

COMMUNICATIONS FAILURE IN HYATT REGENCY DISASTER

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ABSTRACT: In July, 1981, two suspended walkways overlooking the lobby of the Hyatt Regency Hotel in Kansas City, Mo., collapsed, killing 114 people and injuring 200 more. The immediate cause of the accident was a structural design flaw in the box beam-hanger rod connections supporting the walkways. However, a more fundamental cause was a series of communication failures between the structural engineer and the steel fabricator. Confusion developed about whether the fabricator was to assume the professional role of "designer" or "developer," design drawings failed to clearly communicate important design information to indicate that the box beam-hanger rod connection shown was an "incomplete" design, and ambiguities in communicating intent were never resolved—all contributing to the ultimate tragedy. Specific areas of miscommunication that led to the inadequate box beam-hanger rod design that made the structural collapse inevitable are examined. The purpose is twofold: (1) To provide some insight into the complexities of communication systems in the construction industry; and (2) to encourage engineers to develop more effective foresight as a result of the communication lessons that emerge in hindsight from the tragedy.

INTRODUCTION

On July 17, 1981, two suspended walkways overlooking the lobby of the Hyatt Regency Hotel in Kansas City, Mo., collapsed, killing 114 people and injuring more than 200. Lawsuits resulting from the accident amounted to more than \$3 billion. In terms of human loss, this was the "most devastating structural collapse ever to take place in the United States" (Pfrang and Marshall 1982).

The Hyatt Regency accident occurred not because inherently defective materials were used in constructing the walkways, but because the structural engineer failed to clearly and completely communicate his design intentions regarding the box beam-hanger rod connections that supported the suspended walkways. This communication failure resulted in confusion about design responsibility at several levels of interaction between the structural engineer and the steel fabricator, ultimately leading to the use of a design plan and materials inadequate for supporting the loads acting on the box beam-hanger rod connections.

Purpose

Communication systems within different professions develop their own idiosyncratic complexities and more commonly follow "custom and practice" than prescribed patterns of rules. This is true in such diverse fields as medicine, law, education—and civil engineering. Investigations in the aftermath of the Hyatt Regency tragedy helped bring into clearer focus the com-

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munication patterns followed by structural engineers and highlighted the problems that can result when poor or ambiguous communication leads to a misunderstanding of responsibilities.

The purpose of this paper is to analyze the Hyatt Regency disaster from a communications perspective and to focus on those critical situations in the design and planning process when clearer communication might have prevented the tragedy. We also will discuss those instances in which ambiguous communication—or no communication at all—virtually made the tragedy inevitable. Finally, we intend to illustrate the dynamics of communication systems in the construction industry and emphasize the importance of greater awareness of role definition and communications networks in structural engineering.

Plan of Development

We focus primarily on the communication problems that developed between the structural engineer and the steel fabricator working on the Hyatt Regency Project, by reviewing: (1) The crucial role definitions of *designer* and *developer*; (2) critical terminology describing types of steel-to-steel connections and the extent of connection design; and (3) the means of communicating design responsibility from structural engineer to steel fabricator. We also consider how “custom and practice” in the industry contributes to role definition and how false or mistaken assumptions in the Hyatt Regency case led to fatal errors in communication that preceded the actual collapse of the walkways.

Most of our information comes from the report of the Deutsch Commission (Deutsch 1985), which heard the arguments of the Missouri Board for Architects, Professional Engineers and Land Surveyors against Daniel Duncan, Jack Gillum, and G.C.E. International, Inc., the structural engineers on the Hyatt Project.

BRIEF HISTORY OF HYATT REGENCY CASE

In early 1976, the Crown Center Redevelopment Corporation proceeded with its plans to build a major hotel in Kansas City. During the schematic design development phase from July, 1976, through the summer of 1977, the structural engineer worked with the architect to decide upon and design a basic plan. The structural engineer prepared structural drawings and specifications during the fall of 1977 and spring of 1978. Construction began in the spring of 1978 and the 750-room hotel was completed in July, 1980. The accident happened less than a year after the hotel opened for business.

Walkway Design

The Hyatt Regency Hotel was designed in three sections: (1) A 40-story tower section to the north; (2) a function block to the south; and (3) a connecting atrium. Three 120-ft suspended walkways spanned the 50-ft high atrium area, connecting the tower section and the function block. Two walkways were constructed on the west side, at the second and fourth floor levels, and one on the east side, at the third floor level. (See Fig. 1.)

