DESIGNING FOR CONSTRUCTION SAFETY – A CONSTRUCTION MANAGEMENT APPROACH

Rizwan U. Farooqui, Ph.D. Scholar, Department of Construction Management
College of Engineering & Computing, Florida International University, 10555 West Flagler St. #2952, Miami, FL 33174, US, A, Tel: (305)-348-3172, Fax: (305)-348-6255, rfaro001@fiu.edu

Syed M. Ahmed, Associate Professor & Graduate Program Director, Associate Editor, ASCE Journal of Construction Engineering & Management (JCEM), Department of Construction Management, College of Engineering & Computing, Florida International University, 10555 West Flagler St. #2952, Miami, FL 33174, USA, Tel: (305)-348-2730, Fax: (305)-348-6255, ahmeds@fiu.edu

Nida Azhar, Lecturer, Department of Civil Engineering, NED University of Engineering and Technology, Karachi, Pakistan, Tel: (92-21)-9261261 ext. 2205, Fax: (92-21)-9261255, nidaazhar_ned@hotmail.com

ABSTRACT

Studies have suggested and confirmed that designers can provide critical input involving construction worker safety. Continued progress is being made in the areas of education and training to better serve all participants in the construction industry, including owners, designers and contractors. Construction management has also become an acceptable and growing profession as it serves to address constructability issues through the sharing of information among all participants in the project. This paper offers a construction management (CM) approach to designing for construction safety by proposing a structured CM approach to information sharing and project collaboration for construction safety. The proposed structured CM approach has been developed based on the findings of a structured survey targeted to design and CM professionals in the construction industry.

Keywords: DFCS, Construction Management, OSHA

1. INTRODUCTION

Designing for construction safety entails addressing the safety of construction workers in the design of the permanent features of a project. The design defines the configuration and components of a facility and thereby influences, to a large extent, how the project will be constructed and the consequent safety hazards (Gambatese, 2000). For example, a decision would have to be made at the site concerning fall protection. This leaves open the possibility of a fall injury if inadequate fall protection is used, workers are not trained, or if fall protection is not used at all. If the designer specifies a 42 inch high parapet wall,

not only does the design comply with the building code (safe for the public), the risk of a fall injury during the lifetime of the structure is eliminated because fall protection would not be required. Many other suggestions for how to design the permanent features of a project to facilitate safety during construction have been documented (Gambatese et al. 1997).

Studies by Whittington et al. (1992) and Suraji et al. (2001) reveal that a significant number of injury accidents originate from conditions upstream of the construction process during planning, scheduling, and design. Though the impact of the design on construction safety is evident and the potential benefits of its implementation are apparent, widespread application of this concept in the United States construction industry is currently lacking (Gambatese et al., 2005). Designing for safety has been proven to be a viable intervention in construction in the United States (Gambatese et al., 2005)

This paper offers a construction management (CM) approach to designing for construction safety by proposing a structured CM approach to information sharing and project collaboration for construction safety. The proposed structured CM approach has been developed based on the findings of a structured survey targeting design and CM professionals in the construction industry.

2. DESIGNING FOR CONSTRUCTION SAFETY – THE NEED

Designers are generally assumed to be responsible for the deign of a building or structure; that meets the local building codes, takes into account accepted engineering practices and is safe for the public. Although typical contract terms do not define designers as being responsible for the safety of construction workers, all designers should feel an ethical obligation to take action to prevent a serious injury to a construction worker if the hazard was imminent and obvious to them. As accepted by all, decisions made by designers affect the cost, quality and duration of a construction project. Similarly, construction safety can also be enhanced greatly by their prompt input. The quality management principle that quality must be "designed in" also applies to safety: safety must be designed into a project.

In addition, studies have shown that design professionals can have a significant influence on construction safety; 22% of 226 injuries that occurred from 2000-2002 in Oregon, WA and CA were linked with the design, 42% of 224 fatalities in the U.S. between 1990-2003 were linked with the design (Behm, "Linking Construction Fatalities to the Design for Construction Safety Concept", 2005). In Europe, a 1991 study concluded that 60% of the fatal accidents resulted from decisions made before site work began (European Foundation for the Improvement of Living and Working Conditions). These statistics clearly suggest that design professionals can play their part in construction safety by incorporating design elements that provide safety for construction workers during construction and maintenance projects.

Recognizing the importance of the design to construction safety, the American Society of Civil Engineers (ASCE) states in its policy on construction site safety (Policy Statement Number 350) that engineers shall have responsibility for "recognizing that safety and constructability are important considerations when preparing construction plans and specifications."

