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## AT&T Practices

# Enhancement of Earthquake Safety in Existing Facilities

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## About This Document

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### Purpose

This practice provides guidelines for managers with building operations responsibilities for the enhancement of earthquake safety in existing buildings. These guidelines were established in order to achieve earthquake safety in AT&T buildings consistent with the earthquake safety criteria defined by the AT&T hazard management strategy.

Guidelines presented in this practice incorporate experience obtained from two major post earthquake rehabilitation projects at Oakland and Sherman Oaks, California. They also incorporate experience from earthquake retrofit projects and observations in other network equipment buildings. Section 1 describes voluntary seismic rehabilitation options. Section 2 describes post earthquake damage repair which might be required by the agencies having jurisdiction as a condition for unrestricted occupancy. Risk management alternatives described here are deemed applicable to all AT&T buildings irrespective of their ownership. However, it is recognized that different rehabilitation implementation strategies may apply depending upon the particular ownership position (i.e. fully or partially owned and leased buildings).

## **Scope**

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This document applies to all AT&T occupied buildings where new installation projects involve alteration of existing building conditions for which construction permits are required prior to implementation.

## **Reason(s) for Issue**

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This practice is issued to assist in mitigation of typical seismic vulnerabilities observed in network equipment buildings. Seismic vulnerabilities can often be attributed to improved knowledge of building behavior during earthquakes which didn't exist at the time of the original construction. Alternatively, seismic vulnerabilities may exist due to building alterations implemented without regard to effects on building behavior during earthquakes.

## **Admonishments**

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Project implementation in accordance with guidelines provided in this practice is typically subject to jurisdictional requirements. It is necessary and important to assess implications of all relevant jurisdictional requirements, which may extend beyond the intended scope of the project, prior to project initiation.

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# Seismic Rehabilitation of Existing Facilities

# 1

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# Seismic Rehabilitation of Existing Facilities

# 1

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## 1.1 Risk Management Alternatives

### 1.1.1 Overview

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The seismic rehabilitation of existing facilities described here represents a voluntary attempt by AT&T to manage its earthquake risk exposure. This is because all AT&T facilities, irrespective of type and vintage, were constructed in accordance with the prevailing codes at the time building permits were granted. While codes are periodically being changed, code changes are not enforced retroactively and therefore do not trigger building rehabilitation. However, it is important to note that when rehabilitation projects are planned, they must comply with prevailing code requirements at the time of permit applications.

**⇒ NOTE:**

Occasionally, seismic rehabilitation or other improvement projects, depending upon their extent, may trigger code compliance requirements beyond the originally contemplated scope of work.

AT&T earthquake risk management objectives in existing facilities can be generally classified in three broad groups. These are based on the needs to ensure adequate life safety, achieve target network reliability and control damage. The need to ensure adequate life safety is also the primary building code objective. Each of the above objectives are specifically defined in the following sections.

### **1.1.2 Life Safety**

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Provision of adequate life safety is the minimum objective for all AT&T buildings. Hence, when an engineering assessment determines that a potential life safety concern may exist, a rehabilitation to remove this concern is required. It is important to note that retrofits to alleviate life safety concerns should not be justified merely due to periodical changes in building code requirements. Typical examples of vulnerabilities which may result in life safety concerns are described in Section 1.2. The scope of rehabilitation projects to alleviate life safety concerns must meet, but need not exceed, the minimum requirements of the prevailing building codes.

### **1.1.3 Network Reliability**

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In certain existing network facilities it may be necessary to ensure largely continued uninterrupted post-earthquake network operations. These facilities include critical and major offices where service outage may have significant effect to the AT&T brand name. In order to ensure adequate post-earthquake continuity of network operations, certain limitations must be placed on the post-earthquake damage to the facility. Design criteria for seismic rehabilitation projects to ensure adequate post-earthquake continuity of network operations may exceed the minimum requirements of the prevailing building codes. Specific implications due to the adaptation of more stringent criteria, such as cost, schedule and potential disruption during construction, must be clearly defined in advance.

### **1.1.4 Damage Control**

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In certain network facilities, other than those identified in Section 1.1.3 above, it may be desirable to control earthquake damage beyond the minimum life safety objective defined in Section 1.1.2 above. This condition may occur in situations where relatively simple and cost effective mitigation measures may alleviate potentially significant post-earthquake losses. Another example may involve situations where normal building access following an earthquake may be restricted. Such situations may justify mitigating measures and need to be assessed on an ad-hoc basis. It is generally expected that mitigation measures to control damage would involve relatively limited scope, and are unlikely to merit retrofit measures beyond minimum code requirements.

## **1.2 Vulnerability Identification**

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### **1.2.1 Initial Screening**

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Initial screening of facilities for seismic vulnerabilities can be performed considering parameters such as prevailing hazard, building age, construction type, and inadequate past performance. Facilities could be considered as candidates for a vulnerability assessment if one or more of the following conditions exist.

- Location in earthquake hazard zones 3 and 4 (defined in AT&T Standard 760-200-024, *Earthquake Resistant Guidelines for New Buildings*, Section 1.1.2)
- Construction vintage prior to 1973
- Construction materials include brick, hollow clay tile, and terra cotta
- Deficient or irregular conditions in categories listed below.

AT&T Building Engineering should have the primary responsibility for identifying possible needs for a seismic vulnerability assessment using the above guidelines.

It should be noted that while in general earthquake hazard and risk are directly proportional, experience has shown that variations are possible due to inconsistent building construction quality. Observations have also shown that most prevailing seismic vulnerabilities in network facilities can be classified in several broad categories which are described in Section 1.2.4 through Section 1.2.9 below.

### **1.2.2 Earthquake Hazards**

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The consequences of a particular seismic vulnerability (i.e. risk level) depend upon the prevailing earthquake hazard at the site. Relevant information concerning earthquake hazards in the United States is provided in AT&T Standard 760-200-024, *Earthquake Resistant Design Guidelines for New Buildings*, Section 1 and is incorporated here by reference.

### **1.2.3 Assessment Procedures**

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Assessment of seismic vulnerabilities and associated risks in existing buildings can be most effectively accomplished using the following two tiered process:

- Initially, a qualitative assessment is made by experienced personnel based on site observations. Vulnerabilities and conceptual remediation measures are reported via an AT&T Infrastructure Opportunity Identification Form (IOIF).

- Depending upon the outcome of the initial assessment it may be necessary to further confirm the findings by means of a limited analysis. The recommended remediation and estimated project cost are reported via an AT&T Feasibility Design Review (FDR).

AT&T Building Engineering should have the primary responsibility in determining the required extent of assessment.

#### **1.2.4 Deficient Structural Systems**

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Structurally deficient systems are typically uncovered by engineers with an advanced understanding of building behavior during earthquakes. Since all AT&T facilities met the jurisdictional requirements under which building permits were granted, the identification and mitigation of deficient structural systems is only required to meet AT&T's hazard management strategy. Deficient structural systems are most commonly observed either due to the use of inferior construction materials or inadequate design details. Specifically, the following conditions may contribute to undesirable structural response during earthquakes:

- **Deficient Materials** - Systems which consist of deficient materials often perform poorly in earthquakes. Deficient materials may include unreinforced masonry or lightweight concrete (Figure 1-1 and Figure 1-2).
- **Deficient Members** - Structural members must be adequately detailed to ensure good seismic performance. Deficient members may include concrete columns with minimal transverse reinforcement (confinement), or slender steel columns or braces which are prone to buckling under load. Deficiencies may also be introduced into building systems, for example when large openings are cut in existing floor slabs or shear walls for new mechanical systems (Figure 1-3 and Figure 1-4).
- **Deficient Connections** - Structural connections are often subjected to large forces during earthquakes. It is generally desirable for connections to be stronger than the adjoining members to ensure that the system remains tied together throughout the earthquake. Deficiencies may include inadequately detailed or deteriorated connections (Figure 1-5).

Assessment of deficient conditions noted above, which are typically concealed, can be most effectively made by experienced engineers with access to "as-built" drawings.



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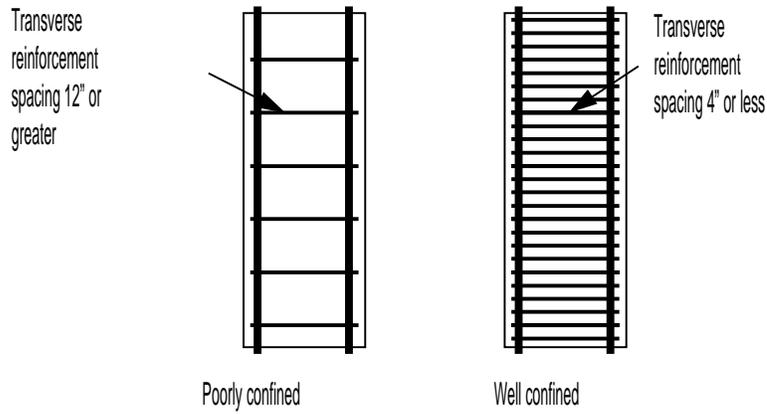
**Figure 1-1. Unreinforced Masonry Buildings often Perform Poorly in Earthquakes**



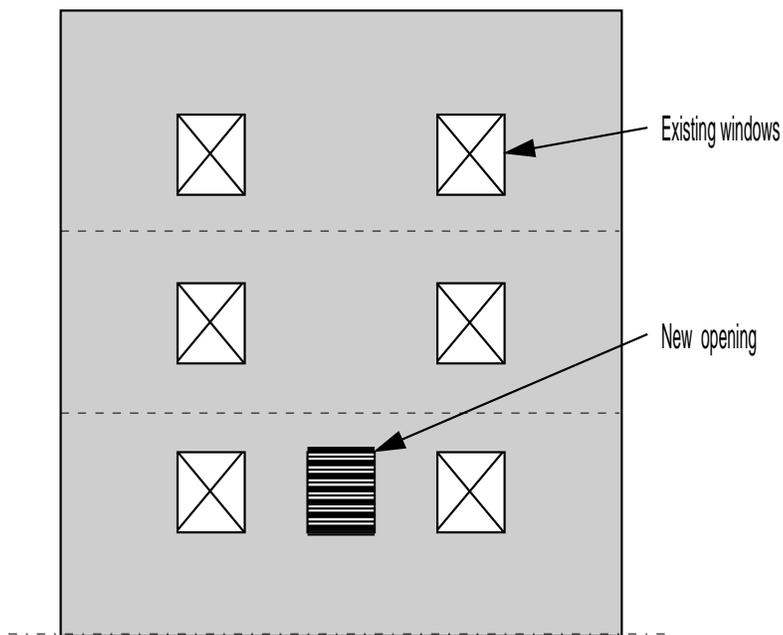
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**Figure 1-2. Poor Performance of a Lightweight Concrete Wall in an Earthquake**