Each walkway was supported on the north end by sliding bearings and connected on the south end by field welding to embedded plates. Intermediate support consisted of three pairs of 1-1/4-in. diameter hanger rods. Each

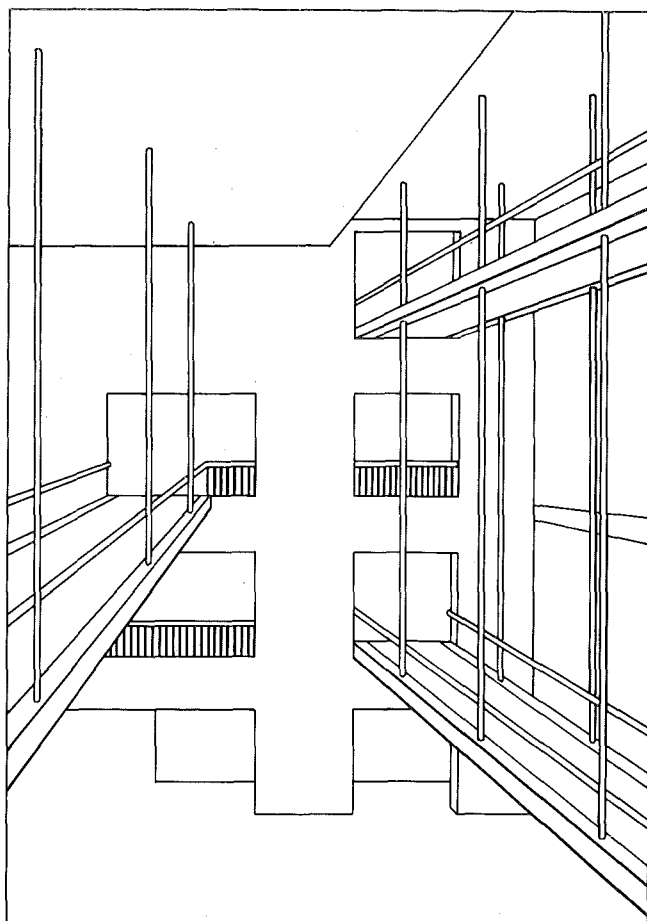


FIG. 1. View of Hyatt Regency Atrium Looking South (Adapted from Pfrang and Marshall 1982)

walkway bridge consisted of a formed steel deck overlaid with a 3-1/4-in. thick concrete slab. Transverse box beams, formed by two 8-in. channels welded toe-to-toe, were placed laterally under the bridge at 30-ft intervals. Longitudinal support was provided on each side by four 16-in. deep, 30-ft long steel I-beams laid lengthwise between, and welded to, the transverse box beams.

The third and fourth floor walkways were suspended from the atrium roof. Each hanger rod extended from the ceiling, passed through a hole in the welded seam of the transverse steel box beam, 2 in. from the end, and terminated on the beam's underside, secured by a nut and washer assembly. On the west side, a second hanger rod passed through a second hole in the fourth floor box beam (4 in. behind the first) and was secured by a nut and washer assembly on the upper side of the beam. This rod supported the

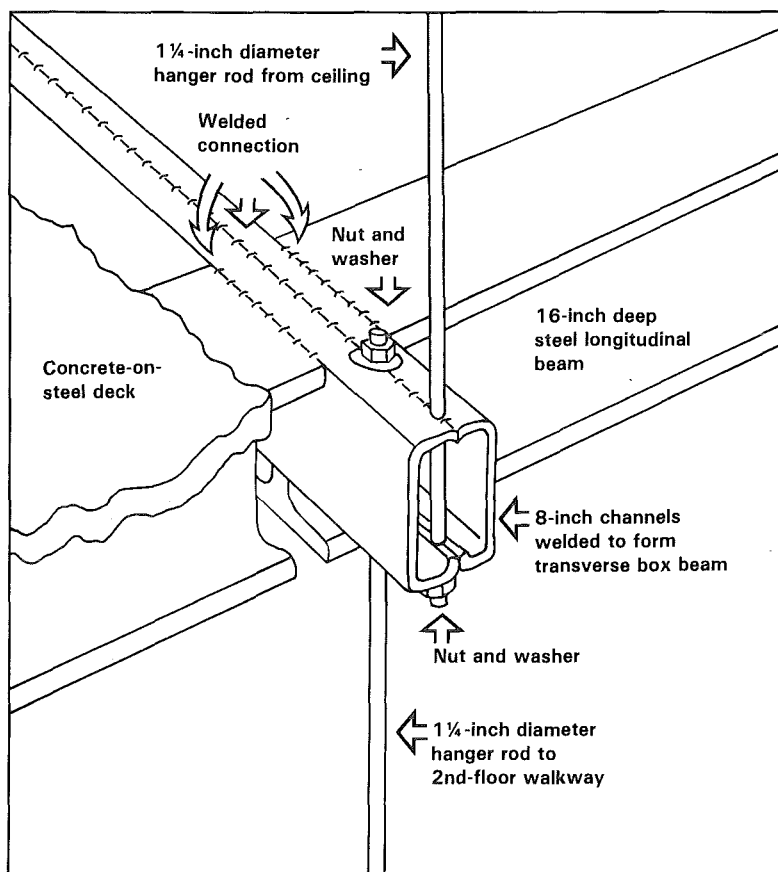


FIG. 2. Typical Fourth Floor Box Beam-Hanger Rod Connection (Adapted from "Hyatt Walkway Design Switched" 1981)

second floor walkway by extending downward through a hole in the second floor box beam, terminating with a nut and washer on the beam's underside (Pfrang and Marshall 1982; "Hyatt walkway design switched" 1981). Fig. 2 shows a typical fourth floor box beam-hanger rod connection.

