the building, and the type of non-structural elements. These possible contributions to the hazard of the building will be discussed in more detail below.

2.1 Earthquake Effects

When earthquake-shaking occurs, a building gets thrown from side to side or up and down. That is, while the ground is violently moving from side to side, the building tends to stay at rest, similar to a passenger standing on bus that accelerates quickly. Once the building starts moving, it tends to continue in the same direction, but by this time the ground is moving back in the opposite direction (as if the bus driver first accelerated quickly, then suddenly braked). Thus the building gets thrown back and forth by the motion of the ground, with some parts of the building lagging behind and then moving in the opposite direction. This force that the building sustains is related to its mass and the acceleration, according to Newton's law force = mass x acceleration. The heavier the building, the more force is exerted. Therefore, a tall, heavy, reinforced-concrete building will be subject to much more force than a lightweight one-story wood-frame house, given the same acceleration. Damage can be due to structural members (beams and columns) being overloaded or due to differential movements between different parts of the structure. If the structure is sufficiently strong to resist these forces or differential movements, little damage will result. If the structure cannot resist these forces or differential movements, structural members will be damaged, and collapse may occur.

Earthquakes with Richter magnitudes less than 5 rarely cause significant damage to buildings, since acceleration levels and duration of shaking for these earthquakes are relatively small. In addition to damage caused by ground shaking, damage can be caused by buildings pounding against one another, ground failure that causes the degradation of the building foundation, landslides, fires, and tidal waves.

2.2 How Earthquake Forces are Resisted

Buildings experience horizontal distortion when subjected to earthquake motion. When these distortions get large, the damage can be catastrophic. Therefore, most buildings are designed with lateral-force-resisting systems (LFRS) to resist the effects of earthquake forces.

In many cases, LFRS make a building stiffer and thus minimize the amount of lateral movement and consequently the damage. LFRS are usually capable of resisting only forces that result from ground motions parallel to them. However, the combined action of LFRS along the width and length of a building can typically resist earthquake motion from any direction. LFRS differ from building to building, because the type of system is controlled to some extent by the basic layout and structural elements of the building. Basically, LFRS consist of axial (tension or compression), shear and bending resistant elements.

2.3 Types of Building Structures and Typical Earthquake Damage

A wide variety of construction types and building materials are used in urban and rural areas of India. These include local materials such as mud, straw and wood, semi-engineered materials such as burnt brick and stone masonry and engineered materials such as concrete and steel. The seismic vulnerability of the different building types depends on the choice of building materials and construction technology adopted. The building vulnerability is generally highest with the use of local materials without engineering inputs and lowest with the use of engineered materials and skills.

The RVS procedure presented here has considered different building types, based on the building materials and construction types that are most commonly found in India. Masonry buildings are presented. The likely damages to buildings have been categorized in different Grades depending on the seismic impact on the strength of the building.

Following are the fifteen building types used in the RVS procedure. Alpha-numeric reference codes used on the Data Collection Form are shown in parentheses.

2.4 Configuration Problems

Configuration, or the general vertical or horizontal shape of buildings, is an important factor in earthquake performance and damage. Buildings that have simple, regular, symmetric configurations generally display the best performance in earthquakes. The reasons for this are

- Non-symmetric buildings tend to twist in addition to shaking laterally, and
- The various wings of a building tend to act independently, resulting in differential movements, cracking and other damage. - Rotational motion introduces additional damage, especially at re-entrant or internal comers of the building. The term "configuration" also refers to the geometry of lateral-load-resisting systems and the geometry of the building. Asymmetry can exist in the placement of bracing systems, shear walls, or moment-resisting frames that are used to provide earthquake resistance in a building.

2.5 Non-Structural Hazards

'Non-structural' is the name given to the building components that are usually designed by the architect or the mechanical and electrical engineers and shown on their drawings. They can be divided into two groups associated with building exterior and interior. Investigation of non-structural elements can be time-consuming and should be done during a detailed seismic evaluation of the particular building. However, the screening process should also include a review of certain characteristics:

2.5.1 Exterior Non-Structural Components

- Exterior cladding or Veneers and Window Glass: Exterior wall panel or cladding and window glass can fall onto the storefronts, streets, sidewalks and adjacent properties, if their connectors to the building structure have insufficient strength or sometimes ductility.
- Parapets, Cornices, Ornamentations and Other Appendages: Parapets and other such appendages are very vulnerable during earthquakes. Falling masonry parapets caused death to passing pedestrians during past earthquakes. These architectural features are usually of a non-structural type and can receive substantial motion amplification that causes them to fail.