Outside the United States, the European Union mandates consideration of safety in the design (CEC 1992). The United Kingdom's Construction (Design and Management) Regulations (HMSO 1994), established to comply with the EU Directive, place a duty on the designer to ensure that every designer should, while preparing or modifying a design which may be used in construction work in Great Britain, avoid foreseeable risks to the health and safety of any person likely to be affected by such construction work; and in so doing should give collective measures priority over individual measures (MacKenzie et al., 2000). Similarly, many other developed countries such as Australia (Bluff, 2003) and South Africa (Republic of South Africa, 2003) have already incorporated responsibilities for designers for construction safety. Lacking a regulatory mandate, as is the case in the United States, implementation of the concept in practice will likely depend on the benefits received from designing for safety compared to the effort and resources necessary for its implementation.

A requirement of incorporating safety into the design stage of a project to enhance construction worker safety has been proposed (Gambatese et al., 2005) as an additional measure in providing better construction worker safety and health and is commonly referred to as designing for construction safety (DFCS). This concept of thinking through the risks associated with various means and methods of construction, as dictated by the design, can produce positive results in both safety related claims and reduced project costs.

3. DESIGNING FOR CONSTRUCTION SAFETY – OSHA REGULATIONS

In a research study conducted by Gambatese, Hinze, and Behm (2005), design suggestions were developed that can ultimately be addressed in the design documents. Contained within the research findings are numerous constructability safety measures that can be undertaken, many of which have been developed from those directly exposed to hazardous construction work. OSHA has language within its regulations that refers to the engineer of record providing designs with construction worker safety in mind. Subparts L through X of the OSHA regulations have been identified as areas where the greatest influence can be placed to incorporate safety design modifications.

Examples of such suggestions are as follows; in Subpart M – Fall Protection 1926.501, Design windowsills to be 42 inches minimum above the floor level. Windowsills at this height will act as guardrails during construction. OSHA Subpart 1926.502 suggests the design of perimeter beams and beams above floor openings to support lifelines (minimum dead load of 5400 pounds.). It also states to design connection points along the beams for

the lifelines. The contract drawings should note which beams are designed to support lifelines, the number of lifelines, and the locations along the beams.

Currently, most of OSHA's construction regulations require engineering controls in Subpart P (Excavation), Subpart L (Scaffolds), and Subpart R (Steel Erection) among others. These are a few areas that if addressed in the design stage can explicitly aid in construction worker safety through the OSHA regulations.

4. DESIGNING FOR CONSTRUCTION SAFETY – LEGAL CONCERNS

The traditional construction industry model has been split into two distinct fields, design and construction. As the industry moved from the master builder system into more specialty fields, definitions were developed in dealing with standards of practice, construction scope and defining areas of risk. Legislative proceedings were undertaken in the late 1980's to introduce bills in support of placing responsibility for safety on the design professional, along with the constructor through the use of a competent person on site to oversee worker safety. DFCS is not attempting to place blame on the designer but rather to bring to the forefront the ethical practice and the value of implementing construction worker safety through design efforts.

Designing for safety relies on the integration of construction process knowledge and the incorporation of proven methods into the design. Architects and engineers are not prepared to address this deficiency and lack proper training and fear exposure to legal proceedings as a result of injuries due to their designs.

Exposure to liability remains the greatest challenge in persuading designers to take on greater responsibility. Courts have found designers liable for the deaths of construction workers based on their prior knowledge of risks associated with different types of construction (Loulakis and Shean, 2005) . Ultimately contract language should reflect that designing for safety was a strong consideration for the project in question; however, safety remains the responsibility of everyone.

The American Institute of Architects rule 2.105 requires that architects take action when an employer or client makes a decision that may adversely affect the safety to the public, but this obligation is restricted to the completed facility. Similarly, the National Society of Professional Engineers clause holds the engineer responsible for the safety, health and welfare of the public in the performance of their professional duties. In summary court decisions have gone both ways and continue to be challenged.

5. DESIGNING FOR CONSTRUCTION SAFETY – A CONSTRUCTION MANAGEMENT APPROACH

Construction management can assure project success under various delivery methods. CM is distinct from both design and construction and well recognized as a specialized

profession. Through the CM model, resources of various disciplines and backgrounds converge to provide construction leadership in the planning, design and construction phases. Due to project delivery constraints; timing, project capitalization, owner experience, and the complex nature of projects, the CM can serve as an agent to the owner and/or consultant in the pre-design and design phases.

Constructors in the CM model can greatly influence and contribute to DFCS through the flow of information as shown in the modified Figure 4. Project knowledge, risk assessment, design reviews, constructor input and a comprehensive management plan can provide the optimal mix of project safety designs. As will be discussed in the proposed CM model for DFCS, CM offers the best placement of safety assessment and identification in creating a successful and timely project.