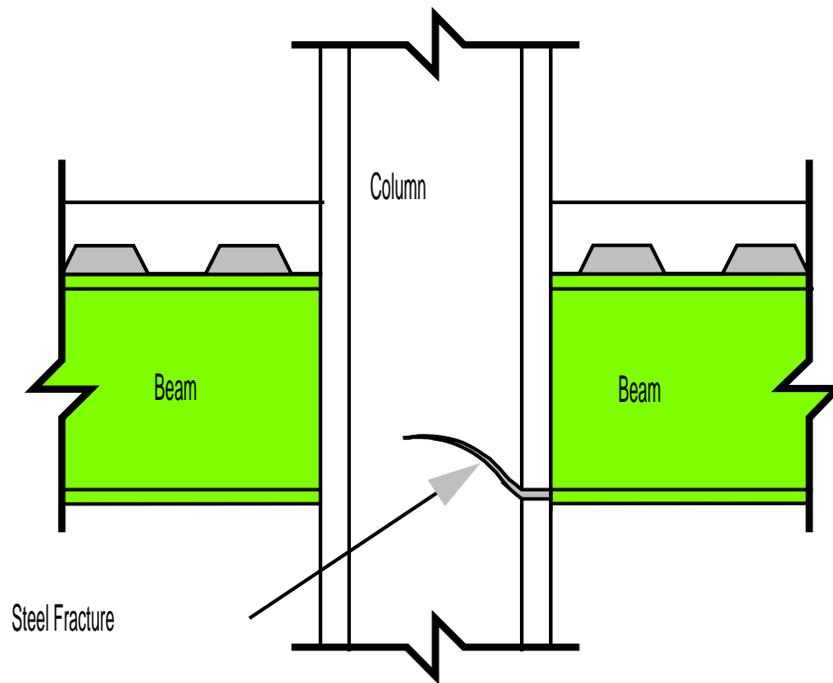
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**Figure 1-3. Example of Adequate Detailing of a Later-load Resisting Concrete Member**



**Figure 1-4. Weakness Introduced into a Concrete Wall by Cutting a New Opening**



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**Figure 1-5. Earthquake Fracture of a Steel Connection due to Inadequate Design and Construction Practices**

### **1.2.5 Structural Irregularities**

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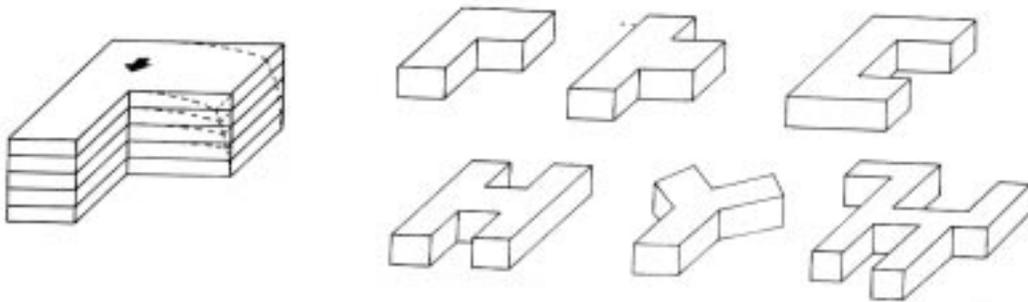
Irregular conditions present a common source for significant risk during earthquakes. Structural irregularities typically manifest themselves as global or local discontinuities in plan or vertical configuration. Certain structural irregularities may not be immediately apparent because they exist in building segments which are functionally interconnected but structurally independent. Typical structural irregularities, some of which have been observed in AT&T occupied buildings, are listed below:

- Complex or long, extended building shapes (Figure 1-6)
- Asymmetric lateral load resistance (Figure 1-7 and Figure 1-8)
- Incomplete lateral load resistance (Figure 1-8)
- Asymmetric mass distribution (Figure 1-9)
- In-plane offsets in lateral load-resisting elements (Figure 1-10)
- Out-of-plane offsets in lateral load-resisting elements (Figure 1-11)

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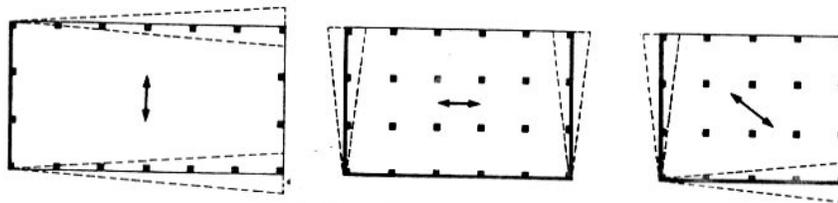
- Significant changes in story stiffness or strengths (Figure 1-12)
- Large openings in walls or floors (Figure 1-13).

Assessment of irregular conditions noted above, some of which may not be immediately obvious, can be most effectively made by experienced engineers based on performance observations of similar buildings during past earthquakes.



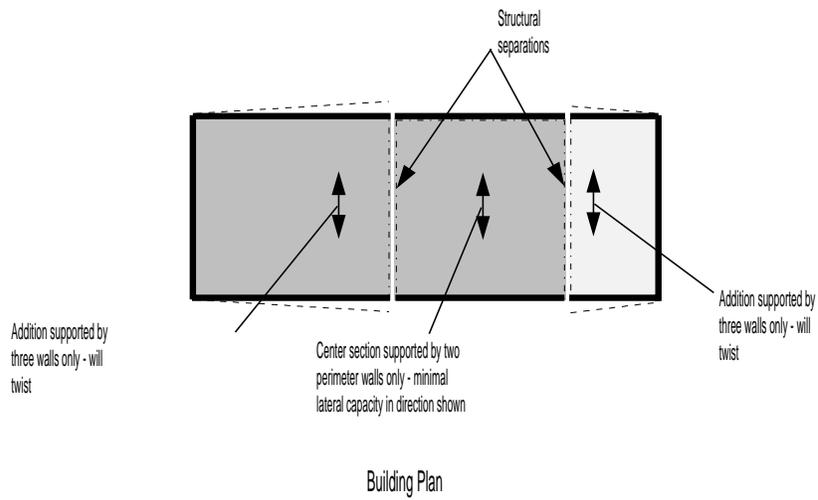
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**Figure 1-6. Irregular Structural Configurations**



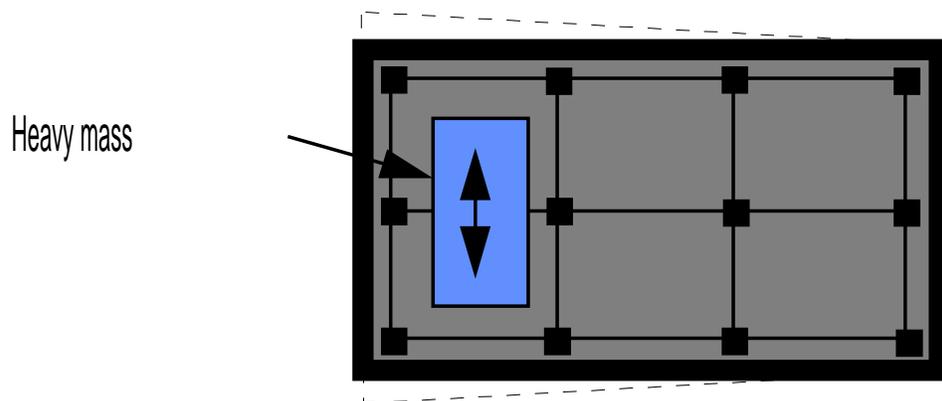
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**Figure 1-7. Asymmetric Lateral Load Resistance**



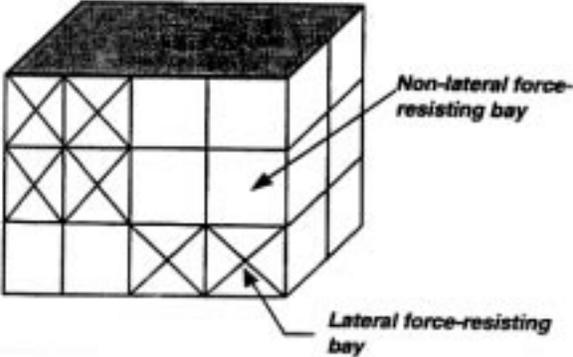
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**Figure 1-8. Inadequate and Asymmetrical Lateral Load Resistance**



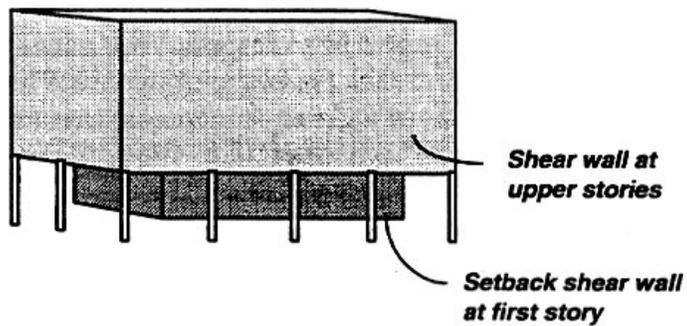
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**Figure 1-9. Asymmetrical Mass Distribution**



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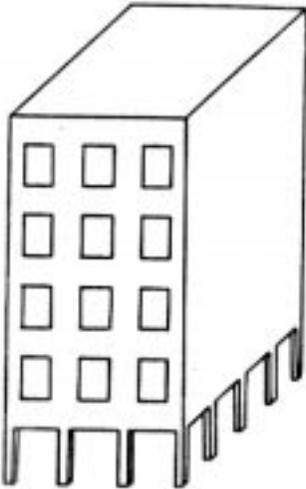
Figure 1-10. In-Plane Offsets in Lateral Load-Resisting Elements



