Ethics Across the Curriculum

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Abstract

Engineering ethics is an extremely important part of the education of Civil, Environmental and Architectural Engineers. Although personal ethics are the foundation for engineering ethics, personal ethics are developed prior to the time students arrive at the University and, for a variety of reasons, are not discussed as part of engineering ethics. Engineering ethics focuses on academic ethics, professional ethics, and international ethics. Engineering ethics are introduced at the freshman level. The focus throughout the freshman, sophomore, and junior years is on the academic ethics from the CEAE Department's viewpoint, regardless of what the students' personal ethics may have been prior to entering the University of Kansas.

During the senior year, professional and international ethics are discussed in all design classes. Because personal ethics are developed from a variety of sources, it seems obvious that professional ethics also must be presented in a variety of design classes so that the students will see that this is a very important aspect of all phases of an engineering career. In each design class, at least one lecture will be devoted to a case study in which the importance of engineering ethics is emphasized. Thus, students will be exposed to engineering ethics in a variety of design courses by a variety of engineering faculty, most of whom are Professional Engineers.

I. Introduction

Ethics has been defined as a body of moral principles or values, dealing with right and wrong and the morality of motives and ends.

Accordingly, it is an issue that individuals must deal with throughout their lives. Growing up, values and moral principles of students were "learned" from parents, teachers, friends, and their own observations of issues and behavior in our society. As students enter an engineering school, they come with a diverse set of ethics obtained from a variety of sources. Thus, we should not expect students to learn engineering ethics as applicable to academic, professional, and international issues from a single source, e.g. one course or one professor, no matter how good the course or professor may be. Students should be exposed to engineering ethics in many classes by many faculty members if they are to internalize engineering ethics as a strong foundation for their entire professional career.

Civil Engineers are the creators of the vast public and private infrastructure systems that enable us to transport people, water, raw materials, manufactured goods, and energy to wherever they are needed. Environmental engineers deal with waste products of all kinds to help maintain public health and our environment. Architectural engineers work with architects to create safe, economical buildings of all types necessary for human housing, commerce, government, and industry needs. Civil, Environmental and Architectural Engineers plan, design, build, and maintain the roads, bridges, buildings, water-distribution systems, dams, power-transmission systems, and environmental systems, that are critical to the survival of the human race and vital ecological systems. Accordingly, in all these activities, it is essential that engineers act in an ethical manner to insure the safety of the public.

II. General Ethics Coverage

A profession is defined as a specialized activity that requires a large body of theory and knowledge, specific skills, training, mental capacity, and the ability to deal with complex situations for the service of others. People who do these activities are referred to as professionals. Examples of professionals include engineers, medical doctors, lawyers, veterinarians, and ministers.

The mission of the Civil, Environmental, and Architectural Engineering (CEAE) Department at the University of Kansas is to provide our students with an outstanding engineering education so that they are able to help sustain our existing infrastructure system and to create new infrastructure systems. A critical part of that education is a clear understanding of the importance of always acting in an ethical manner.

Recognizing that students come to our Department with a variety of ethical backgrounds, we need to continuously emphasize engineering ethics in three broad areas:

1. Academic:

   The importance of doing ones' own work, not cheating, and performing to the best of ones' ability. This is the foundation for professional ethics. The importance of academic ethics and the consequences of not developing individual academic ethics is emphasized in each CEAE course. In each course, the focus is on developing personal responsibility as a basis for a life-long professional career, not just to prevent cheating. Prevention of cheating is a by-product.
2. Professional:

   Many professional engineering issues may be legal, but are not necessarily either ethical or good engineering. Acting in an ethical manner in all areas of a professional career is essential if professional engineers are to maintain the trust and confidence of the public.
3. International:

   In an international economy, engineers will be dealing with cultures that may include different procedures or rules than are applicable to our country.

> Engineers must, therefore, be well-grounded in professional ethics to interact properly in international activities. ASCE is proposing changes to their Code of Ethics to include international ethics.

III. ASCE Code Of Ethics

The American Society of Civil Engineers (ASCE) defines a profession as “The pursuit of a learned art in the spirit of public service.” ASCE expands the definition as follows:

> “A profession is a calling in which special knowledge and skill are used in a distinctly intellectual plane in the service of mankind, in which the successful expression of creative ability and application of professional knowledge are the primary rewards. There is implied the application of the highest standards of excellence in the educational fields prerequisite to the calling, in the performance of services, and in the ethical conduct of its members. Also implied is the conscious recognition of the profession’s obligation to society to advance its standards and to prescribe the conduct of its members.”