2.5.2 Interior Non Structural Components

- **Non-Structural Partition Walls**: Partitions of different types of material may be destroyed, overturned, cracked, or separated from the remainder of partitions. However, only the unsupported heavy partitions are considered life-threatening.

- **Mechanical and Electrical Equipment**: Mechanical and electrical equipment items, such as pumps, fans, piping, duets, and electrical panels, when well attached to the walls or floors, generally perform well during earthquakes. However, rigid piping and their support sand hinges may fail.

- **Interior Storage Water Tanks & Vessels**: Tanks and pressure vessels may fall from their supports and cause severe damage to floors and other structural elements. They are, however, considered life-threatening only when they carry hot or corrosive materials or when their failure causes other main structural elements to fail.

3. GENERAL SURVEY IMPLEMENTATION INSTRUCTIONS

3.1 Survey Implementation Sequence:

Several steps are involved in collecting data, and planning and performing a rapid screening of potentially seismically hazardous buildings. As a first step, a general procedure should be approved. Second step, the appropriate people should be informed about the purpose of the survey and how it will be carried out then there are many decisions to be made, such as use of the survey results and actions to be taken.

The general sequence of implementing the survey methodology presented in this manual consists of:

- Budget development and cost estimation selection of buildings to be surveyed development of mapping system for survey areas
- Walking around building photographing the building for identification purposes
- Walking through the building and sketching the floor plan noting basic data (number of storeys, structural system and materials, major problems, etc.)
- Determining the score (seismic priority index) for the building according to the procedure presented
- This sequence may be altered where field inspection is replaced by inspection of drawings.
- General aspects of planning and implementation then gives a detailed description of
- What to look for and how to use the seismic screening form.
- Selection of information sources to be included in survey and used in decision-making budget Development and Cost Estimation.
- Development of record-keeping system training of survey personnel
- Selection and review of seismic screening form
- Pre-field data collection
- Identification of structure

3.2 Pre-Field Planning

It may be decided, due to budget, time, or other types of constraints, that priorities should be set and certain buildings surveyed immediately, whereas others can be surveyed at a later time, because they do not pose immediate life-safety issues. An area may be selected because it has a higher density of potentially seismically hazardous buildings relative to other areas.

3.3 Training of Personnel

It is anticipated that a training program will be required to ensure the quality of the data and uniformity of decisions among inspection personnel. Training should include discussions of basic lateral-force-resisting systems with building components attached to them and how they behave when subjected to seismic loads, how to use the screening form, what to look for in the field, and how to account for uncertainty.

In addition, in conjunction with a professional engineer experienced in seismic design, inspectors should simultaneously survey buildings of several different types and compare results. This will serve as a calibration for the inspectors.

3.4 Survey Tools to be taken into the Field

The screening procedure is intended to be rapid, simple, and standardized as to data collection. Relatively few tools or equipment are needed. The following is a checklist of items that may be needed in performing a rapid visual survey as described: Clipboard for holding survey forms

1. Pen or pencil
2. Camera, preferably instant
3. Flashlight
4. Tape or stapler
5. Straight edge
6. Copy of manual
7. A simple hand calculator

3.5 Information Sources

Information as to the buildings themselves (identification, use, size, year built and possibly type of structure), seismicity and site soil conditions may be available from supplemental sources. The information should be reviewed and collated for a given area before commencing the field survey for that area. In addition, survey data can be added to the databases and used to generate maps and reports. Some sources of supplemental information are:

Building Department Files: Building department files will vary greatly from jurisdiction to jurisdiction. For example, in some locations all old files have been thrown out, so there is not information on older buildings. In general, files may contain permits, plans and structural calculations required by the city. Sometimes there is occupancy and use information, but little information about structural type will be found except by reviewing plans or calculations.

(a) **Previous Studies**: In a few cases, previous building inventories or studies of hazardous buildings or hazardous non-structural elements may have been performed. These studies may be limited to a particular structural or occupancy class, but they may contain useful maps or other relevant structural information and should be reviewed. Other important studies might address related seismic hazard issues such as liquefaction or landslide potential

(b) **Soils Information:** Because soil conditions are a major factor in the risk to the building, the screening procedure includes a screening factor for soil conditions. Since soil conditions cannot be readily identified by visual methods in the field, geotechnical, geologic, or liquefaction potential maps and other information should be collected and put into a readily usable map format for use during the field survey field survey. The screening procedure employs a simplified soils categorization.