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**Figure 1-11. Out-of-Plane Offsets in Lateral Load-Resisting Elements**

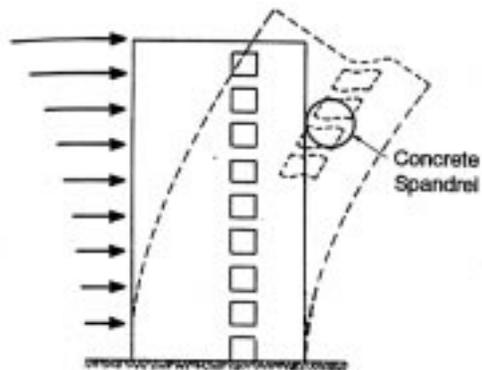
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**Figure 1-12. Soft Story Condition created by Large Openings at First Floor**

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**Figure 1-13. Discontinuity and Source Damage created by Vertically Aligned Wall Openings**

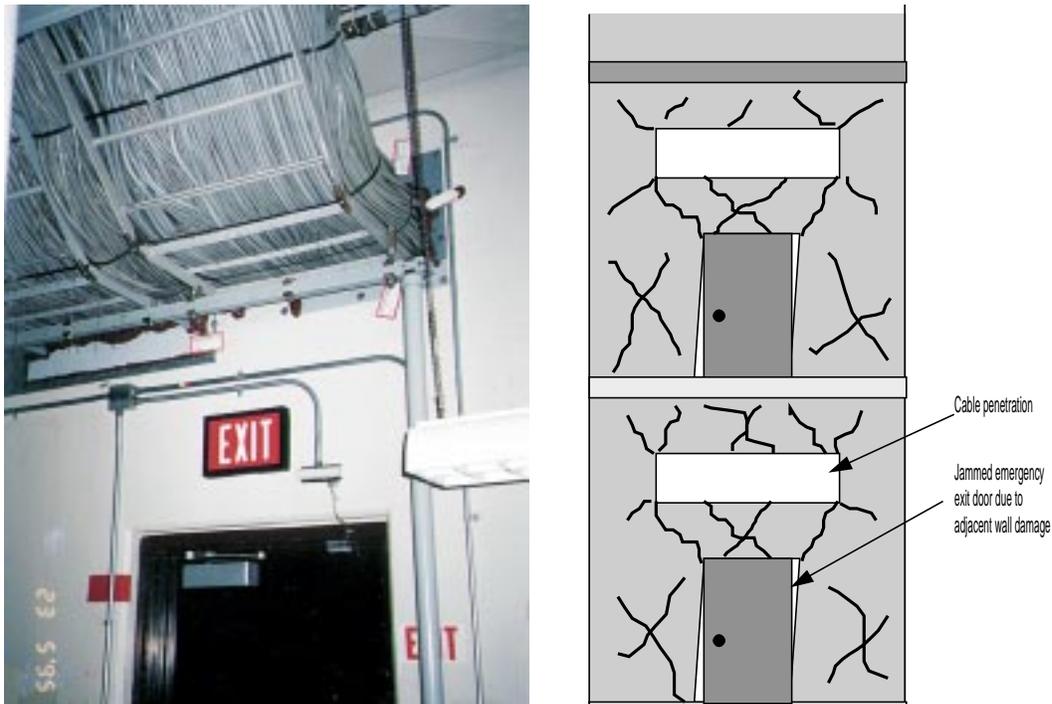
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### 1.2.6 Emergency Egress

Securing unhindered emergency egress during and following an earthquake is mandatory. This is a necessary requirement to ensure life safety and therefore is also a condition for continued occupancy. The following conditions may exist under which emergency egress may be disrupted:

- **Exit door damage** - Exit doors may become dislodged due to excessive damage to wall elements (i.e. concrete spandrels) located directly above the doors (Figure 1-14).
- **Obstruction of exit paths** - Excessive damage to brittle materials, such as hollow clay tile, terra cotta, or glass in exit paths may obstruct safe exit (Figure 1-15).
- **Stair tower damage** - Detached stair towers may be inadequately connected to the building or lack adequate lateral resistance to enable emergency egress (Figure 1-16).

Assessment of safe emergency egress requires a thorough understanding of structural earthquake response behavior which can be most effectively made by experienced structural engineers specializing in this area.



**Figure 1-14. Vertically Aligned Openings and Perforated Concrete Spandrels are prone to Damage and could affect Emergency Exit Doors (continued on next page)**



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**Figure 1-15. Brittle Terra Cotta Adjacent to and above Emergency Exit Path**



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**Figure 1-16. Bridges and Stair Tower must have Adequate Seismic Resistance to Enable Emergency Egress**

### **1.2.7 Building Appendages**

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Building appendages may present a falling object hazard during earthquakes. This is of particular concern in situations where buildings are located adjacent to sidewalks with significant pedestrian traffic. Examples of building appendages include:

- **Penthouses** - Rooftop structures are often subject to large accelerations during earthquakes. These structures may lack adequate structural systems to resist the lateral loads (Figure 1-17).

- **Parapets** - Experience has shown that inadequately braced building parapets are susceptible to earthquake damage, particularly when located atop multistory buildings. Failure is more likely to occur when parapets are constructed of unreinforced masonry or are relatively tall (Figure 1-18).
- **Canopies** - Canopies are occasionally provided along portions of the buildings. In general canopies are light structures intended to provide shelter from the elements. The stability of canopies under earthquake loads should be confirmed.
- **Towers** - Antenna towers for microwave or other radio telecommunication purposes are often placed atop network buildings. Proper attachment of the towers to the building structures are key to the performance of the towers during an earthquakes. Because towers are exposed to the elements, periodical maintenance is necessary to ensure adequate performance (Figure 1-19).

Mitigation of risk due to falling objects should be performed to meet reasonable standards of care for life safety protection. However, it should be noted that it is not practical and may not be feasible to preclude the possibility of falling objects during strong motion earthquakes.



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**Figure 1-17. Generator Penthouse with Inadequate Lateral Resistance**



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**Figure 1-18. Unreinforced Masonry Parapets often have Inadequate Out-of-Plane Support**



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**Figure 1-19. Rooftop Microwave Towers may have Inadequate Framing to Resist Seismic Loads**

### **1.2.8 Building Interaction**

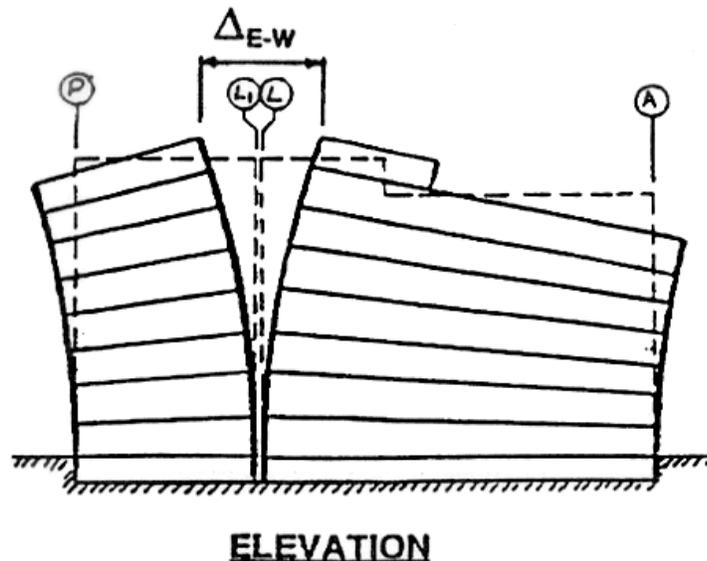
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Many AT&T buildings were constructed in phases and often structurally independent buildings were placed only a few inches apart. This was done to facilitate functional interconnection across the buildings. As a result telecommunications and infrastructure systems traverse the gaps between the buildings. During earthquakes, adjacent structurally independent buildings may undergo differential displacements leading to severing of systems as well as building damage. Types of differential displacements of concern are as follows:

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- **Out-of-phase along building elevation** - Out-of-phase motions along the building elevation (Figure 1-20) imply a condition in which adjacent buildings are either pulling apart from, or pound at each other. Damage to the systems traversing the gap between the buildings is likely to occur as the buildings are pulling apart while damage to the structure is likely to occur as the buildings are pounding at each other. The latter is of particular concern when adjacent floor diaphragms do not line up (Figure 1-21).
- **In-phase along building elevations** - In-phase motions along the building elevation (Figure 1-22) may result in excessive differential vertical displacements between adjacent stories. This condition is likely to cause damage to relatively rigid conduits and ducts fixed to the structures at close proximity on both sides of the inter-building gap.
- **Out-of-phase along building plans** - Out-of-phase motions along the building plans (Figure 1-23) may result in excessive horizontal differential displacements between adjacent floor diaphragms. This condition is likely to cause damage to relatively rigid conduits and ducts fixed to the structures at close proximity on both sides of the inter-building gap.

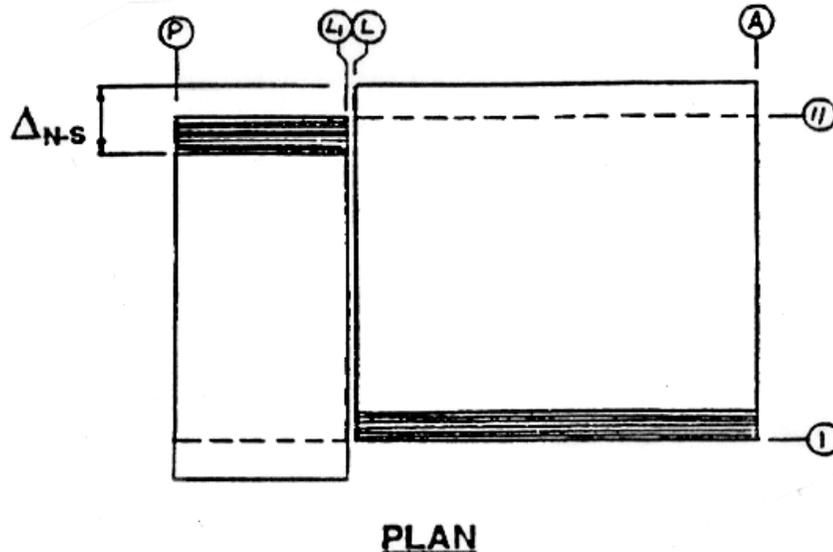
It should be noted that the severity of all three types of differential displacements listed above tends to increase with building height and is typically of greater concern at upper floors.