The American Association of Engineering Societies (AAES) has listed the attributes of a profession as follows:

1. “It must satisfy an indispensable and beneficial social need.
2. Its work must require the exercise of discretion and judgment and not be subject to standardization.
3. It is a type of activity conducted upon a high intellectual plane.
    a. Its knowledge and skills are not common possessions of the general public; they are the results of tested research and experience and are acquired through a special discipline of education and practice.
    b. Engineering requires a body of distinctive knowledge (science) and art (skill).
4. It must have group consciousness for the promotion of technical knowledge and professional ideals and for rendering social services.
5. It should have legal status and must require well-formulated standards of admission.”

Furthermore, AAES states that those who claim to practice a profession must:

1. “Have a service motive, sharing their advances in knowledge, guarding their professional integrity and ideals, and rendering gratuitous public service in addition to that engaged by clients.
2. Recognize their obligations to society and to other practitioners by living up to established and accepted codes of conduct.
3. Assume relations of confidence and accept individual responsibility.
4. Be members of professional groups, and carry their part of the responsibility of advancing professional knowledge, ideals, and practice.”

A profession must, as a group, promote the dissemination of knowledge learned through the practice of the profession. True professionals will be involved in the education process, not only in providing information to one seeking entrance into the profession, but also to the continuing education of people already within the professions.

All professions have built-in regulative codes that mandate ethical behavior on the part of its members. ASCE's Code of Ethics consists of four principles which are described as follows:

"Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

1. Using their knowledge and skill for the enhancement of human welfare
2. Being honest and impartial and serving with fidelity the public, their employees and clients
3. Striving to increase the competence and prestige of the engineering profession
4. Supporting the professional and technical societies of their disciplines"

These four principles are followed by the Seven Canons that deal with specific actions by professionals. These are:

1. "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
2. Engineers shall perform services only in areas of their competence.
3. Engineers shall issue public statements only in an objective and truthful manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession.
7. Engineers shall continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision."

Engineers shall uphold and advance the integrity, honor, and dignity of the engineering profession and shall promote the most effective use of financial resources through honest and impartial service and fidelity to the public, employers, associates, and clients.

1. Engineers shall be scrupulously honest in their control and spending of monies intended for the projects on which they work.
2. Engineers shall adopt a zero-tolerance approach to bribery, fraud, deception, and corruption in any design or construction work in which they are engaged.
3. Engineers should be especially vigilant in countries in which the payment of gratuities and/or bribery are institutionalized practices.
4. Engineers must include certifications in all contract documents specifying zero

tolerance of bribery, extortion, or other fraud during the execution of the project.

5. Engineers must strive for complete transparency in the engagement of agents who facilitate projects and other work, to include the reporting of purposes, names, addresses, and gratuities and commissions paid for all agents in their employ.
6. Engineers shall be duty bound by the ASCE bylaws to report any observed violations of the Society's Code of Ethics.

In essence, a professional must use his or her special position of authority for the benefit of his or her client, and for the good of the public, rather than for personal gain. Professionals deal with clients and the general public, who place their trust in the integrity of the professionals, rather than customers, who can shop for the type of goods or services they want.

IV. CEAE Ethics Coverage

Development of a strong engineering ethics foundation for our students should occur over the entire engineering curriculum. Coverage occurs in the following courses:

1. CE 191, Introduction to Civil Engineering
2. ARCE 103, Introduction to Architectural Engineering
3. Continued reference to engineering ethics, and the ASCE Code of Ethics in all other freshman, sophomore and junior courses. This coverage consists primarily of academic ethics, as the basis of professional ethics are introduced.
4. CE 499, Professional Issues
5. Specific lectures in all senior design courses using actual case studies to emphasize the importance of professional engineering ethics in all areas of civil, environmental, and architectural engineering. Because all seniors are required to take at least five design courses, engineering ethics will be covered from a broad spectrum of areas of CEAE.

Professional ethics will be emphasized using case studies developed for the following specific design courses.