Collapse

The collapse involved the second and fourth floor walkways and occurred during an early evening Tea Dance that took place in the hotel's atrium area. The walkways fell to the atrium floor, with the fourth floor walkway coming to rest atop the second. Investigators concluded that the structural failure began at the east end of the middle box beam on the fourth floor walkway. The bottom weld on the box beam at the hanger rod connection broke, allowing the box beam to slip down over the nut and washer at the lower end of the floor-to-ceiling hanger rod. This led to the failure of the other fourth floor box beam-hanger rod connections. Because the fourth floor walkway

supported the hanger rods for the second floor walkway, it, too, collapsed when the fourth floor box beams gave way.

Physical Causes of Accident

Initial speculation attributed the accident to the added weight and vibrations of people dancing on the walkways, thus causing destabilization of the structures and making them break apart. Later investigation, however, identified the major reasons for the collapse as design flaws that had never been properly corrected nor reviewed during construction, and the system of reviews that typically exist in the construction professions.

Some major conclusions reached by the National Bureau of Standards (NBS) in its investigation of the accident (Pfrang and Marshall 1982; Birchfield 1982) include:

1. The loads acting at the time of the collapse were only 53% of the requirement specified by the Kansas City Building Code.
2. All fourth floor outside hanger rod connections were potential fracture points at the time of the collapse.
3. As constructed, the box beam-hanger rod connections, the fourth floor-to-ceiling hanger rods, and the third floor walkway hanger rods did not satisfy the design provisions of the Kansas City Building Code.
4. Neither the quality of workmanship nor the materials used in the walkway system played a significant role in the collapse.

Communication Failures

Overriding all of the NBS' findings, however, are fundamental failures in communication about design and design change at critical points in the design process. The structural engineer failed to clearly communicate specific load information to the steel fabricator, who assumed that the box beam-hanger rod connection design passed on to him from the engineer was "complete." Acting on that assumption, the steel fabricator copied the connection the engineer had drawn and, in the absence of any instructions to the contrary, simply selected standard materials for the connection between hanger rod and box beam.

According to the Deutsch (1985) Commission, ". . . the omission of loads and other design information [on the final Section Detail Drawing S405.1, sections 10 and 11, depicting the box beam-hanger rod connections] was the major factor in the breakdown of communications between engineer and fabricator, which eventually precipitated the walkway collapse."

The failure of the structural engineer to communicate his intentions to the steel fabricator underlies all other causes of the Hyatt Regency tragedy and is the focus of the rest of this paper.

COMMUNICATION ISSUES

The dynamics of communications systems within the civil engineering profession as a whole are clearly illustrated by an analysis of the significant communication issues that the Hyatt Regency case highlights. All members of the profession must possess and practice highly developed communication skills. There must be among them common agreement about role definitions

and clear consensus about the meaning of terminology used in the profession. Finally, there must be mutual understanding of the methods and strategies—whether they arise from formal prescriptions or from “custom and practice”—followed in transferring certain responsibilities from one team member to another.

Role Definitions: Developer/Designer

In most cases, the roles and responsibilities of the structural engineer and the steel fabricator are clearly defined according to the four basic categories of work involved in structural steel construction: (1) Fabrication; (2) erection; (3) materials; and (4) engineering. However, in matters of engineering, there is a certain overlapping of responsibility, and both engineer and steel fabricator may be called upon to perform engineering work. In the Hyatt Project, critical misunderstandings about separate and overlapping responsibilities led to serious breaches in communication between these team members and led, ultimately, to construction of the faulty walkways.

In instances where engineer and fabricator can perform similar tasks, they clarify their duties through available formal and informal communication channels, including oral and written communication, as well as precise and accurate structural and shop drawings. Confusion and misunderstanding are most likely to occur in those overlapping areas of work where job responsibilities become obscured by “custom and practice,” inadvertently supplanting more established and formalized “rules.”

With respect to the Hyatt Regency case, the inadequacy of the box beam-hanger rod connection design resulted primarily from the structural engineer's failure to communicate clearly his intention that the steel fabricator take responsibility for designing the connection. And this communication malfunction was, itself, due to another related problem: how the structural engineer and the steel fabricator perceived their respective roles in regard to steel-to-steel connection design.

There is a clear distinction between the terms *design* and *develop*, as they have come to be defined in the construction industry, regarding steel-to-steel connections. The steel fabricator's role is a complex and shifting one. It can involve *design* as well as *development* responsibilities. Simply put, a steel fabricator *designs* a connection if such work requires the steel fabricator to use “engineering judgment” to calculate loads and stresses. Steel fabricators *develop* connections by simply following the structural engineer's instructions and by consulting the American Institute of Steel Construction (AISC) *Manual of Steel Construction*, limiting them to “certain set guidelines for the supply of necessary components, materials, and procedures, [without] any exercise of ‘engineering judgment’ such as calculation of loads” (Deutsch 1985).