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**Figure 1-20. Out-of-Plane Motion along Building Elevations can affect Systems and Result in Pounding of Buildings**





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Figure 1-23. Out-of-Phase Motion along Building Plans can affect Systems

### 1.2.9 Architectural Components

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Occasionally concerns of adequate life safety or network operations may arise due to deficient architectural components. Examples of such conditions include:

- **Facades** - Certain cladding materials such as brick veneer, terra cotta and marble may get dislodged during an earthquake (Figure 1-24). Typically these cladding materials are fastened to the building by means of thick mortar set or thin adhesive set with or without mechanical anchors. In general, when mechanical anchors were used to secure the cladding to the building structure it is unlikely that large fragments of cladding will become detached. In situation where mechanical anchors were not used it might be possible to establish the adequacy of the cladding attachment by means of simple in-situ tests (Figure 1-25).
- **Partitions** - In some older buildings partition walls were constructed of hollow clay tiles which tend to fail in a brittle manner when subjected to earthquake loads. Brittle failure may involve the dispersion of fragments in the vicinity of the wall, potentially jeopardizing adjacent network operations (Figure 1-26).

- *Ceilings* - Inadequately braced suspended ceilings often collapse during earthquakes. This vulnerability is of concern particularly in heavily populated buildings (Figure 1-27).

Earthquake safety concerns related to architectural components are relatively unique and therefore of limited extent. Determination of applicable conditions can be most appropriately made by experienced structural engineers specializing in this area.



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**Figure 1-24. Damaged Terr Cotta Facade following an Earthquake**



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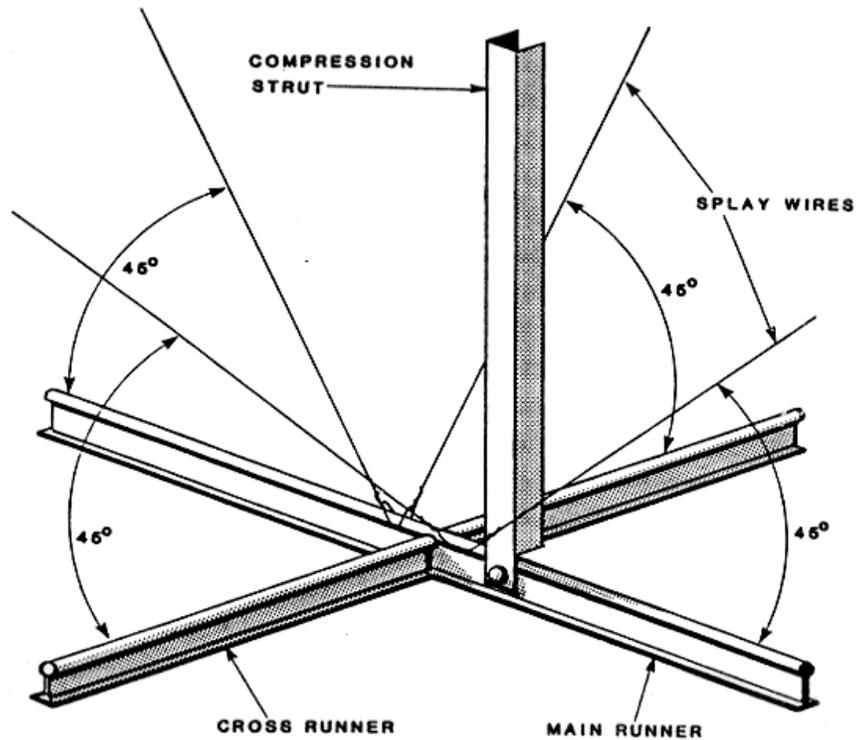
**Figure 1-25. Limited Destructive Testing to verify the Presence of Mechanical Anchorage and to determine the Adequacy of the Mortar Bond**



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**Figure 1-26. Typical Hollow Clay Tile Partition**

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Figure 1-27. Seismic Bracing of a Suspended Ceiling

## 1.3 Rehabilitation Strategies

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### 1.3.1 Overview

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Correction of vulnerabilities indicated above often requires a comparative assessment among several options. Since the implementation of any feasible rehabilitation strategy involves interfaces with functioning network systems, the process may last an extended period of time. Several feasible rehabilitation strategies are listed below.

### 1.3.2 Occupancy Planning

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In certain situations, occupancy adjustments such as relocation or abandonment may present a preferred rehabilitation strategy. This strategy might be particularly attractive for surplus assets or largely vacant older buildings. However, in occupied buildings the need to relocate equipment or other functions may deem this strategy unattractive.

### 1.3.3 Local Retrofit

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Correction of the prevailing vulnerability by means of remediation is the most common strategy to address the concern. Remediation typically entails some measures of physical retrofitting. The extent of the desired retrofit is dependent upon the particular concern. In many situations it might be possible to employ a local retrofit addressing the particular concern at hand without globally modifying the overall building. Local retrofits may present a desired rehabilitation strategy based on cost, schedule and convenience.

### 1.3.4 Global Retrofit

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Remediation by means of a global building retrofit might be necessary under certain situations. Examples of such situations may include the following:

- ***Global structural concerns*** - Some vulnerabilities may involve the global makeup of the building. In these situations a global retrofit might be necessary. Buildings constructed of unreinforced masonry may fall in this category.
- ***Access limitations*** - The presence of operating equipment or other limitations may require the implementation of an indirect global retrofit solution.
- ***Improved performance*** - Life extension of older buildings may necessitate the implementation of global retrofits directed at an improved building performance.
- ***Mandatory retrofits*** - Global retrofits necessary for compliance with modern codes may be mandated by the authorities. Such requirements arise only following an earthquake and are typically dependent on the extent of damage sustained by the building.

## **1.4 Design Considerations**

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### **1.4.1 Overview**

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Rehabilitation of the vulnerabilities described in Section 1.2 above is strictly voluntary. This is because all AT&T buildings were constructed in accordance with the prevailing codes and ordinances at the time permit applications were filed. While building codes and ordinances are periodically being updated, their enforcement is not retroactive.

### **1.4.2 Design Basis**

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The rehabilitation design basis shall be established during the feasibility design review stage. The design basis should include engineering assessment of the “as built” and “retrofitted” conditions, identification of constructability issues and associated costs. As appropriate, the engineering assessment should consider several safety enhancement alternatives. The design basis must clearly indicate the codes and ordinances with which the proposed work must comply.

### **1.4.3 Strengthening the Existing Structural System**

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A common safety enhancement alternative may involve the local or global strengthening of existing members. Examples of strengthened existing members include thickened shear walls or improved connections. Implementation of this retrofit approach implies that upon strengthening, the original structural system can achieve the desired rehabilitation objectives.

### **1.4.4 Modifying the Existing Structural System**

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Modifications to the existing structural system through the introduction of new members can present an attractive retrofit alternative. Examples of new members include new shear walls, braced frames or motion isolation and energy dissipation devices. Implementation of this retrofit approach often results in alterations to the manner in which lateral loads are resisted. Hence, it is necessary to ensure that the modified structural system is complete.

### **1.4.5 Constructability Issues**

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In existing buildings, constructability considerations often determine the selection of the preferred retrofit approach. This is because it is critical that construction operations be carried out without jeopardizing life safety or network reliability. Accordingly, strict controls must be placed on phenomena such as dust emission, generation of noise, induced vibrations and introduction of electromagnetic fields due stray currents. Limited access and clearances may also influence the particular retrofit selection. Adequate temporary protection must be provided during construction and when feasible it is preferred that construction activities be carried out on the exterior of the building envelope.

### **1.4.6 Appearance Issues**

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Earthquake safety enhancement retrofits applied to the exterior of buildings may invoke the need to address appearance issues. Retrofit designs limiting the need to address appearance issues should be preferred. Jurisdictions may require special attention to appearance issues in conjunction with the structural retrofit. Such requirements may exist when buildings are designated to be of historical significance or in situations where the buildings are located in a designated redevelopment zone, typically down town. In the case of historically significant buildings it is typically necessary to preserve the exterior appearance of the building while in redevelopment zones some variances are possible.

## **1.5 Rehabilitation Methods**

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### **1.5.1 Overview**

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Selection of the appropriate rehabilitation method is a target which depends upon several variables including the building particulars, vulnerability type, retrofit objectives, design considerations, construction schedule and cost. The following sections describe some rehabilitation methods which were either previously applied or considered for application to AT&T buildings.

### **1.5.2 Structural System Retrofit**

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As discussed above, the retrofit of structural systems may involve strengthening of existing members or the introduction of new members. In both cases the objective is to augment the existing structural system lateral load resisting capacity. The capacity of existing concrete or masonry shear walls can be increased by thickening. Combined action of the existing and the thickened portions of the walls is

achieved through the use of epoxy bonded reinforcement dowels (Figure 1-28). The capacity of steel construction can be augmented by the introduction of new braces (Figure 1-29) or by improving the capacity of existing connections (Figure 1-30).