1. CE 562 – Structural Design I – Steel
2. CE 563 – Structural Design II – Concrete
3. CE 552 – Water Resources Engineering Design
4. CE 576 – Municipal Water Supply and Wastewater Treatment
5. CMGT 400 – Construction Administration
6. CE 580 – Transportation Planning and Management
7. CE 582 – Highway Engineering
8. CE 588 – Foundation Engineering
9. CE 573 – Biological Principles of Environmental Engineering
10. CE 574 – Design of Air Pollution Control Systems
11. ARCE 680 – Architectural Engineering Design I
12. ARCE 681 – Architectural Engineering Design II

In each of these design courses, a case study is developed that shows the importance of engineering ethics to that particular subject. This process should emphasize the importance of engineering ethics in all areas of civil, environmental, and architectural engineering by a wide, diverse group of faculty, most of whom are Professional Engineers.

A representative case study for CE 562, Structural Steel Design, is presented in the Appendix. Other case studies will be added as developed.

V. Summary

In summary, engineering ethics is an important and vital part of engineering education. Because of that fact, engineering ethics is defined, presented, and emphasized in all required courses across the civil, environmental, and architectural curriculum by all CEAE faculty members, most of whom are Professional Engineers. To not emphasize the importance of engineering ethics is unfair to our students, and unethical as well.

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Appendix – CE 562

Steel Design

Collapse of the Kansas City Hyatt Regency

In 1981, a suspended walkway collapsed in the Kansas City Hyatt Regency Hotel, killing 114 people and injuring over 200 people, Figs A-1 and A-2. A Missouri state judge found the structural engineers guilty of gross negligence, misconduct, and unprofessional conduct. As a result of that failure, the American Society of Civil Engineers established a policy of holding structural engineers responsible for all aspects of structural safety in their building designs.

Although the judge's rulings indicated far more serious behavior than just unethical, had the ASCE Code of Ethics been closely adhered to, this tragedy might have been prevented. Specifically, expert testimony claimed that even the original box beam design fell short of minimum safety standards. The box beam design consisted of two channels placed together at their tips rather than back to back as is normally done, Fig A-3. In both configurations, the moment of inertia (I_{XX}) is the same, thus the theoretical load capacity is the same. However, in the normal case, the load is transferred to the supporting rod through the backs of the channels. This detail is stronger because the load is transferred through the stiffest portion of the channels. In addition, had a plate approximately 4-inches square been used instead of a much smaller, weaker, round washer, the load capacity of the detail would have been increased even further, Fig A-4. These simple changes would have resulted in a much stronger connection, which probably would not have failed.

The channels were placed tip to tip so that longitudinal beams could be connected to the channels at their backs rather than at the tips, Fig A-5. This is poor detailing from a structural viewpoint because the connecting rod can be pulled easily through the channels, Fig A-6. It may not be unethical behavior, but clearly the structural engineer must "hold paramount the safety, health and welfare of the public in the performance of their professional duties." Thus, the basic design clearly was not the best.

What led to the ruling of the gross negligence, misconduct, and unprofessional conduct, however, was the fact that the original (poor) design was altered during preparation of fabrication drawings so that the load on the small washer and nut was actually doubled, as show in Fig A-7. Regardless of who made the change, the structural engineer has the special knowledge and training to know better. Actually, college sophomores in a statics class would have known better.

Accordingly, the judge found the engineer guilty of "a conscious indifference to his professional duties as the Hyatt project engineer who was primarily responsible for the preparation of design drawings and review of shop drawings for that project." He also concluded that the chief engineer's failure to closely monitor the project managers work betrayed "a conscious indifference to his professional duties as an engineer of record."

The engineer did not intentionally create a poor detail and thus his actions were not illegal or criminal. However, his behavior clearly violated the ASCE Canon of Ethics by not holding "paramount the safety, health, and welfare of the public in the performance of their professional duties." Furthermore, he did not "act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession."

Fortunately, unethical behavior does not always lead to such tragedies. However, the structural engineer has a special responsibility to always act in an ethical manner.