The structural engineer is responsible for defining the precise role the steel fabricator will play in the design or development of a connection. The structural engineer must communicate exact instructions to the fabricator through the structural design drawings. These instructions depend, in turn, on a clear understanding of the type of connection the drawing depicts—*simple*, *complex*, or *special*—and the nature of the design—whether it is *complete* or *incomplete*. Clarification of these terms is essential to accurately communicate the extent of a steel fabricator's design responsibilities. Misunder-

standing about any of these matters can have serious consequences and, indeed, places a heavy obligation on team members for communicating exact intentions.

Definition of Terms

There are three basic types of steel-to-steel connections: (1) Simple; (2) complex; and (3) special. A *simple* connection (or "book" connection) has no unusual or extreme loads acting on it and may be properly designed by looking it up in the *AISC Manual* and following the directions there. A *complex* connection, on the other hand, is one that has extreme or unusual loads acting upon its members, or one that must bear loads transferred to it from several directions. A complex connection can be designed only if proper load information is available.

Design of a *special* connection falls somewhere between simple and complex connections. A simple connection becomes a special connection if concentrated loads are placed on it—in that case the *AISC Manual* does not provide all of the information needed to properly design it. In addition, lack of redundancy (inability to transfer loads to other members or connections, in the event that one member or connection in a system fails) combined with concentrated loads and eccentricities classifies a connection as special.

The box beam-hanger rod connection was in fact a nonstandard, *special* connection. A concentrated load was applied to the end of the box beam, creating a structural eccentricity. Because of this concentrated load, the connection could not be adequately designed by relying solely on the uniform load tables for simple beam connections that appear in the *AISC Manual*. In addition, the box beam-hanger rod connection was considered *special* because of its nonredundancy—the failure of any of the fourth floor connections would have led to the collapse of the walkway system. The use of bearing plates and stiffeners would have made the connection *simple* by removing the eccentricity of the concentrated load, thus allowing the connection to be designed using the *AISC Manual*.

Two other terms are important in the overall process of identifying the steel fabricator's role in connection design or development. These refer to the nature of the connection design that appears on the structural engineer's detail drawings. A connection design is *complete* if it depicts a complete arrangement of members, calls out specific types of materials, such as grade of steel, weld type, etc.—or leaves selection of materials to the fabricator, based on the engineer's general notes and the *AISC Manual*—and does not indicate any load information. An *incomplete* connection design depicts only a rough arrangement of members but includes instructions about how to design the connection—and must include pertinent information about loads, stresses, eccentricities, etc.

Whenever a detail drawing presents a complex or special connection, the connection design must be either complete or incomplete. The only time the structural engineer may properly fail to provide connection design of any sort is in the case of a simple connection, which depicts only an arrangement of members. In this instance, the fabricator/detailer consults the *AISC Manual* and then designs the connection, using standard load information.

Communicating Design Responsibility

Although it has become common practice in the structural engineering

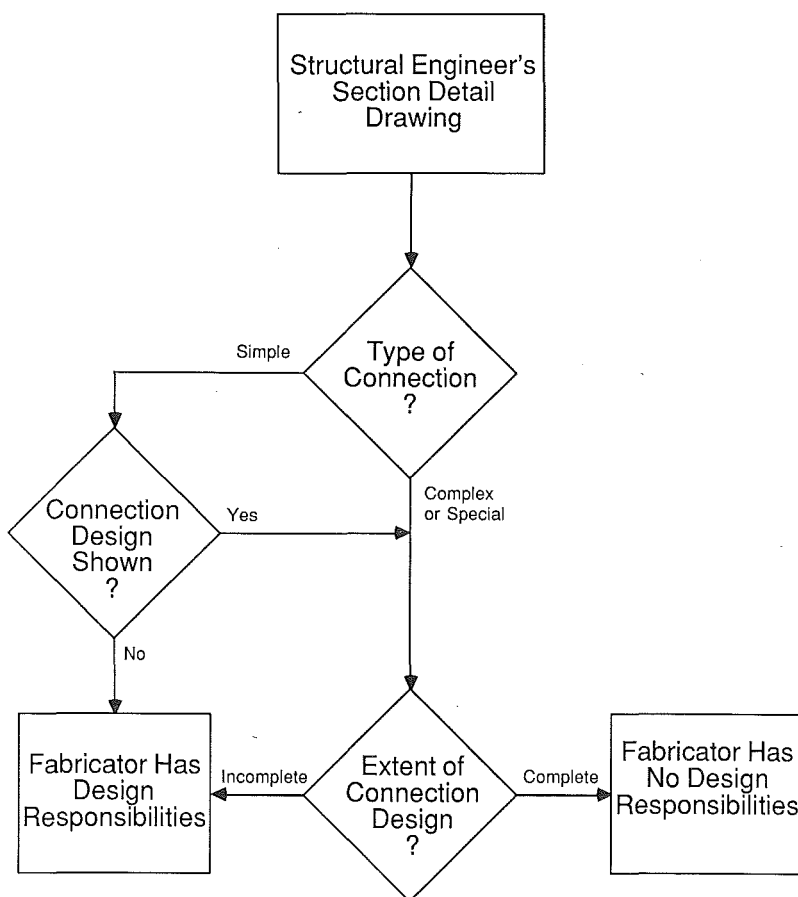


FIG. 3. Communication of Design Responsibility from Structural Engineer to Steel Fabricator