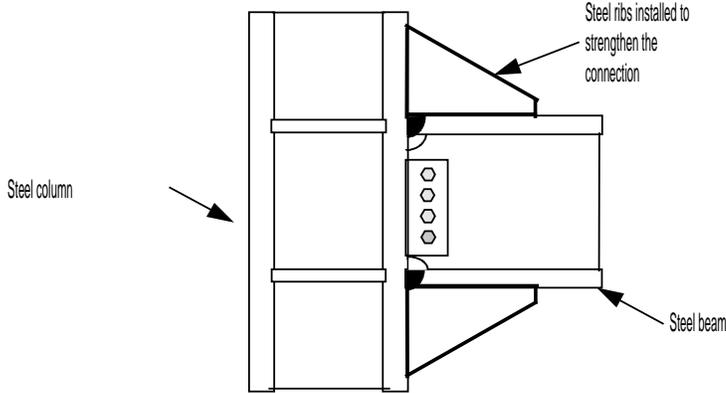
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**Figure 1-28. Reinforcement and Dowels installed for New Wall Thickening**



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**Figure 1-29. New Steel Braces installed for Seismic Resistance**



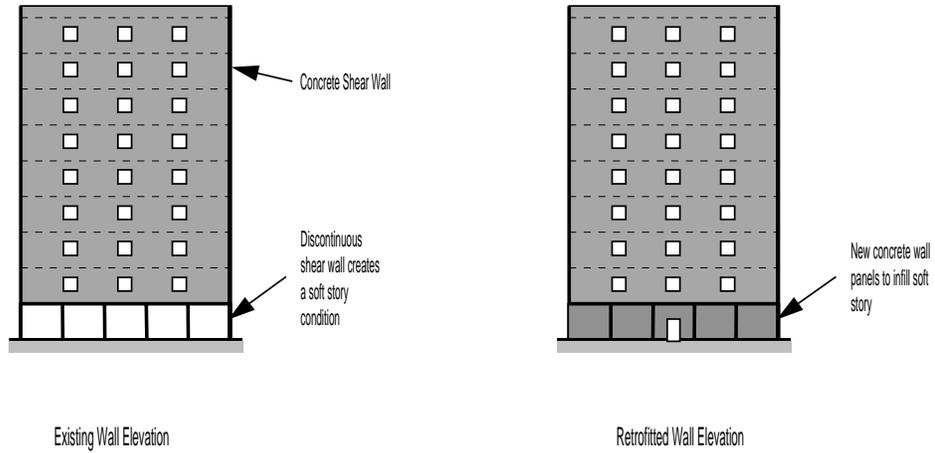
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**Figure 1-30. Strengthening a Steel Moment Frame Connection by installing Vertical Steel Ribs**

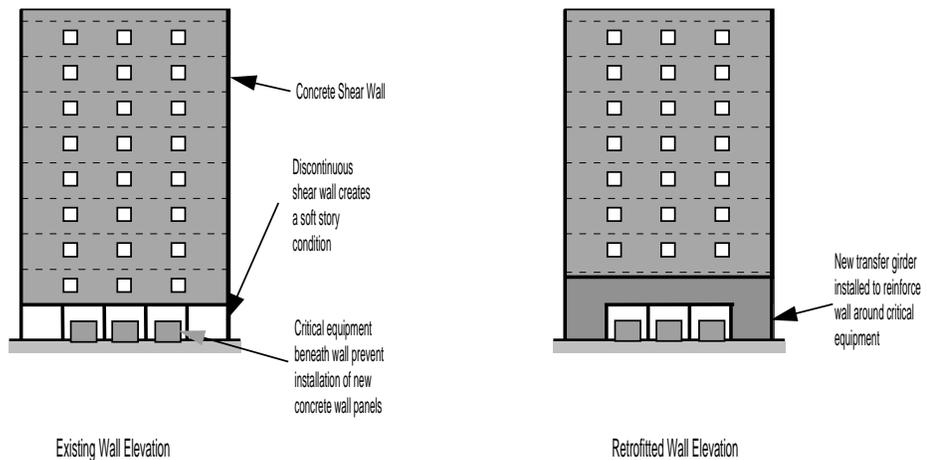
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### 1.5.3 Retrofit of Irregularities

Removal of structural irregularities is the preferred retrofit approach. Vertical structural irregularities due to abrupt changes in story stiffness or strength can be removed through the use of infill wall panels (Figure 1-31). In certain situations where it may not be possible to remove undesired irregularities other mitigating solutions should be implemented (Figure 1-32).



**Figure 1-31. New Infill Wall Panels installed to remove a Soft Story Condition (see Figure 1-12 for comparison)**



**Figure 1-32. Transfer Girder installed to Bridge over a Soft Story which could not be filled**

### 1.5.4 Retrofit of Emergency Egress

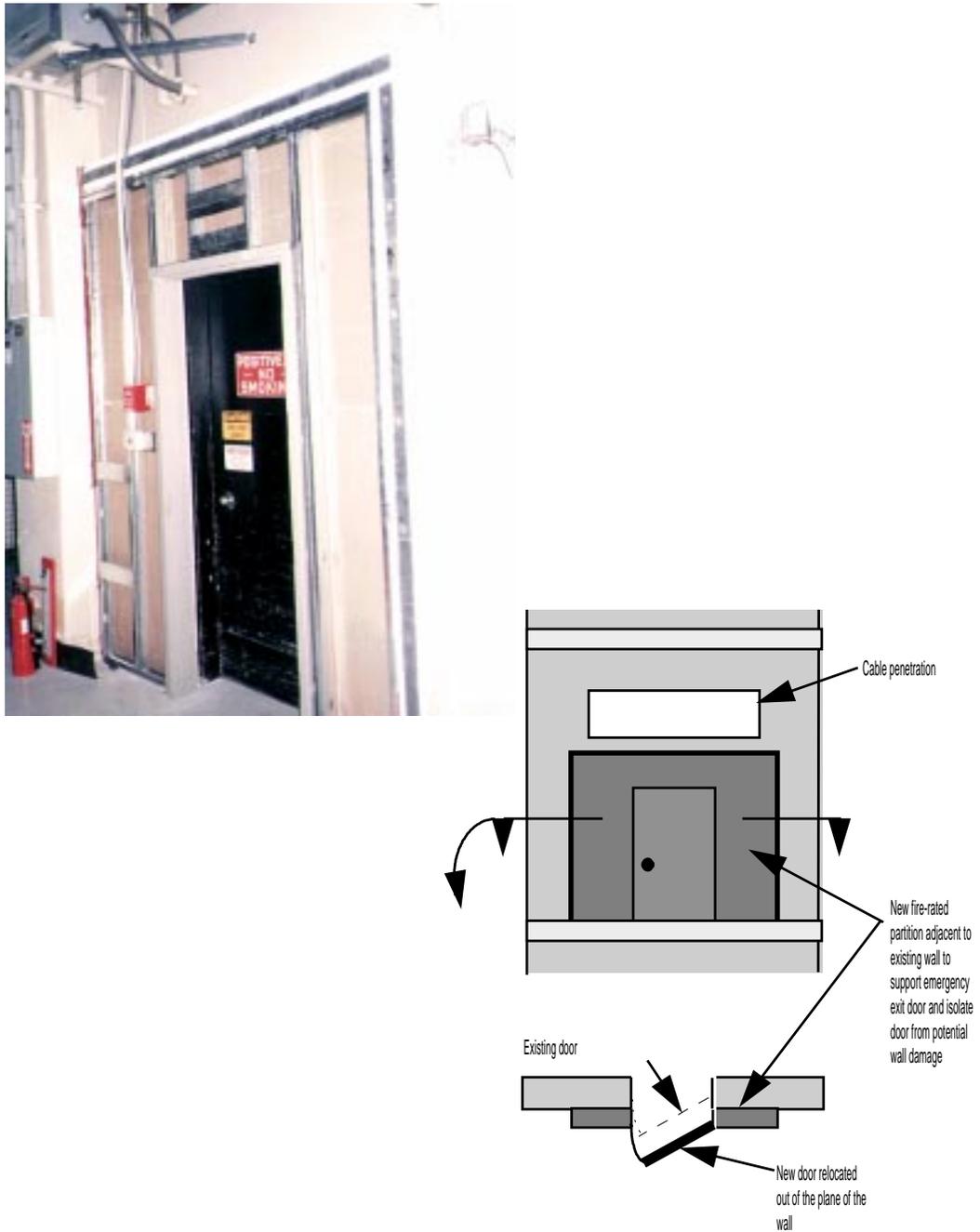
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Assurance of safe emergency egress requires verification of the overall stability of the egress system, provisions for unhindered access and removal of potential obstructions along the path. In certain situations where the egress system is exterior to the building adequate stability can be ensured by properly securing the egress system to the structure such that physical separation is prevented (Figure 1-16 and Figure 1-33). Unhindered access often involves the need prevent fire doors at entrances to emergency egress from becoming dislodged. Emergency exits likely to be dislodged by adjacent wall damage can be isolated from the damage by offsetting the door outside the plane of the wall (Figure 1-34). Obstructions to emergency egress due to failure of brittle materials should be minimized by means of containment or removal (Figure 1-35).



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**Figure 1-33. To Ensure Adequate Lateral Support of the Emergency Egress Stair, Additional Anchorage was installed to Tie the Stair Landings to the Building**



**Figure 1-34. Vertically Aligned Wall Openings created a Local Discontinuity and Source of Damage (see Figure 1-13). Emergency Exit Door Frames were isolated from the Wall to enable Egress despite Wall Damage**



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**Figure 1-35. Glass Panels above Emergency Exit were replaced with Tempered Safety Glass to Reduce Egress Hazards**

### **1.5.5 Building Appendage Retrofit**

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Building appendages including penthouses, parapets, canopies and towers should be retrofitted to ensure their stability. Appendages are often mounted at upper levels of buildings and thus may be subject to motion amplifications (see AT&T Standard 760-200-024, *Earthquake Resistant Design Guidelines for New Buildings*, which must be considered in providing the appropriate retrofits. Retrofits to achieve adequate structural stability of appendages typically involve the installation of bracing (Figure 1-36 and Figure 1-37).



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**Figure 1-36. Generator Penthouse with New Steel Bracing for Seismic Resistance (see Figure 1-17 for comparison)**



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**Figure 1-37. Unreinforced Masonry Parapet with New Seismic Bracing (see Figure 1-18 for comparison)**

### 1.5.6 Minimizing Building Interaction

Conduits traversing inter-building gaps are most susceptible to differential building motion. As many of these conduits support essential network systems their integrity must be ensured. To address this concern, a phased remediation approach may be required. A short-term solution can be applied by providing adequate slack in cables and conduits which traverse inter-building gaps (Figure 1-38). A permanent solution is possible by structurally interconnecting adjacent buildings (Figure 1-39). The latter approach is required to prevent potential failure of future conduit installations which have inadequate allowances for differential motion.