In studies conducted by Szymberski (1997), the time/safety influence curve was developed to demonstrate that designer influence could be an integral part of construction safety. As shown, safety can be best controlled during the early stages of the design development when the influence is high, even as the project is being conceptualized, and diminishes throughout the project life cycle.

Regardless of the chosen contract form or project delivery utilized, design-bid-build (DBB), design-build (DB), or construction manager/general contractor (CM/GC) even greater influence can be achieved in the conceptual design phase through the incorporation of the experiences of construction management. The earlier that construction management is on board a greater influence can be placed on the effective influence on safety and vice versa. This concept holds true for all related professionals on the project, as the influence on safety decreases with project evolvement, as suggested by Szymberski. Fig. 1 represents the Time / Safety Influence Curve (Szymberski, 1997).

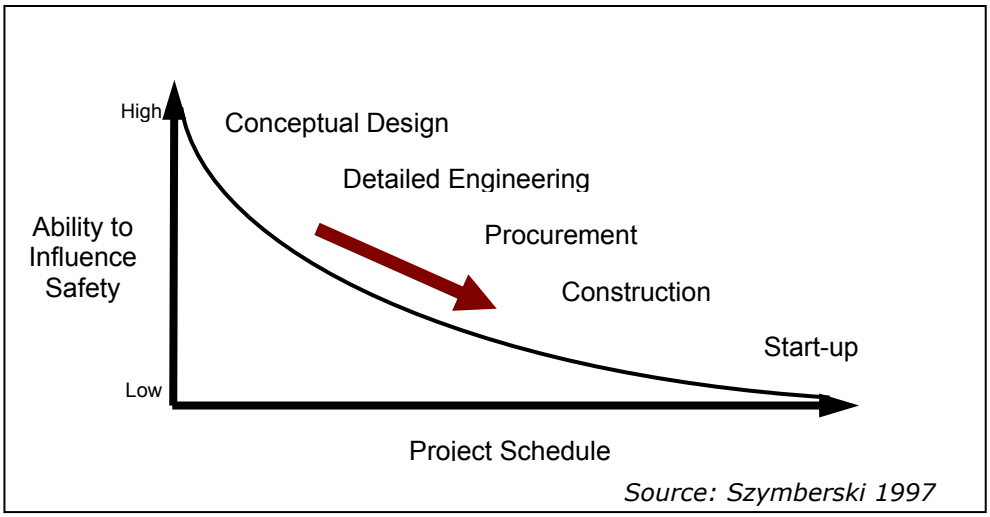

Fig. 1: Time / Safety Influence Curve (Szymberski, 1997)

There are practical reasons for each party participating in a construction project to encourage DFCS, in addition to ethical responsibilities. Subcontractors and general contractors that self-perform work have several practical reasons to encourage DFCS: it reduces accident rates, thereby reducing workers' compensation insurance rates, and increases project productivity. Benefits to owners from reducing the risk is that one or more construction accidents cause delays in project completion and hence loss of profitability. Owners incorporating Owner-Controlled Insurance Programs (OCIPs) get financial benefits from the lower accident rates that DFCS provides. Designers who perform DFCS can use this ability to market themselves as progressive, team-oriented professionals who will help to deliver a project with reduced liability and increased profitability. Designers who are part of design-build teams should benefit financially from the reduced accident rates experienced during construction.
In Burke's tripod (2006), the partners in construction management can be said to include a relationship conducive to construction worker safety as it relates to the contractual relationship between owner, designer and contractor (see Fig. 2). Suggestions on how this typical tripod can be modified to improve the information flow are discussed later in this paper (Fig. 3).

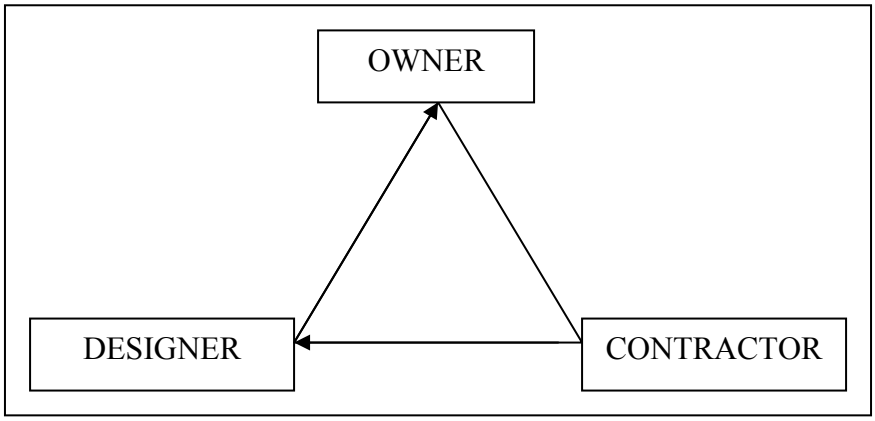

Fig. 2. The Tripod - The partners in Construction Management (Burke, 2006)

Extending the responsibility of construction worker safety to that of trade contractors, suppliers, and the construction management team overseeing construction, can reduce accident rates, thereby reducing workers' compensation insurance rates, and increase overall project productivity.