profession for steel fabricators to assume some design responsibilities, they cannot do so without explicit direction from the structural engineer. Steel fabricators do not routinely assume responsibility for designing steel-to-steel connections. Rather, “. . . it is only upon a proper communication of the engineer's desire or acquiescence that the fabricator perform a function that any obligation of design arises” (Deutsch 1985).

The structural engineer chooses who shall design what type of connections and communicates that choice through the structural detail drawings submitted to the steel fabricator and upon which the fabricator (or steel detailer) bases the shop drawings used in actual construction. The structural engineer may design some or all of the connections on the structural drawings or may indicate that the fabricator is to design some or all of them.

Fig. 3 illustrates in flow chart form the process the steel fabricator goes through to determine what role to play in connection design. The fabricator's

interpretation of the structural drawings depends heavily on how clearly the structural engineer has communicated his or her intent.

If the structural engineer indicates that a complex or special connection is called for and wishes to indicate that it has already been designed, the structural drawings should clearly show a *complete* design of the connection. Seeing the complete design, the fabricator knows to simply copy it on to the shop drawings and understands that design work is not required. The fabricator's role is clearly identified as *developer*.

However, if the structural engineer wants the steel fabricator to *design* a connection, the structural drawings will show an *incomplete* connection design—one that includes only some callouts, or none at all, and omits some or all of the pieces required to make the connection—but *does* show all relevant information about loads, stresses, and eccentricities. The fabricator designs a *simple* connection by looking at the engineer's general notes and consulting the AISC *Manual*. In the case of a *complex* or *special* connection, however, the fabricator designs the connection using the load information the structural engineer has included on the structural drawing, along with the engineer's general notes and the AISC *Manual*.

The steel fabricator's role (as designer or developer) is determined solely by the structural engineer's communication of intent. The fabricator who is to simply *develop* a connection is not required to use engineering "judgment," is limited to the guidelines set by the structural engineer, and develops the connection by following the materials selection standards in the AISC *Manual*. The fabricator who is to *design* a connection must use engineering "judgment" to calculate loads and to assemble parts sufficient to carry such loads. The fabricator designs the connection based on acceptable engineering practice and on information included in the structural drawings, the engineer's general notes, and the AISC *Manual*.

COMMUNICATION BREAKDOWN

Throughout the design and construction of the box beam-hanger rod connections in the Hyatt Regency walkways, the structural engineer assumed that the steel fabricator and steel detailer were also doing *design* work. The fabricator and detailer, however, interpreted the structural engineer's drawings to mean that they were limited only to *development* responsibilities. This essential confusion resulted from inadequate communication on the part of the structural engineer, whose design drawings did *not* clearly assign design responsibility to the steel fabricator. Table 1 illustrates the flow of information about the box beam-hanger rod connections from the engineer's initial sketches to the fabricator's shop drawing.

Preliminary Sketches

The structural engineer initially prepared a preliminary sketch of the general design of the Hyatt walkways. This sketch showed design criteria, including calculations of preliminary design loads. He later created a preliminary sketch of the more detailed box beam-hanger rod connection on which he noted a 60-kip/sq in. yield strength for the hanger rods and a 22-kip design load for the box beam connections. This sketch also showed a symbol for a weld connection between the box beam and the longitudinal I-beam,

TABLE 1. Flow of Information in Hyatt Regency Walkway Design Drawings

Drawing (1)	Prepared by (2)	Shows (3)
Preliminary design drawing of walkway	Structural engineer	Design criteria, including calculation of design loads
Preliminary sketch of box beam-hanger rod connection	Structural engineer	• 60-ksi notation for yield strength of hanger rod connections • 22-kip design load for box beam-hanger rod connections • Weld symbol for weld between box beam and longitudinal I-beam and "full development" notation
Final section detail drawing S405.1, sections 10 and 11, of box beam-hanger rod connection	Structural engineer	• Weld symbol and "full development" notation for weld between box beam and I-beam • Callout for 1-1/4-in. round steel rods • Callout for nut and washer <i>Does Not Show</i> • Specific directions for fabricator to design connections; • 60-ksi notation for rods • 22-kip notation for box beam-hanger rod connections • Callouts for stiffeners or bearing plates • Callouts for size or type of weld between 8-in. C channels forming box beam • Callout for grade of steel for hanger rods • Callout for size and type of nut and washer
Fabricator's shop drawing 30	Steel fabricator/detailer	Only a <i>copy</i> of the connection depicted on S405.1 at sections 10 and 11, with these additions, based on structural engineer's general notes and AISC <i>Manual</i>: • Selection of heavy hex nut and washer for threaded end of hanger rod • Callout for ASTM-A-36 steel for hanger rods • Callout for partial penetration weld for box beam

along with the notation "full development." This weld information, however, did not properly belong on the section detail drawing of the box beam-hanger rod connection.