(c) **Seismic Zone**: The varying geology at different locations in the country implies that the likelihood of damaging earthquakes taking place at different locations is different. Thus, a seismic zone map is required to identify these regions. Based on the levels of intensities sustained during damaging past earthquakes, the 1970 version of the zone map subdivided India into five zones – I, II, III, IV and V

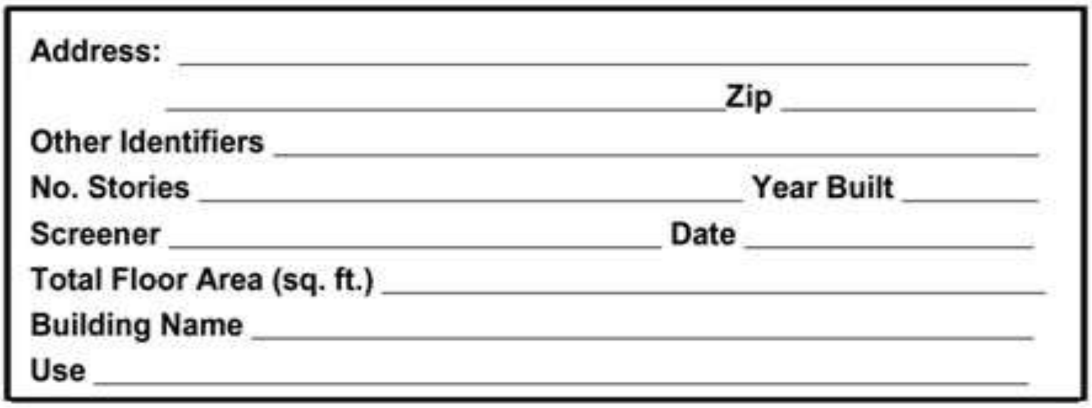
4. COMLPETING THE DATA COLLECTION FORM

4.1 Some important points

This provides instructions on how to complete the data Collection Form. It is assumed that the Data Collection Form has already been selected, based on the seismicity level of the area to be screened. The data Collection Form is completed for each building screened through execution of the following steps:

- Verifying and updating the building identification information
- Walking around the building to identify its size and shape, and sketching a plan and elevation view on the Data Collection Form
- Determining and documenting occupancy
- Determining soil type
- Identifying potential non-structural falling hazards, if any, and indicating their existence on the Data Collection Form
- Identifying the seismic lateral-load resisting system and circling the related Basic Structural Hazard Score on the Data Collection Form
- Identifying and circling the appropriate seismic performance attribute Score
- Modifiers on the Data Collection Form
- Determining the Final Score and deciding if a detailed evaluation is required
- Photographing the building and attaching the photo to the form

4.2 Verifying and Updating the Building Identification Information



Address:

Zip

Other Identifiers

No. Stories **Year Built**

Screener **Date**

Total Floor Area (sq. ft.)

Building Name

Use

Fig: 1 – Building Identification information part of RVS form

Space is provided in the upper right-hand portion of the Data Collection Form to document building identification information (address, name, and number of stories, year built, and other data). It is desirable to develop and document this information during the pre-planning stage, if at all possible. This information may be entered manually. Proper identification and location of the building is critically important for subsequent use in hazard assessment and mitigation by the RVS authority. The authority may prefer to identify and file structures by street address, parcel number, building owner, or some other scheme. However, it is recommended that as a minimum the street address and zip code be recorded on the form.

4.2.1 Number of Stories

The height of a structure is sometimes related to the amount of damage it may sustain. On soft soils, a tall building may experience considerably stronger and longer duration shaking than a shorter building of the same type. The number of stories is a good indicator of the height of a building approximately 9 to 10 feet per story for residential, 12 feet per story for commercial.

4.2.2 Year Built

This information is one of the important of the RVS procedure. Building age is tied directly to design and construction practices. Therefore, age can be a factor in determining building type and thus can affect the final scores. This information is not typically available at the site and thus should be included in pre-field data collection.

4.2.3 Screener Identification

The screener should be identified, by name, initials, or some other type of code. At some later time it may be important to know who the screener was for a particular building, so this information should not be omitted.

4.2.4 Total Floor Area

The total floor area, in some cases available from building department or assessor files, will most likely be estimated by multiplying the estimated area of one story by the total number of stories in the building. The length and width of the building can be paced off or estimated (during the planning stage) from Sanborn or other parcel maps. Total floor area is useful for estimating occupancy load and may be useful at a later time for estimating the value of the building.