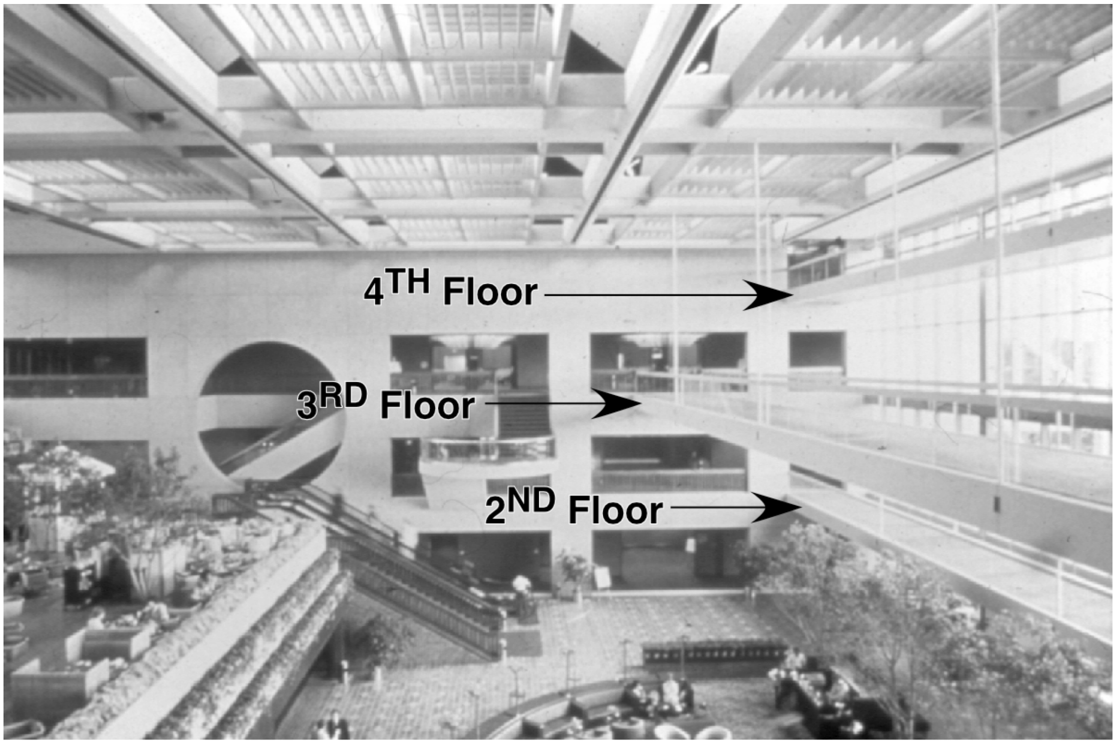

Figure A-1 Hyatt Walkways

Figure A-2 Failed Walkways

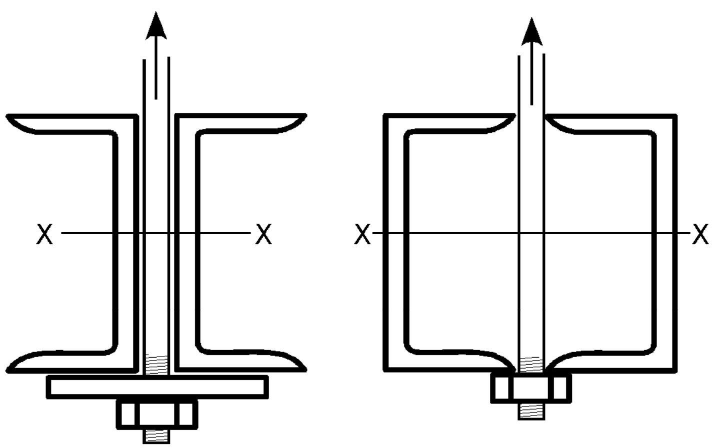