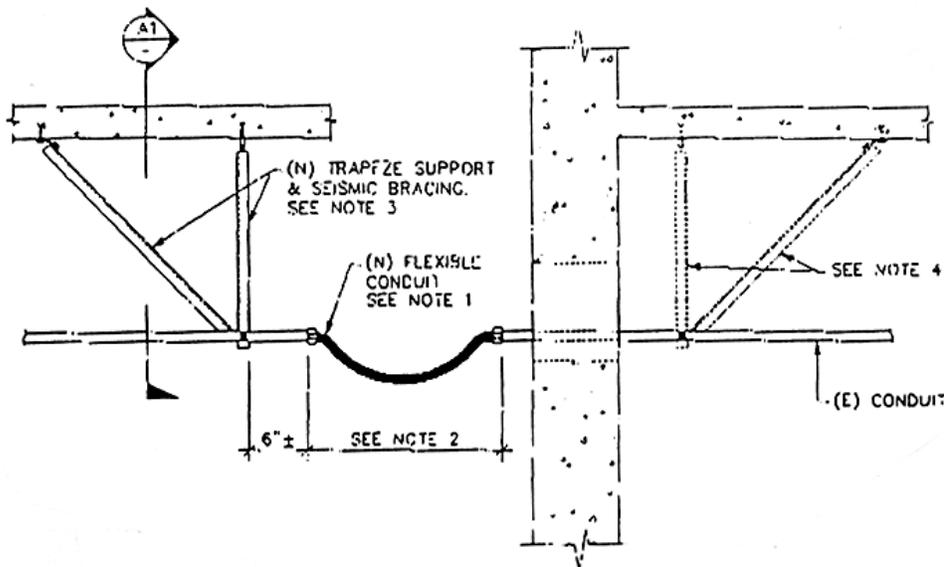


Figure 1-38. Cables Retrofitted to provide Adequate Flexibility across a Structural Separation

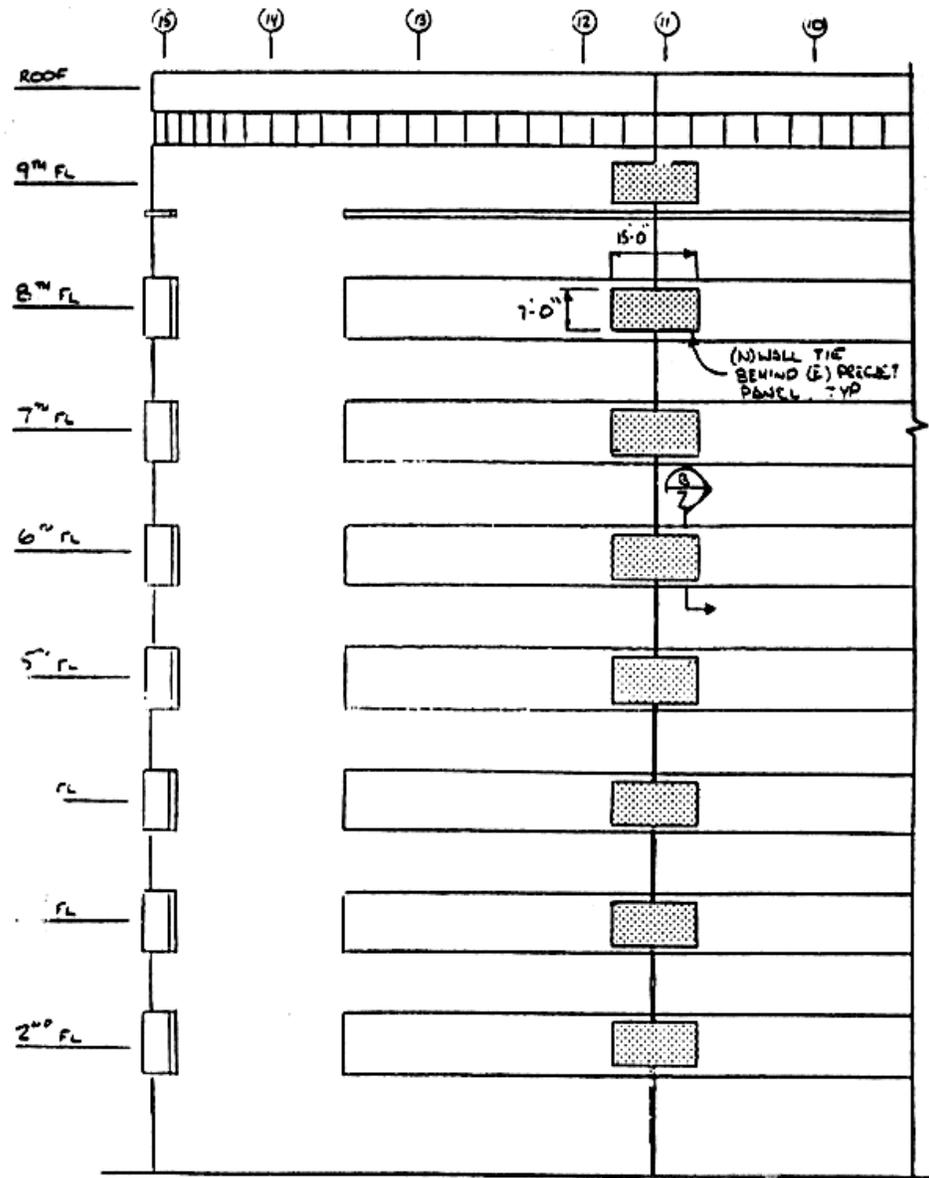


Figure 1-39. Structural Tie between Adjacent Buildings to prevent Relative Movement during an Earthquake

### **1.5.7 Retrofit of Architectural Components**

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Retrofit of architectural components such as facades, partitions and suspended ceilings should be considered only in situations when life safety or network reliability concerns may exist. In determining the need for retrofit of architectural components, a standard of care commensurate with commonly acceptable industry practice should be considered. For example, concerns due to facades constructed of brittle materials such as terra cotta should be addressed if there is a reason to believe that large pieces of material may peel off the building during an earthquake. Possible evidence to raise concern might be in the form of excessive corrosion stains or cracking. In such situations an appropriate form of testing should be performed prior to determining a preferred course of action. Potential retrofits may vary from rerouting of traffic away from the immediate vicinity of the building, selective installation of protective canopies, confinement and removal.

## **1.6 Implementation**

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### **1.6.1 Overview**

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Many AT&T buildings house continuous operations which can't tolerate disruption at any time. In addition, equipment spaces often require environmental controls which are susceptible to the effects of building construction activities as described in Section 1.4.5 above. For these reasons, as well as the strive for superior project quality, proper attention should be given to project planning and quality control prior to commencement of implementation.

### **1.6.2 Pre Construction Planning**

---

Important aspects of the pre-construction planning may require the filing of detailed outlines for sensitive construction activities using the appropriate methods of procedures provisions. Sensitive activities are typically those carried out in close proximity to operating equipment but this requirement may also apply beyond the actual work areas in order to establish proper construction staging and access procedures. Special requirements such as the need to accommodate AT&T declared quiet time must be recognized.

### **1.6.3 Quality Assurance**

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Quality assurance in seismic retrofit projects must be particularly stringent because the final product typically relies on the combined action of existing and new construction. Hence, project specifications must be carefully adhered to. This

is particularly critical for items such as material properties of concrete, installation of epoxied dowels and structural welding. All noncompliance observations must be immediately reported to project engineer of record.

## 1.7 Cost Considerations

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Based on their cost, seismic rehabilitation projects can be generally classified in two broad categories as follows:

- **Quick retrofits** - These are relatively inexpensive retrofits which are self evident and can in most cases be implemented without the need for extensive design. Examples of such retrofits may include inserting missing bolts, installing minor bracing, and replacement of corroded or broken welds. Retrofits belonging to this class should typically involve costs of \$10,000 or less.
- **Engineered retrofits** - These include potentially involved retrofits for which the budgets must be established via a Feasibility Design Review process and an engineered design should be prepared.

The cost of most seismic rehabilitation projects will be somewhat influenced by the need to meet prevailing code requirements. In particular it is important to note that some jurisdictions may determine that a seismic rehabilitation project, albeit voluntary, could be used to trigger other code requirements (i.e. access for disabled persons, fire and life safety, etc.). It is therefore important to identify prior to development of the project budget all related regulatory requirements. Another recommended strategy to control the cost of seismic rehabilitation in network equipment buildings is to maximize the work around the exterior envelope of the building. This is likely to reduce the need for costly measures for equipment protection.

Actual costs for engineered retrofits are highly variable and depend upon the particular vulnerability being addressed. Experience has shown that the cost of retrofits to address global structural concerns may be in the range of \$20 per square foot considering the gross area of the building.



# Earthquake Damage Repair for Existing Facilities

# 2

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# Earthquake Damage Repair for Existing Facilities

# 2

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## 2.1 Objectives

### 2.1.1 Overview

---

In the aftermath of a major earthquake it may be necessary to prioritize damage repair operations in order to resume normal business activities. The extent of the necessary repair depends upon the specific damage sustained at each facility. The scope of this section is limited to addressing damage repair operations related to building structures.

### 2.1.2 Life Safety

---

Assessment of adequate life safety conditions is of utmost importance following a major earthquake. This assessment must be made by a qualified AT&T representative or by a building official representing the local jurisdiction. Consideration must be given to observed damage, hidden but likely damage, and potentially adverse effects due to aftershocks. AT&T personnel and public access to the building shall be prohibited until completion of the life safety assessment. Subsequent access shall conform to specific directions provided by qualified AT&T and/or jurisdiction representatives.

### **2.1.3 Network Recovery**

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Resumption of normal network operations is a high priority but less critical than ensuring adequate life safety. Hence, resumption of normal network operations must be suspended until such time when concerns regarding adequate life safety no longer prevail. It is possible that only portions of a damaged facility may become available for resumption of network operations. In such cases, a clear delineation should be made to identify the areas which must remain off limits to AT&T network personnel.