4.3 Sketching the Plan and Elevation Views

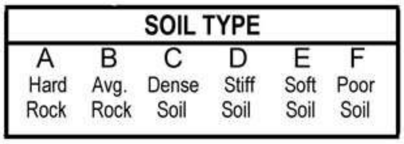
As a minimum, a sketch of the plan of the building should be drawn on the Data Collection Form (see Figure 3-3). An elevation may also be useful in indicating significant features. The sketches are especially important, as they reveal many of the building's attributes to the screener as the sketch is made. In other words, it forces the screener to systematically view all aspects of the building. As indicated in the previous section, the length and width of the building can be paced off or estimated from Sanborn or other parcel maps.

Fig: 2 – RVS form's part for building plan & elevation

Otherwise indicate that the sketch is typical of all sides. The sketch should note and emphasize special features such as existing significant cracks or configuration problems. Dimensions should be included.

4.4 Determining Soil Type

As indicated in Section, soil type should be identified and documented on the Data Collection Form during the pre-field soils data acquisition and review phase. If soil type has not been determined as part of that process, it Sample Data Collection Form needs to be identified by the screener during the building site visit. If there is no basis for classifying the soil type, a soil type E should be assumed. However, for one-story or two-story buildings with a roof height equal to or less than 25 feet, a class D soil type may be assumed when site conditions are not known.



SOIL TYPE					
A	B	C	D	E	F
Hard Rock	Avg. Rock	Dense Soil	Stiff Soil	Soft Soil	Poor Soil

4.5 Determining and Documenting Occupancy

Two sets of information are needed relative to occupancy:

- building use,
- Estimated number of persons occupying the building.

4.5.1 Occupancy

Occupancy-related information is indicated by circling the appropriate information in the left centre portion of the form. The occupancy of a building refers to its use, whereas the occupancy load is the number of people in the building. Although usually not bearing directly on the structural hazard or probability of sustaining major damage, the occupancy of a building is of interest and use when determining priorities for mitigation.

OCCUPANCY

Assembly	Govt	Office	Number of Persons	
Commercial	Historic	Residential	0 – 10	11 – 100
Emer. Services	Industrial	School	101-1000	1000+

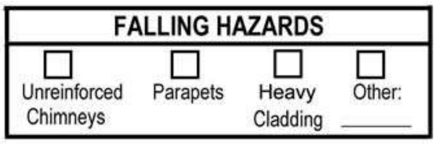
Fig: 4 – Part of a form Occupancy

4.5.2 Occupancy Load

Like the occupancy class or use of the building, the occupancy load may be used by an RVS authority in setting priorities for hazard mitigation plans. The community may wish to upgrade buildings with more occupants first. As can be seen from the form (Figure 3-5), the occupancy load is defined in ranges such as 1-10, 11-100, 101-1000, and 1000+ occupants. The range that best describes the average occupancy of the building is circled. For example, if an office building appears to have a daytime occupancy of 200 persons and occupancy of only one or two persons otherwise, the maximum occupancy load is 101-1000 persons. If the occupancy load is estimated from building size and use, an inserted asterisk will automatically indicate that these are approximate data.

4.6 Identifying Potential Non-structural Falling Hazards

Non-structural falling hazards such as chimneys, parapets, cornices, veneers, overhangs and heavy cladding can pose life-safety hazards if not adequately anchored to the building. Although these hazards may be present, the basic lateral load system for the building may be adequate and require no further review.



FALLING HAZARDS

☐ Unreinforced Chimneys ☐ Parapets ☐ Heavy Cladding ☐ Other: ______

Fig: 5 – Part of form Falling Hazard

A series of four boxes have been included to indicate the presence of Non-structural falling hazards .The falling hazards of major concern are:

- **Unreinforced Chimneys**. Unreinforced masonry chimneys are common in older masonry and wood-frame dwellings. They are often inadequately tied to the house and fall when strongly shaken. If in doubt as to whether a chimney is reinforced or unreinforced, assume it is unreinforced.

- **Parapets.** Unbraced parapets are difficult to identify from the street as it is sometimes difficult to tell if a facade projects above the roofline. Parapets often exist on three sides of the building, and their height may be visible from the back of the structure.
- **Heavy Cladding**. Large heavy cladding elements, usually precast concrete or cut stone, may fall off the building during an earthquake if improperly anchored. The loss of panels may also create major changes to the building stiffness (the elements are considered non-structural but often contribute substantial stiffness to a building), thus setting up plan irregularities or torsion when only some fall. Glass curtain walls are not considered as heavy cladding in the RVS procedure.