Figure A-3 Ideal and Actual Channel Design

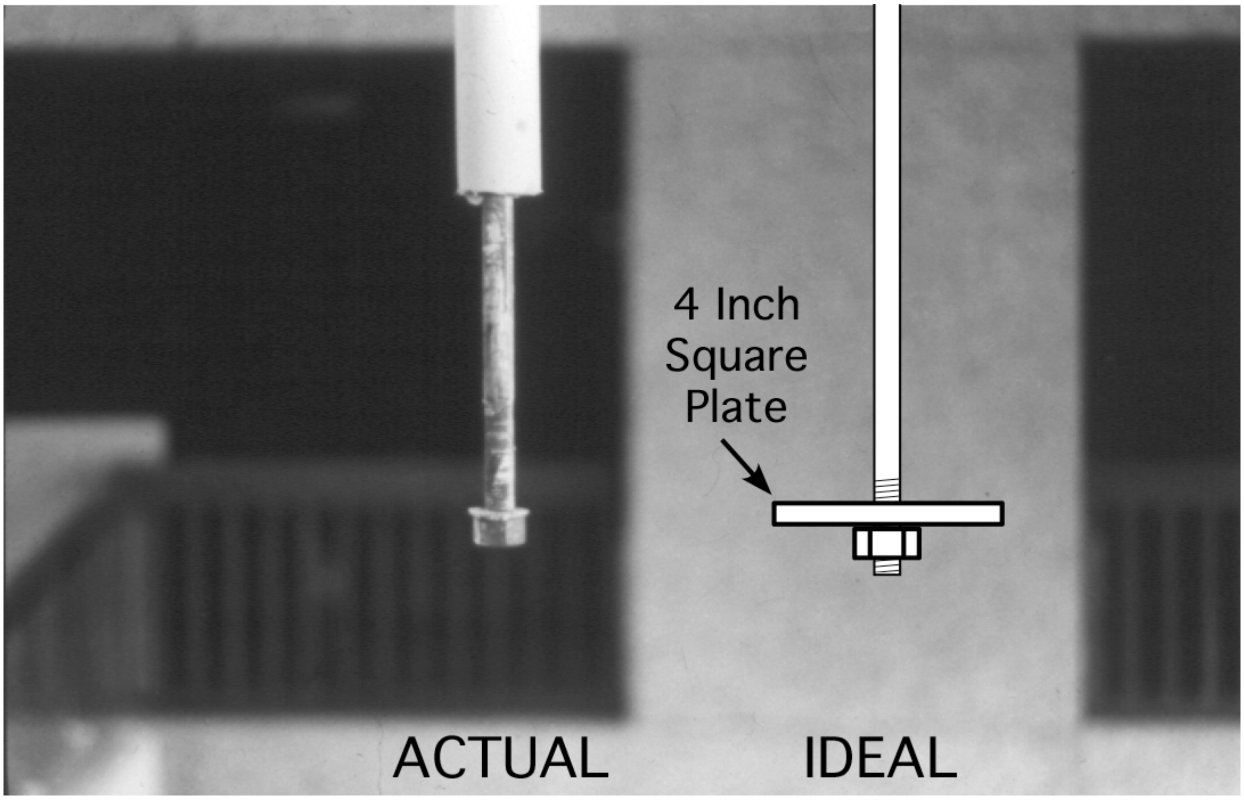

Figure A-4 Actual and Ideal Channel Support