### **2.1.4 Building Access**

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Control of access is the most common way for jurisdictions to classify the condition of a facility following an earthquake. These classifications are made known by posting of official colored placards at major facility entry ways as follows (Figure 2-1):

- ***Inspected*** - Green placards indicating that normal building access has not been altered due to the earthquake.
- ***Limited Entry*** - Yellow placards indicating that due to the earthquake building access is restricted. This typically implies that people may enter the facility at their own risk and normal public access is not advised.
- ***Unsafe*** - Red placards indicating that building access is off limits.

The above classifications should be used by qualified AT&T representatives in determining the post earthquake condition of the building.

<b>INSPECTED</b> <b>NO RESTRICTION ON USE OR OCCUPANCY</b>	
This structure has been inspected (as indicated below) and no apparent structural hazard has been found. Report any unsafe conditions to local authorities; reinspection may be required.	Date _____ Time _____
<input type="checkbox"/> <b>Exterior Only</b> <input type="checkbox"/> <b>Exterior and Interior</b>	This facility was inspected under emergency conditions for: _____ (Jurisdiction) on the date and time noted.
Facility Name and Address: _____ _____ _____	Inspector ID/Agency: _____ _____ _____
<b>Do Not Remove this Placard until Authorized by Governing Authority.</b>	

<b>LIMITED ENTRY</b> <b>OFF LIMITS TO UNAUTHORIZED PERSONNEL</b>	
<b>Warning:</b> This structure has been damaged and its safety is questionable. Enter only at own risk. Aftershocks or other events may result in death or injury.	Date _____ Time _____
<b>Restrictions on use:</b> <input type="checkbox"/> Entry for emergency purposes only <input type="checkbox"/> Other _____ _____	This facility was inspected under emergency conditions for: _____ (Jurisdiction) on the date and time noted.
Facility Name and Address: _____ _____ _____	Inspector ID/Agency: _____ _____ _____
<b>Do Not Remove this Placard until Authorized by Governing Authority.</b>	

<b>UNSAFE</b> <b>DO NOT ENTER OR OCCUPY</b>	
<b>Warning:</b> This structure has been seriously damaged and is unsafe. Do not enter. Entry may result in death or injury.	Date _____ Time _____
Comments: _____ _____ _____	This facility was inspected under emergency conditions for: _____ (Jurisdiction) on the date and time noted.
Facility Name and Address: _____ _____ _____	Inspector ID/Agency: _____ _____ _____
<b>Do Not Remove this Placard until Authorized by Governing Authority.</b>	

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Figure 2-1. Posting Placards

## **2.2 Initial Damage Reconnaissance**

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### **2.2.1 Overview**

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Initial damage reconnaissance performed immediately following the earthquake may need to be carried out under difficult conditions. Difficulties which may be encountered are due to schedule or logistical constraints. Schedule constraints may arise due to the need for damage assessment in a relatively short duration. Logistical constraints often occur due to access difficulties caused by damage. Despite these constraints it is important for the initial damage reconnaissance to be performed in an organized manner in order to reduce the likelihood of errors and omissions. Outlined below are key components of the initial damage reconnaissance to be carried out by a qualified AT&T representative.

### **2.2.2 Damage to Structural Elements**

---

Assessment of damage to structural elements must commence by means of observations of the facility exterior. Should conditions observed on the exterior suggest obvious life safety concerns, no further inspection of the facility interior should be performed and the it should be posted unsafe. In this situation no further occupancy should be allowed until the results of a further detailed engineering assessment are available.

In situations when observations of the exterior do not unveil obvious life safety concerns, the damage assessment should proceed to the facility interior. Prior to commencement of interior observations an effort should be made to locate as-built or design drawings describing the existing structural systems. It is important to note that many AT&T facilities were constructed in phases over many years and therefore the entire facility may be described on several sets of drawings. A review of the drawings should be performed to establish the nature of construction and determine important locations for structural observations. The latter is important because structurally significant damage might be concealed and therefore not immediately apparent to the observer.

Damage observations should be documented on floor and elevation diagrams using the grid designations as they appear on the drawings. Photographs should be taken to correspond to all significant damage observations. In the case of concrete and masonry construction, damage observations should note items such as extent of spalling, cracking and crack widths. In the case of steel construction, members are often concealed by fire protection covers. In such cases, primary observations should be made next to member joints. Particular attention should be paid to the observation of vulnerabilities described in Section 1.2.

Upon completion of the observations described above, a determination should be made, by a qualified AT&T representative, regarding the safety of continued operations in the facility and the corresponding posting per Section 2.1.4 above. It should be noted that in cases when a facility is composed of separate structures it is possible for these structures to obtain different safety posting. Likewise, it is also possible for selected areas within a structure to be posted with limited entry while the remaining areas are approved for normal occupancy.

### **2.2.3 Damage to Non-Structural Elements**

---

Non-structural elements are all building elements which do not materially participate in resisting earthquake forces. Such elements may include cladding, partitions, suspended ceilings, furniture etc. Following a major earthquake, damage to non-structural elements might be significant but not particularly critical to the continued safe occupancy of the facility. Typically, damage to non-structural elements may result in access difficulties and possibly limited safety concerns. However, most safety concerns due to such damage can be alleviated reasonably quickly by means of cleanup operations. In certain situations, such as damage to brittle cladding described in Section 1.2.9, it may be necessary to post the affected portions of the exterior perimeter of the facility as limited entry while the interior can be approved for normal occupancy. The assessment of damage to non-structural elements can be performed concurrently with the structural damage assessment using the same procedures as described above. Particular attention should be given to the identification of potentially unstable objects which may present a falling hazard.

### **2.2.4 Damage to Equipment**

---

Damage to equipment by itself will seldom trigger an altered facility occupancy posting. In some situations, however, damage to equipment may affect the safe occupancy of the facility. This may occur due to damaged mechanical or electrical equipment. For example, damaged elevators, leaking fuel or water tanks, and non-functioning electrical switch gear may result in the determination of an unsafe occupancy. In most situations such damage can be repaired or its effects mitigated relatively quickly, thus limiting the unsafe exposure.

### **2.2.5 Prioritization of Damage Repair Requirements**

---

Damage repair operations following completion of the initial reconnaissance observations should be prioritized as follows:

- Removal of life safety concerns
- Resumption of network operations

- Restoration of normal occupancy.

In general damage repair operations to achieve the above objectives can be classified in two broad categories. These are:

- Emergency Repairs
- Long Term Repairs.

Emergency repairs typically commence immediately following the event and should focus on the removal of life safety concerns and resumption of network operations. Long term repairs typically commence following detailed engineering assessments and should focus on the restoration of normal occupancy. It should be noted that all damage repair operations must secure the necessary building permits as required by the jurisdiction.

## **2.3 Emergency Repairs**

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### **2.3.1 Overview**

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Emergency repairs may typically last from a few weeks to a few months following the earthquake. Large earthquakes typically produce many aftershocks which are likely to be felt during the course of the emergency repairs. It may be necessary to monitor any progression of adverse effects due to such aftershocks. Because earthquake damage can be often misinterpreted, it is necessary to limit dissemination of incomplete damage assessment information. Repair activities may involve various disciplines requiring close coordination. Hence, it is beneficial for post-earthquake emergency repairs to be directed by experienced personnel.

### **2.3.2 Design Considerations**

---

In order to expedite emergency repair operations it is recommended that qualified AT&T representatives directing such repairs be present at the affected facility. Due to time constraints design of repairs is often guided by sound engineering assessment of in-site conditions. For the same reasons it may not be possible to develop all required construction documents prior to implementation. However, it is necessary to maintain adequate records of all design decisions so these can be subsequently included in properly developed design documents. Typical emergency repair activities may include the installation of barricades or fences, shoring, and selective removal or demolition.

### **2.3.3 Implementation Considerations**

---

Repair activities must be carried out in a safe manner. Potential effects of repair activities on network equipment must be considered and addressed. Access to areas where repair operations are being performed should be limited to personnel directly involved with such activities. In general it is necessary to minimize the effects of dust, noise, vibrations, and stray currents. In the aftermath of a major earthquake, qualified construction personnel might be in short supply. Hence, it is generally beneficial to engage contractors having prior familiarity with the facility.

## **2.4 Detailed Engineering Assessment**

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### **2.4.1 Overview**

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In situations where significant damage may have occurred, detailed engineering assessment should commence as soon as practical. This assessment is necessary to determine long term repairs which in most cases are directed at the restoration of normal occupancy. It can be reasonably expected that the detailed assessment will employ various advanced tools for purposes of surveying the damage and analyzing its effects.

### **2.4.2 Detailed Damage Survey**

---

A detailed survey should be performed to systematically record all damage which should be considered in the detailed engineering assessment. Experience has shown that for a variety of reasons, some damage is often undetected during the initial reconnaissance. Damage recorded during the detailed survey shall be properly documented on building drawings which may be later submitted to the jurisdiction as part of the repair permit application. Data collection and measurements of damage performed as part of the detailed survey may include obtaining accelerometer records, checking building plumbness, recording dimensions of concrete cracking and spalling, recording particulars of reinforcement and structural steel fracture, and measuring displacements of various systems such as cable trays, pipes, ducts and hoists. It should be noted that, to the extent possible, the detailed survey must include areas not routinely accessed such as chases for mechanical and smoke exhaust stacks, elevator shafts and areas between adjacent buildings.

### **2.4.3 Effects of Damage on Structural Behavior**

---

Earthquake damage may affect the load resistance capacity of structural members. The residual load resistance capacity of a structure depends upon the extent of damage to the assemblage of members composing the structural system. It is important to note that frequently structural members such as beams, columns, floors, and walls are used to resist both gravity and earthquake loads. Hence, damage to such members may be of concern not just relative to their ability to resist subsequent earthquake loads but also with respect to their ability to support normal operational loads. In these situations it may be necessary to install temporary shoring as discussed in Section 2.3.2 above. Damage effects on structural behavior may vary greatly depending upon the type of damage and the particular design details. For example cracks in concrete due to shear are likely to be of greater concern than similar cracks due to flexure. Likewise, cracks in poorly confined members (Figure 1-3) are likely to be of greater concern than similar cracks in well confined members. It is recommended that, at a minimum, damage effects on structural behavior be investigated when observations reveal the following conditions:

- Concrete cracks wider than 0.125 inch
- Residual differential displacements between adjacent stories larger than 0.005 times the story height
- Fracture of reinforcement and structural steel.