4.7 Identifying the Lateral-Load Resisting System and Documenting the Related Basic Structural Score

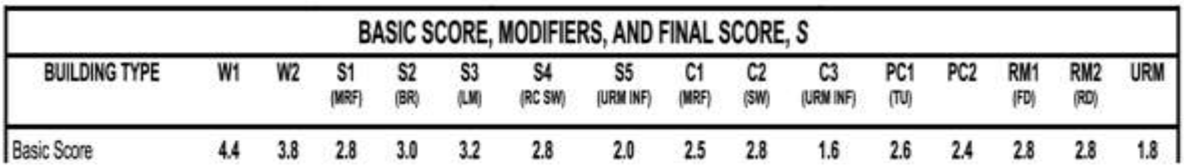
The RVS procedure is based on the premise that the screener will be able to determine the building's lateral-load-resisting system from the street, or to eliminate all those that it cannot possibly be. It is further assumed that the lateral load-resisting system is one of fifteen types that have been observed to be prevalent, based on studies of building stock in the United States

4.7.1 Fifteen Building Types Considered by the RVS Procedure and Related Basic Structural Scores

Following are the fifteen building types used in the RVS procedure. Alpha-numeric reference codes used on the Data Collection Form:

1. Light wood-frame residential and commercial buildings smaller than or equal to 5,000 square feet (W1)
2. Light wood-frame buildings larger than 5,000 square feet (W2)
3. Steel moment-resisting frame buildings (S1
4. Braced steel frame buildings (S2)
5. Light metal buildings (S3)
6. Steel frame buildings with cast-in-place concrete shear walls (S4)
7. Steel frame buildings with unreinforced masonry infill walls (S5)
8. Concrete moment-resisting frame buildings (C1)
9. Concrete shear-wall buildings (C2)
10. Concrete frame buildings with unreinforced masonry infill walls (C3)
11. Tilt-up buildings (PC1)

12. Precast concrete frame buildings (PC2)
13. Reinforced masonry buildings with flexible floor and roof diaphragms (RM1)
14. Reinforced masonry buildings with rigid floor and roof diaphragms (RM2)
15. Unreinforced masonry bearing-wall buildings (URM)



BASIC SCORE, MODIFIERS, AND FINAL SCORE, *S*

BUILDING TYPE	W1	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM
Basic Score	4.4	3.8	2.8	3.0	3.2	2.8	2.0	2.5	2.8	1.6	2.6	2.4	2.8	2.8	1.8

Fig: 6 – Part of RVS form for basic score S

4.7.2 Identifying the Lateral-Force-Resisting System

At the heart of the RVS procedure is the task of identifying the lateral-force-resisting system from the street. Once the lateral-force-resisting system is identified, the screener finds the appropriate alpha-numeric code on the Data Collection Form and circles the Basic Structural Hazard Score immediately beneath it

Ideally, the lateral-force-resisting system for each building to be screened would be identified prior to field work through the review and interpretation of construction documents for each building.

4.7.3 Interior Inspections

Ideally, whenever possible, the screener should seek access to the interior of the building to identify, or verify, the lateral-force-resisting system for the building. In the case of reinforced masonry buildings, entry is particularly important so that the screener can distinguish between RM1 buildings, which have flexible floor and roof diaphragms, and RM2 buildings, which have rigid floor and roof diaphragms.

As with the exterior inspection, the interior process should be performed in a logical manner, either from the basement to the roof, or roof to basement. The screener should look at each floor thoroughly.

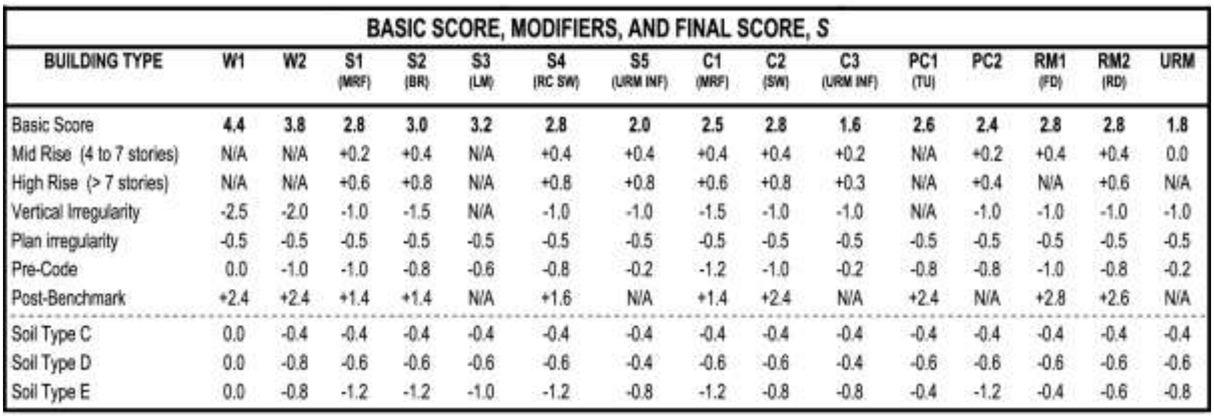
The RVS procedure does not require the removal of finish materials that are otherwise permanently affixed to the structure. There are a number of places within a building where it is possible to see the exposed structure. The following are some ways to determine the structure type.