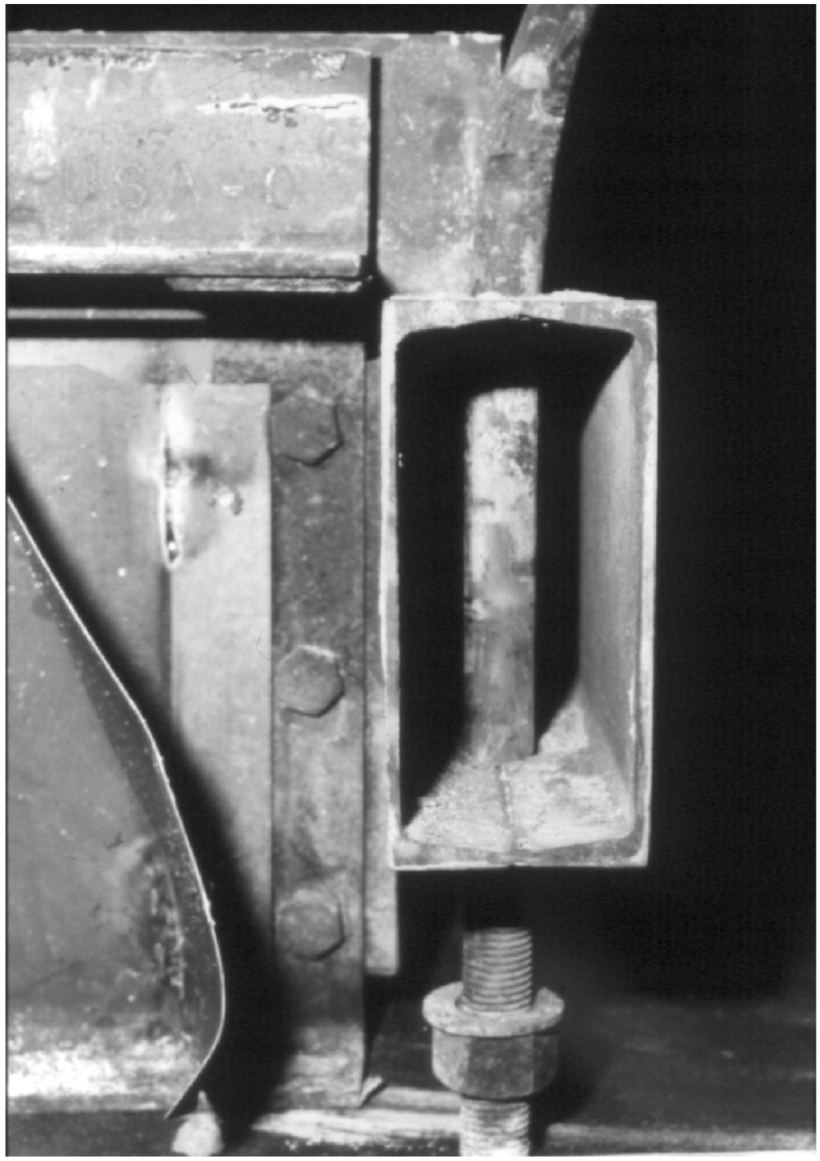

Figure A-5 Beam Connected to Side of Channel

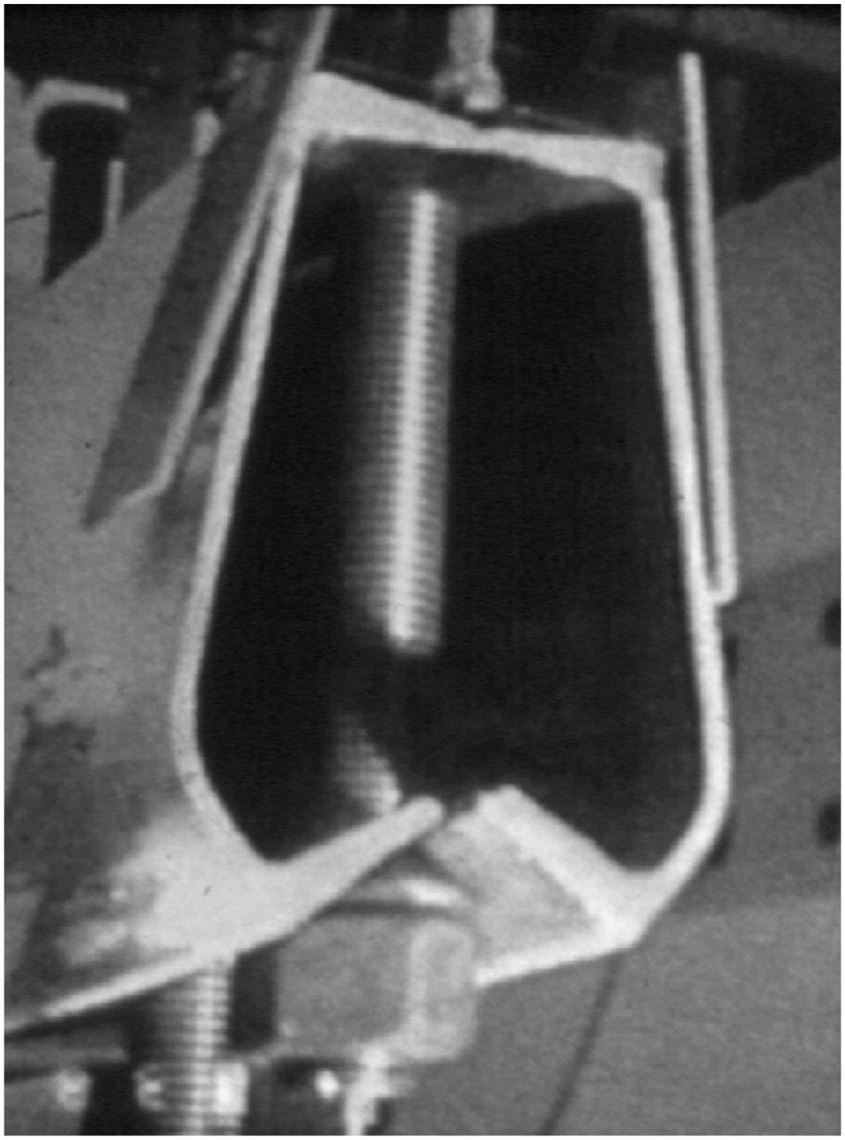