It is important to note that the preliminary sketches *did* contain essential load information that would have alerted the fabricator to his responsibility for connection *design*. However, this crucial information never found its way to the final section detail drawing that the structural engineer passed on to the steel fabricator. The fact that essential load information was missing from the detail drawing while irrelevant weld information was included indicates that the structural engineer failed to carefully review the detail drawings before sending them on.

Final Section Detail Drawing S405.1

The structural engineer then created the final section detail drawing (Structural Drawing S405.1) which showed at sections 10 and 11 a box beam-hanger rod connection that was typical of all such connections in the walkways. *In transferring information from the preliminary sketch to the final section detail drawing, the structural engineer omitted key load information that would have clarified his intent* that the steel fabricator take design responsibility for the box beam-hanger rod connections. Because the essential load information was now absent, the steel fabricator properly assumed the role of developer only, unaware of the structural engineer's original intention that he actually design the connection.

Drawing S405.1, sections 10 and 11, *did not* contain any specifications directing the fabricator to design the box beam-hanger rod connections. In addition, it *did not* include the earlier 60-ksi yield strength notation for the steel rods or the 22-kip notation for the design load of the box beams. And, although the drawings included a weld symbol and the "full development" notation, these referred to the connection between the box beam and the longitudinal I-beam and *should not* have been present on the detail drawings for the box beam-hanger rod connection. The drawings *did not* indicate the type of weld to be used in creating the box beam. Similarly, although the drawings included callouts for 1-1/4-in. round steel rods and a nut and washer, they *did not* contain any notations about the grade of steel nor the type of nut and washer to be used. Finally, the drawings *did not* call out bearing plates or stiffeners or instruct the fabricator to analyze the connection for the use of bearing plates or stiffeners. The detailer interpreted what he saw at sections 10 and 11 to be a "completely designed" connection. He correctly assumed the role of developer only and, in that role, created Shop Drawing 30.

Shop Drawing 30

To create his shop drawing, the detailer simply *copied* the connection depicted on drawing S405.1, sections 10 and 11. He *did not know* he was to design the box beam-hanger rod connection and did not attempt to do so. He merely developed the design, based on "fabricator's judgment," by designating the standard pieces that were either: (1) Indicated as necessary on the structural drawing; (2) prescribed by the *AISC Manual*; or (3) left to his own discretion. Believing that S405.1, sections 10 and 11, showed a completely designed connection, the fabricator merely selected a standard grade of steel for the hanger rods, a nut and washer for the rod's threaded end, and a weld to hold the two 8-in. C channels together.

Later analysis determined that the use of stiffeners or bearing plates would have made the box beam comply with the Kansas City Building Code. However, Drawing S405.1 does not call out stiffeners or bearing plates in conjunction with the box beam-hanger rod connection, so the fabricator did not select them. If stiffeners or bearing plates were to have been used, the structural engineer should have so indicated on Drawing S405.1, or in some other way instructed the fabricator to consider using them. Because the structural drawing did not include loads or other related design information, the fabricator assumed that he was required only to choose a standard nut and washer for the 1-1/4-in. round steel rod.

The fabricator chose a minimum "assembly weld" to hold the two chan-

nels of the box beam together. If a particular type of weld were necessary to make the box beam capable of carrying the loads exerted on it, the structural engineer should have selected the weld and called it out on Drawing S405.1. Or he should have made a notation on the structural drawing or used some other mode of direct communication to request that the fabricator design the box beam. In the absence of other information, the fabricator interpreted the design to require a minimum assembly weld and called out a partial penetration weld for aligning the two channels of the box beam.

Finally, the fabricator selected a regular grade of steel (ASTM-A-36) for the hanger rods—which did not meet the Kansas City Building Code requirements. A higher grade of steel for the rods would have met the code. However, because the structural engineer's General Notes specifically stated that "all structural steel shall conform to ASTM-A-36, except as noted" (Deutsch 1985), and because Drawing S405.1, sections 10 and 11, neither called for the use of high strength steel in the hanger rods nor indicated the yield strength of the rods, the fabricator was merely complying with the structural engineer's instructions when he called for ASTM-A-36 steel to be used for the rods.

Summary of Evidence from Design Drawings

In the hearings before the Deutsch (1985) Commission, the structural engineers argued that omission of *any* information on the structural drawings should alert the fabricator to *design* responsibility. However, that argument does not conform to the general "custom and practice" that has developed in structural engineering, governing assignment of design responsibility. It applies *only*, as we have said, in cases of *simple* connection.