The effects of the above damage on structural behavior should be investigated by means of engineering analyses, testing, or both.

### **2.4.4 Computerized Simulations of Structural Response**

---

Damage assessment engineering analyses can be best performed by means of computerized simulations of the structural response. Such simulations are mandatory for post earthquake damage assessment of all AT&T buildings over three stories. In performing computerized simulations of the structural response the following attributes should be considered:

- *Calibration of recorded and computed motion response* - When earthquake ground motion and building response records are available they should be used to calibrate the motion response predicted by the computer model.
- *Assessment of damage progression* - Motion response analyses should be performed considering the undamaged condition prior to the earthquake as well as the damaged state following the earthquake. The latter should be performed considering appropriate representation of the damage.

- *Consideration of multiple repair options* - The use of a computerized motion response simulation facilitates the consideration of multiple damage repair options. This is particularly important in occupied environments where access difficulties must be considered in the selection of the preferred retrofit option.

There are various methods which can be used for the analysis. Some of these methods are described in AT&T Standard 760-200-024, *Earthquake Resistant Design Guidelines for New Buildings*, Section 5 and are incorporated here by reference. The selection of the most appropriate analysis method should be made based upon the particulars at hand.

## **2.5 Long Term Repairs**

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### **2.5.1 Overview**

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Long term repairs are directed at the restoration of normal unrestricted facility occupancy. Depending upon the extent of damage these repairs may last months or years. Long term repairs may involve major multi-discipline construction activities requiring close coordination with ongoing network operations.

### **2.5.2 Design Considerations**

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The design of long term repairs can present special considerations such as:

- *Design criteria* - The desired post repair performance level must be selected. Choices must be made between restoration of preexisting conditions or improved performance. Accordingly, the physical boundaries of the proposed repairs must be determined.
- *Code issues* - In most cases the buildings being repaired were constructed in accordance with earlier code editions. The repair work, however, must comply with requirements of current editions of the building codes. Hence, structural compatibility between the original and repaired components must be ensured.
- *Limitations* - Due to the need to interface with existing structures, it is possible that certain design objectives may present feasibility or cost limitations. For example, retrofit of foundations may belong to the latter category.

In addition to the above, inadequate or missing data may necessitate physical testing to obtain required information. Examples may include soil and concrete sampling, chemical analysis of steel for weldability, and others.

### 2.5.3 Implementation Consideration

---

Primary implementation considerations for long term repairs evolve mostly around the logistical aspects of construction in the vicinity of operating network equipment. In order to avoid unacceptable conflicts it is required that all construction activities follow predetermined methods of procedures and maximum protection be afforded to network equipment. In extreme situations it may be necessary to relocate certain network equipment, such as DC power, in order to allow for access. Other issues which must be contended with in the course of performing long term repairs are the common use of certain facilities such as power, elevators and lavatories and limited mobilization space particularly in down town locations. Quality assurance and control are important components of the repair design which must be maintained despite difficult conditions.

### 2.5.4 Cost Considerations

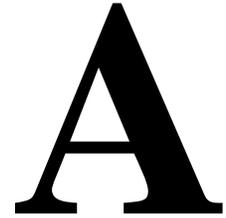
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In addition to the standard components contributing to the total project cost, post-earthquake damage repair projects may need to bear additional surcharge due to:

- *Limited availability of trades and supplies* - Following a major regional earthquake some shortages may exist. Examples of trades and equipment in short supply are qualified structural welders, epoxy injection contractors, and scaffolding.
- *Protection of network equipment* - Installation of temporary protective partitions for protection of network equipment is quite common in post earthquake repair projects.
- *Protection of neighboring assets* - In situations where the buildings are located within close proximity to adjacent assets such as other buildings, parking lots, etc., it may be necessary to adequately protect such assets.
- *Relocation of network equipment* - Occasionally the need to access certain areas for construction necessitates the relocation of network equipment.
- *Limited access* - Access limitations typically increase the project cost due to reduced productivity.
- *Lease of mobilization sites* - When vacant space is limited, it may be necessary to lease adjacent space from third parties for construction mobilization.
- *Shift work* - Certain constraints may mandate work to be performed at night or on weekends.

It is reasonable to expect that some of the above conditions will prevail in most post earthquake retrofit projects. The impact of these conditions on the total project cost is highly variable. Depending upon the actual project conditions it is possible that the surcharge may more than double the cost relative to new construction of similar items.

## Related Standards



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This appendix lists the related standards referenced through out.

- AT&T 760-100-020, *Selection of Building Sites for Central Offices*, Issue 1, August 1977. Available through CIC.
- AT&T 760-200-020, *Design Loads for Telephone Buildings*, Issue 1, June 1979 - Reprinted May 1985. Available through CIC.
- AT&T 760-200-025, *Enhancement of Earthquake Safety for Existing Buildings*, Issue 1.
- AT&T 760-200-032, *Cable Openings*, Issue 2, May 1978.
- AT&T 760-200-040, *Floor and Ceiling Anchors*, Issue 1, September 1977.
- AT&T 760-200-041, *Equipment Support*, Issue 1, October 1977.
- AT&T 760-200-050, *Mechanical Design*, Draft, January 1996.
- AT&T 760-200-100, *Structural Floors*, Issue 1, October 1977.
- AT&T 760-200-110, *Procurement Requirements for the Raised Seismic Access Floor (SAFloor) System for NSD Equipment Locations*, Draft Issue 5, June 1996.
- AT&T 800-610-155, *Earthquake and Disaster Bracing for Central Office Equipment General Equipment Requirements*, Issue 10, July 1979.
- AT&T 801-900-160, *Network Equipment Development Standards (NEDS) Generic Requirements*, Issue 2, February 1995.

- Bellcore GR-63-CORE, *Network Equipment - Building Systems (NEBS) Requirements: Physical Protection*, Issue 1, October 1995.

## References

# B

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This appendix lists the references used through out the document.

1. Applied Technology Council, *Field Manual: Postearthquake Safety Evaluation of Buildings*. ATC Report No. 20-1, Redwood City, California, 1989.
2. Applied Technology Council, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*. Federal Emergency Management Agency Report No. 273, Washington, D.C. 1996.
3. AT&T 760-200-020, *Design Loads for Telephone Buildings*. Issue 1, June 1979 - Reprinted May 1985.
4. AT&T 760-200-024, *Earthquake Resistant Design Guidelines for New Buildings*. Draft, February 1997.
5. AT&T 760-200-032, *Cable Openings*. Issue 2, May 1978.
6. AT&T 760-200-100, *Structural Floors*. Issue 1, October 1977.
7. AT&T 801-900-160, *AT&T Network Equipment Development Standards (NEDS) Generic Requirements*. Issue 2, February 1995.
8. Bellcore, *Network Equipment-Building System (NEBS) Equipment Requirements: Physical Protection*. Issue 1, Bellcore GR-63-CORE, October 1995.
9. Dowrick, D.J., *Earthquake Resistant Design for Engineers and Architects, 2nd Edition*. John Wiley & Sons, 1977.
10. Harvey, S., *AT&T NCS Infrastructure Segmentation Strategy*. May 21, 1996.

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11. International Conference of Building Officials, *Uniform Building Code*. Whittier, California, 1994.
12. Nilson, A.H. and Winter, G.W., *Design of Concrete Structures*. 11th Edition. McGraw-Hill Book Company, 1991.
13. SAC Joint Venture, *Interim Guidelines: Evaluation, Repair, Modification and Design of Welded Steel Moment Frame Structures*. Federal Emergency Management Agency Report No. 267, August 1995.
14. Structural Engineers Association of California, Seismology Committee, *Recommended Lateral Force Requirements and Commentary*. 6th Edition. Sacramento, California, 1996.
15. Wakabayashi, M., *Design of Earthquake Resistant Buildings*. McGraw-Hill Book Company, 1986.

## **Glossary**

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### **A**

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#### **Accelerometer**

Device which measures and records the motion of the structural element to which it is mounted.

#### **ATC**

Applied Technology Council.

### **B**

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#### **Base Shear**

The total lateral force or shear at the base of a structure.

### **C**

---

#### **Capacity**

The permissible strength or deformation of a structural member.

## **D**

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### **Demand**

The amount of force or deformation imposed on an element.

### **Diaphragm**

A horizontal structural element used to distribute lateral forces to vertical elements of the lateral force resisting system.

### **Dynamic**

Loading and structural response which varies with time.

## **E**

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### **Elastic**

Ability of a structural member to return to its original size after an applied load is removed.

## **F**

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### **FEMA**

Federal Emergency Management Agency.

## **H**

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### **Hazard Level**

Earthquake shaking demands of a specified severity, determined on either a probabilistic or deterministic basis.

## **I**

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### **Inelastic**

Permanent deformation of a structural member resulting from an applied load.

### **Inter-story Drift**

The relative horizontal displacement of two adjacent floors in a building.

## **L**

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### **Lateral Force Resisting System**

Those elements of the structure that provide its basic lateral strength and stiffness, and without which the structure would be laterally unstable.

## **N**

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### **NEHRP**

National Earthquake Hazards Reduction Program.

## **P**

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### **Peak Ground Acceleration**

The maximum ground acceleration at a site during an earthquake, usually expressed as a percentage of gravity.

## **R**

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### **Rehabilitation Objective**

An expression of the desired building performance in the event of an earthquake of a specified severity. Rehabilitation is performed to meet the rehabilitation objective.

**Return Period**

The average period of time, in years, between the expected occurrence of an earthquake of specified severity.

**Redundancy**

Quality of having alternative paths in the structure by which the lateral forces are resisted, allowing the structure to remain stable following the failure of an element.

**Response Spectrum**

A plot calculated from an earthquake ground motion record that gives values of peak structural response as a function of the structural natural period of vibration.

**Rigidity**

The ability of a structure or element to resist loads without deformation. Also referred to as stiffness.

**S**

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**Soft Story**

Story which has a lateral rigidity significantly less than the story above.

**Static**

Loading and structural response which do not vary with time.

**Strength**

The maximum axial force, shear force, or moment that can be resisted by a structural element.

**T**

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**Time History**

Plot of ground motion or structural response as a function of time.

**U**

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**UBC**

Uniform Building Code



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