Figure A-6 Connecting Rod Being Pulled Through Channel

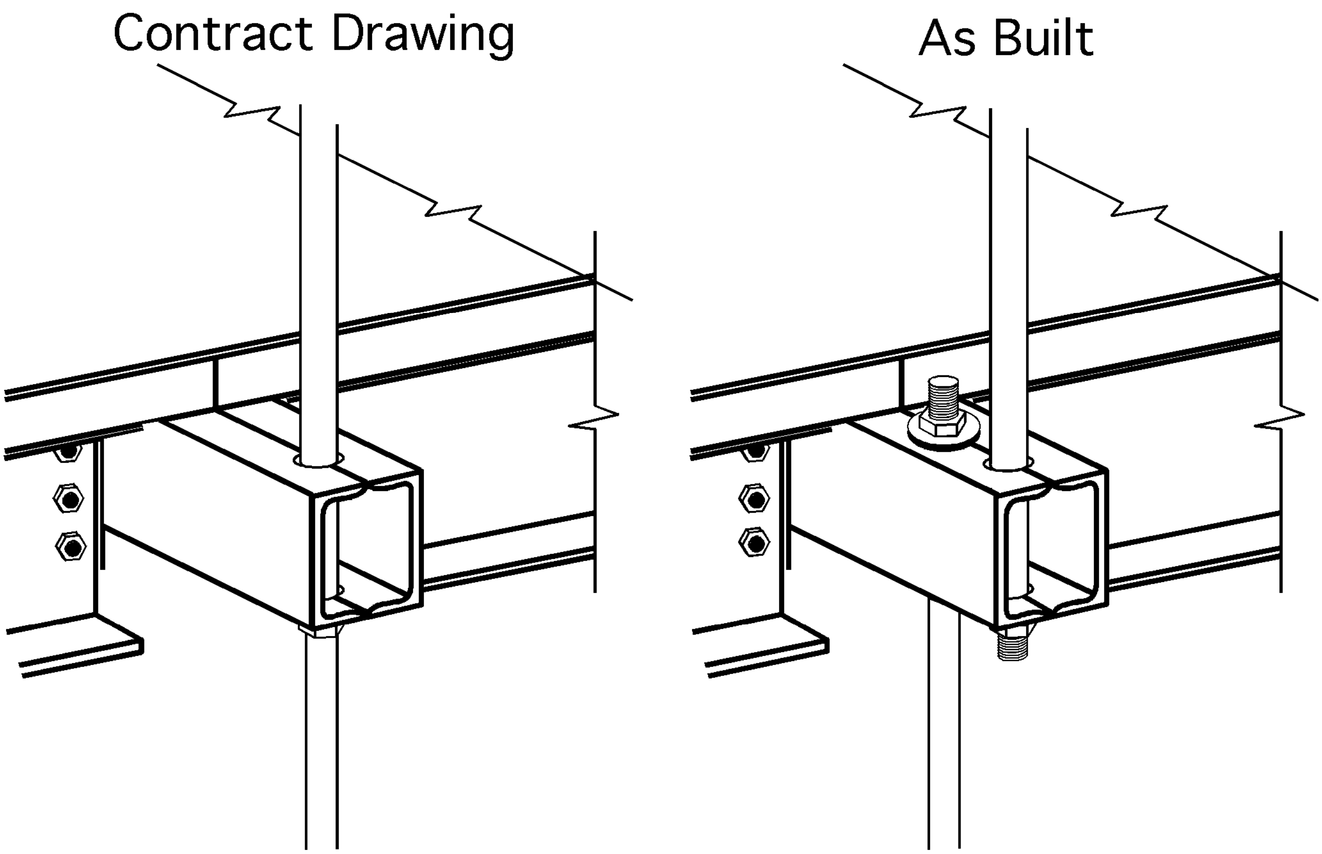

Figure A-7 Design Change