If, as they asserted, the structural engineers depict only, and in every case, "an arrangement of members" and omit all load information or materials designation, then it is left to the fabricator to determine if the connection is *simple*, *complex*, or *special*. But that is not the responsibility of the fabricator—determination of connection type falls clearly within the parameters of the engineer's responsibilities. Also, even if the fabricator correctly determines the type of connection (simple, complex, or special), he or she may still incorrectly identify the extent (complete or incomplete) of the connection design. In that case, as in the Hyatt case, the fabricator may mistakenly assume that the connection design is *complete*. Leaving all such critical determinations up to the fabricator runs the risk of misinterpretation, as the chain of miscommunication in the Hyatt case tragically illustrates.

On these issues the Deutsch (1985) Commission was unequivocally clear: relying on a subordinate to detect "unspoken intent and perform the omitted engineering service" is not permissible. With respect to the obligation for clear communication, the structural engineer "bears the burden of communicating his intent to the contractor and *assumes the risk* of confusion or noncommunication." Finally, in a particularly telling commentary on responsibility, the Commission made its position clear: ". . . the burden of and responsibility for clear communication lies with the engineer who assumes the risk of ambiguity in his design drawings."

RELATED COMMUNICATION ISSUES

Although we have concentrated in this analysis on the communication relationship between engineer and fabricator, there were other contributing fac-

tors related to communication that also played a part in the events that led to the Hyatt Regency accident. We briefly mention them here to illustrate that: (1) The communication structure of a project as large in scope as the Hyatt Regency Project is indeed complex; and (2) many factors have a significant bearing on the effectiveness of communication.

Undocumented Telephone Exchanges

One significant factor contributing to the walkway collapse was a change in the box beam-hanger rod arrangement during construction that virtually doubled the load on the fourth floor connections. The original framing plans called for a continuous rod arrangement, to extend from the ceiling through a single hole in the fourth floor box beam down to the second floor walkway. Investigators determined that, even though the load capacity of such an arrangement would not have met the Building Code requirements, it would have been able to resist the loads acting at the time of the collapse and would have minimized the possibilities of collapse (Pfrang and Marshall 1982).

The decision to change the hanger rod design was never documented through written or graphic communication. Evidence from the hearings following the tragedy indicated that the approvals for the design change came via a chain of telephone conversations, the contents of which were not verified through confirmation memos or other written reports. Thus, subsequently, there was a serious conflict among the parties involved as to who actually made and approved this design change.

For our purposes, who was or was not responsible for approving the change is not a primary issue. The confusion resulting from undocumented telephone approvals in the Hyatt case demonstrates the clear necessity of keeping track of important decisions made over the telephone. One lesson this teaches is that all professionals should keep written records of critical telephone conversations, to insure that instructions (both given and received) are clear and that the interests of safety are served, and to protect against legal liability in cases where something goes wrong.

According to Hensey (1987), engineers should use written communication for, among other things, "confirming [oral] communications or decisions. The only effective way to be sure of receiving the complete communication," Hensey suggests, "is to summarize your understanding of it and see if there are any corrections."

Review Systems

In accordance with standard practice in engineering, the Hyatt shop drawings of the crucial box beam-hanger rod connection were returned to the structural engineer for review and approval. Standard contract documents of the Engineers Joint Council require engineers to review shop drawings only for compliance with the "design concept." In addition, engineers are reluctant (at least they were in 1979) to use the word *approved* on their shop drawing stamp, apparently because insurance carriers have advised them not to. The structural engineers in the Hyatt case claimed to have reviewed the drawings for design concept only (even so, they did not stamp the drawings "approved") and therefore had no obligation to review them further. The fact that ultimately the structural engineers were forced to surrender their full insurance policy to settle the case and lost their licenses to practice engineering in the state of Missouri demonstrates that reviewing drawings for

design concept alone does not reduce the structural engineer's liability (Walter 1987).

The review process merits careful attention and provides an opportunity for clarifying communication between the structural engineer and the steel fabricator. Even though structural engineers are not required to design every steel-to-steel connection on a project, they must—at least—review the shop drawings prepared by the steel fabricator, to ensure that the connection designs meet accepted professional standards of engineering workmanship (Deutsch 1985). Limiting review of shop drawings to “conformance with design concept” can lead to dangerous lapses in quality control and does not materially diminish the engineer's liability. In fact, such cursory review practices may increase potential liability—by creating a sense of false security and failing to provide the review necessary to ensure both quality and safety (Walter 1987).

Fast-Track Construction

The Hyatt Project was considered a “fast-track” project. It has become common practice in the construction industry to begin actual construction of a building before the design work is completed, primarily to avoid the effects of rising construction costs during the design and construction periods. Although no clear evidence emerged in the aftermath of the Hyatt tragedy to indicate that fast-tracking contributed directly to the walkway collapse, it may have affected the flow of communication between the structural engineer and the steel fabricator. Whenever speed is essential, there is a tendency to hurry through the design process, to keep up with the construction schedule. It is possible that a structural engineer may rush or overlook critical reviews because the construction team is ready to proceed, pending the engineer's review and approval of shop drawings.