4.7.4 Screening Buildings with More Than One Lateral-Force-Resisting System

In some cases, the screener may observe buildings having more than one lateral-force-resisting system. Examples might include a wood-frame building a top a precast concrete parking garage, or a building with reinforced concrete shear walls in one direction and a reinforced moment-resisting frame in the other.

4.8 Identifying Seismic Performance Attributes and Recording Score Modifiers

This section discusses major factors that significantly impact structural performance during earthquakes, and the assignment of Score Modifiers related to each of these factors. The severity of the impact on structural performance varies with the type of lateral-force-resisting system; thus the assigned Score Modifiers depend on building type. Score Modifiers associated with each performance attribute are indicated in the scoring matrix on the Data Collection Form



BASIC SCORE, MODIFIERS, AND FINAL SCORE, *S*

BUILDING TYPE	W1	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM
Basic Score	**4.4**	**3.8**	**2.8**	**3.0**	**3.2**	**2.8**	**2.0**	**2.5**	**2.8**	**1.6**	**2.6**	**2.4**	**2.8**	**2.8**	**1.8**
Mid Rise (4 to 7 stories)	N/A	N/A	+0.2	+0.4	N/A	+0.4	+0.4	+0.4	+0.4	+0.2	N/A	+0.2	+0.4	+0.4	0.0
High Rise (> 7 stories)	N/A	N/A	+0.6	+0.8	N/A	+0.8	+0.8	+0.6	+0.8	+0.3	N/A	+0.4	N/A	+0.6	N/A
Vertical Irregularity	-2.5	-2.0	-1.0	-1.5	N/A	-1.0	-1.0	-1.5	-1.0	-1.0	N/A	-1.0	-1.0	-1.0	-1.0
Plan irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Pre-Code	0.0	-1.0	-1.0	-0.8	-0.6	-0.8	-0.2	-1.2	-1.0	-0.2	-0.8	-0.8	-1.0	-0.8	-0.2
Post-Benchmark	+2.4	+2.4	+1.4	+1.4	N/A	+1.6	N/A	+1.4	+2.4	N/A	+2.4	N/A	+2.8	+2.6	N/A
Soil Type C	0.0	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Soil Type D	0.0	-0.8	-0.6	-0.6	-0.6	-0.6	-0.4	-0.6	-0.6	-0.4	-0.6	-0.6	-0.6	-0.6	-0.6
Soil Type E	0.0	-0.8	-1.2	-1.2	-1.0	-1.2	-0.8	-1.2	-0.8	-0.8	-0.4	-1.2	-0.4	-0.6	-0.8

Fig: 8 – Part of RVS form for Basic score, Modifier, and Final Score, S

4.8.1 Mid-Rise Buildings

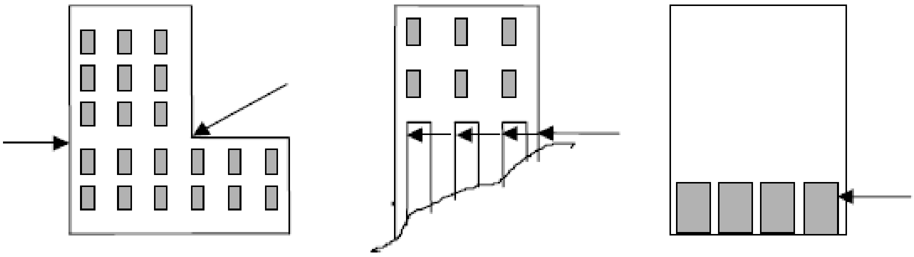
If the building has 4 to 7 stories, it is considered a mid-rise building, and the score modifier associated with this attribute should be circled.

4.8.2 High-Rise Buildings

If the building has 8 or more stories, it is considered a high-rise building, and the score modifier associated with this attribute should be circled.

4.8.3 Vertical Irregularity

This performance attribute applies to all building types. Examples of vertical irregularity include buildings with setbacks, hillside buildings, and building.



Setbacks Hillside Soft Story

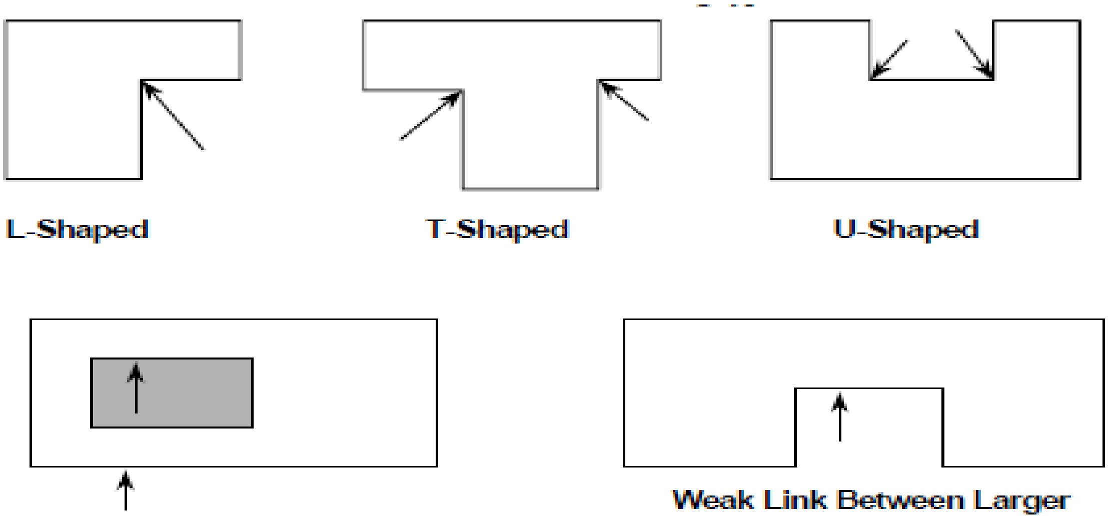
Fig: 9 – Types of Vertical Irregularity

If the building is irregularly shaped in elevation, or if some walls are not vertical, then apply the modifier.

If the building is on a steep hill so that over the up-slope dimension of the building the hill rises at least one story height, a problem may exist because the horizontal stiffness along the lower side may be different from the uphill side. In addition, in the up-slope direction, the stiff short columns attract the seismic shear forces and may fail. In this case the performance modifier is applicable.

4.8.4 Plan Irregularity

If a building has a vertical or plan irregularity, Plan irregularity can affect all building types. Examples of plan irregularity include buildings with re-entrant corners, where damage is likely to occur buildings with good lateral-load resistance in one direction but not in the other; and buildings with major stiffness eccentricities in the lateral force- resisting system, which may cause twisting around a vertical axis.



L-Shaped T-Shaped U-Shaped

Large Opening

Weak Link Between Larger Building Plan Areas

Fig: 10 – Types of Plan Irregularities

Buildings with re-entrant corners include those with long wings that are E, L, T, U, or + shaped.

Plan irregularities causing torsion are especially prevalent among corner buildings, in which the two adjacent street sides of the building are largely windowed and open, whereas the other two sides are generally solid. Wedge-shaped buildings, triangular in plan, on corners of streets not meeting at 90°, are similarly susceptible.

Although plan irregularity can occur in all building types, primary concern lies with wood, tilt-up, pre-cast frame, reinforced masonry and unreinforced masonry construction. Damage at connections may significantly reduce the capacity of a vertical-load-carrying element, leading to partial or total collapse.

4.8.5 Pre-Code

This Score Modifier applies for buildings in high and moderate seismicity regions and is applicable if the building being screened was designed and constructed prior to the initial adoption and enforcement of seismic codes applicable for that building type.