According to a recent analysis of structural problems with various constructed facilities of a large industrial firm, one of the causes identified (in addition to communication/coordination failures) was the time pressure of fast-tracking (Hensey 1987). The example of the Hyatt Regency Project should serve to emphasize the importance of accurate communication and completeness of review, especially in fast-track construction—even if such review delays the project for a brief time.

Fee Arrangements

Understanding that design team members are paid on a fee basis while construction team members are paid on a competitive bid basis illustrates another point of tension that can affect communication. Such payment differentials certainly create different perspectives about the work and how to accomplish it. After the Hyatt Regency collapse, an informal poll of engineers was taken about their practices for designing and reviewing shop drawings of structural connections. Their responses demonstrated that the fee provision bears a very direct relationship to quality control. When asked why they did not completely check connection designs on shop drawings, many said they were not getting paid enough to do so. And when asked why they did not design the connections themselves, again many replied “the fee isn't big enough” (Walter 1987).

Whether the fee issue contributed directly to the problems of review and approval that emerged in the Hyatt Project is difficult to determine. The fact,

however, that many engineers seem to tailor their work to the size of the fee suggests that it might have played a role in the communication failures that occurred in the Hyatt walkway design process. Any future solutions to the "fee problem" depend on engineers first understanding the part communication and review play—independent of fee—in the quality of connection designs *and* in the scope of their liability.

Professional Relationships

The balance of responsibility between engineer and fabricator is not always clear-cut. Where ambiguity about certain responsibilities arises, "encroachment into domain" problems (Deutsch 1985) may result. More simply stated, clarity of communication is essential in those areas where the potential for misunderstanding is high, especially due to domain self-interests.

It is possible that the structural engineer's higher "rank" in the team arrangement of the Hyatt Project caused the steel detailer not to question the integrity of the design that appeared at sections 10 and 11 on Structural Detail Drawing S405.1. The detailer did ask about apparent discrepancies in the arrangement of hanger rods, but that was simply a matter of clarifying a detail of the structural engineer's drawing. If he had any broader questions about the efficacy of the design, he did not bring them up.

One certainly cannot fault the detailer for not asking questions about the design's integrity. However, it seems likely that somewhere along the line someone could have questioned the use of a standard design for a connection that was obviously nonstandard. We can speculate that the questions were never asked, possibly because of hesitance to step over the line into someone else's professional domain.

On the other hand, the structural engineer argued in the post-accident hearings that his failure to review Shop Drawing 30 was based on his confidence in the steel fabricators he was working with. Of course, if he had intended for the fabricator to *design* the box beam-hanger rods connections, he should have carefully reviewed that connection design on Shop Drawing 30. Had he done so, he would have seen that the box beam-hanger rod connection was inadequate within the design specifications of the Kansas City Building Code (Deutsch 1985).

The engineer claimed that he thought it was unnecessary to review the design because he had worked with the steel fabricator on other projects previously and had a great deal of professional respect for the fabricator's ability to exercise engineering judgment in designing a proper connection. Seeing his relationship with the fabricator as "one engineer to another," the structural engineer let the shop drawing go through without review, based on professional "trust." Of course, the structural engineer's personal opinion of the fabricator's engineering abilities in no way diminishes the structural engineer's responsibility for actual connection design.

CONCLUSIONS

Hindsight is valuable in reviewing the Hyatt Regency case only to the extent that such hindsight leads to foresight within the civil engineering profession. Engineers bear some of the most complex communication responsibilities imaginable. Yet, the Hyatt case demonstrates that sometimes their professional attention to communication skill is, at best, marginal, and,

at worst, grossly negligent. While we do not contend that the communication failures that occurred in the design of the Hyatt Regency walkways are typical of the entire profession, we do believe this case points up the need for ongoing education and attention to the kinds of complicated communication situations that frequently arise in structural engineering projects.

Several lessons seem to emerge from the Hyatt Regency disaster:

1. It underscores the risk factor in poorly organized communications systems and illustrates the need for uniform understanding of the means by which specific responsibilities are communicated from one member of a construction project team to another.

2. It helps identify areas of overlapping responsibility and indicates the importance of developing procedures for assigning tasks and reviewing work on several levels and at various stages in project design.

3. It draws attention to the need for better role definition and unambiguous understanding of technical responsibility within the engineering professions.

4. It sharply focuses on the essential ethical and professional responsibilities of structural engineers as they assume overall responsibility for their designs.

An accident like the walkway collapse at the Hyatt Regency is meaningful, only to the extent that other engineers learn something lasting from it. Whatever lessons it teaches must add to the general knowledge of the profession and guarantee that no accident like it ever happens again.

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