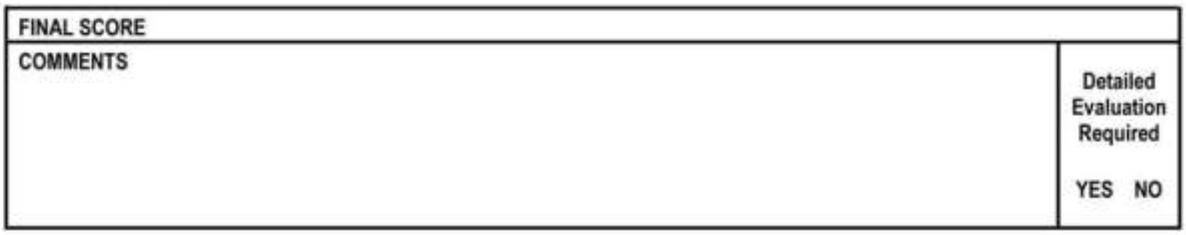
4.8.6 Post-Benchmark

This Score Modifier is applicable if the building being screened was designed and constructed after significantly improved seismic codes applicable for that building type (e.g., concrete moment frame, C1) were adopted and enforced by the local jurisdiction. The year in which such improvements were adopted is termed the “benchmark” year. Benchmark year(s) for the various model building types should have been identified as part of the Data Collection Form review process during the pre-planning stage. Benchmark years for the various building types are provided.

4.9 Determining the Final Score

The Final Structural Score, S, is determined for a given building by adding the Score Modifiers for that building to the Basic Structural Hazard Score for the building. The result is documented in the section of the form entitled Final Score Based on this information, and the “cut-off” score selected during the pre-planning process, the screener then decides if a detailed evaluation is required for the building and circles “YES” or “NO” in the lower right-hand box. Additional guidance on this issue is provided.

When the screener is uncertain of the building type, an attempt should be made to eliminate all unlikely building types. If the screener is still left with several choices, computation of the Final Structural Score S may be treated several ways:



FINAL SCORE	
COMMENTS	**Detailed Evaluation Required** **YES NO**

Fig: 11 – Part of RVS form Final Score & Comments

- The screener may calculate S for all the remaining options and choose the lowest score. This is a conservative approach, and has the disadvantage that it may be too conservative and the assigned score may indicate that the building presents a greater risk than it actually does. This conservative approach will not pose problems in cases where all the possible remaining building types result in scores below the cut-off value. In all these cases the building has characteristics that justify further review anyway by a design professional experienced in seismic design.

4.10 Photographing the Building

At least one photograph of the building should be taken for identification purposes. The screener is not limited to one photograph. A photograph contains much more information, although perhaps less emphasized, than the elevation sketch. Large buildings are difficult to photograph from the street and the camera lens introduces distortion for high-rise buildings. If possible, the photograph should be taken from a sufficient distance to include the whole building, and such that adjacent faces are included. A wide angle or a zoom lens may be helpful. Strong sunlit facades should be avoided, as harsh contrasts between shadows and sunlit portions of the facade will be introduced. Lastly, if possible, the front of the building should not be obscured by trees, vehicles or other objects, as they obscure the lower stories.

5. Using the RVS Procedure Results

5.1 Interpretation of RVS Score

Having employed the RVS procedure and determined the building's Final Structural Score, S, which is based on the Basic Structural Hazard Score and Score Modifiers associated with the various performance attributes, the RVS authority is naturally faced with the question of what these S scores mean. Fundamentally, the final S score is an estimate of the probability (or chance) that the building will collapse if ground motions occur that equal or exceed the maximum considered earthquake (MCE) ground motions. These estimates of the score are based on limited observed and analytical data, and the probability of collapse is therefore approximate.

5.2 Selection of RVS "Cut-Off" Score

One of the most difficult issues pertaining to rapid visual screening is answering the question, "What is an acceptable S?" This is a question for the community that involves the costs of safety versus the benefits. The costs of safety include:

- The costs of reviewing and investigating in detail hundreds or thousands of buildings in order to identify some fraction of those that would actually sustain major damage in an earthquake;
- The costs associated with rehabilitating those buildings finally determined to be unacceptably weak.

5.3 Prior Uses of the RVS Procedure

During the decade following publication of the first edition of the FEMA 154 Handbook, the rapid visual screening procedure was used by private sector organizations and government agencies to evaluate more than 70,000 buildings nationwide

5.4 Other Possible Uses of the RVS Procedure

In addition to identifying potentially seismically hazardous buildings needing further evaluation, results from RVS surveys can also be used for other purposes, including:

- Designing seismic hazard mitigation programs for a community
- ranking a community's seismic rehabilitation needs
- developing inventories of buildings for use in regional earthquake damage and loss impact assessments

- developing inventories of buildings for use in planning post earthquake building safety evaluation efforts; and
- developing building-specific seismic vulnerability information for purposes such as insurance rating