Safety is often viewed by management as being controllable; however there are those areas that are outside of the traditional concept of Total Safety Management (TSM). TSM relies on safety being the responsibility of everyone in the organization. As acknowledged by Dr. V.B. Burke, Professor and Director of Construction Management at Florida Atlantic University, Florida Institute of Safety and Construction, "TSM is an approach to safety of workers and other employees in the workplace that gives companies a sustainable competitive edge in the marketplace. This is accomplished by getting all the employees involved in establishing, enforcing, maintaining, and continually improving

the safety of the work environment so that it is conducive to peak performance at all levels and all times."

Additionally, TSM may be viewed as a precursor to the development of DFCS in that it extends this responsibility to include the designer as part of the management team in designing with construction worker safety in mind.

6. RESEARCH METHODS

The purpose of this research study was to provide an approach to the topic of designing for safety by analyzing it from a construction management perspective so as to introduce a structured methodology to information sharing and project collaboration for construction safety. Drawing on the findings of previous research, examples of successful implementation of designing for safety, and regulations enacted outside the United States, the premise driving the research was that the practice of designing for safety is a viable means for enhancing construction site safety. Also, adopting a construction management approach to designing for construction safety can play a significant role in improving the safety and health of construction workers.

A survey was structured for design and construction management professionals with the objective of addressing the impact of safety design practices in the construction delivery stage of the project in an attempt to set design criteria and standards for construction safety. Taken into consideration were the following: years of design/construction management experience, years of construction experience, knowledge of designing for safety, knowledge of the implications of designing for safety on construction safety, and understanding of construction management project review (including constructability review, value engineering, design coordination, etc.). Data for survey development were collected from published research, Department of Labor, OSHA and from other published and non-published sources.

The types of design disciplines included in the research study were limited to architecture, civil engineering, structural engineering, mechanical engineering, and electrical engineering. These are the primary disciplines involved in the design of construction projects and, by both dollar value and hours expended, their work constitutes the majority of the design effort undertaken on many projects.

Design professionals are employed by design firms that concentrate on one or more design disciplines, and by design–build firms that undertake both the design and construction aspects of the work. A sample of prospective design firm, design–build firm, and designer respondents was created using both convenience and random sampling from local telephone directories, the Internet, web-based professional association directories, and personal contacts of the researchers. A total of 35 different design professionals (16 architects and 19 design engineers) in southern Florida (Miami, Fort Lauderdale, Broward and surrounding areas) were selected.

Construction management (CM) professionals are employed by owners for program management, project management, design review (constructability improvement, value engineering), design coordination, construction coordination and project implementation control; by design–build firms for overall project management; and by contractors for construction management. The role taken and authority assumed by a construction management professional is very much dependent on the hiring authority as well as the project delivery approach – design-bid-build, design-build, CM agency or CM at-Risk. A sample of prospective owner firms, design–build firms, CM firms and contracting firms (general contractors and CM contractors) was created using both convenience and random sampling from local telephone directories, the Internet, web-based professional association directories, and personal contacts of the researchers. A total of 20 construction management professionals in southern Florida (Miami, Fort Lauderdale, Broward and surrounding areas) were selected.

When selecting firms and design professionals for the study, consideration was given to firm type, size, and location to ensure a survey sample representative of the construction industry. In addition, firms that participate in projects in each of the various sectors of the construction industry (residential buildings, commercial buildings, engineering facilities, and industrial facilities) were included in the study sample.

The survey was sent to architects, engineers and construction management professionals in order to best determine the role each played in developing or implementing safety in design in the early stage of project development. The results were compiled and analyzed to develop a proposal for the construction management approach to DFCS.

The research team contacted the 35 design professionals and the 20 construction management professionals to request their participation in the survey on a voluntary basis. Criteria used to determine participation were: willingness and availability to participate in the study; experience as a professional construction manager and knowledge about safety in design. Out of the list of 55 design and construction management professionals contacted, 23 volunteered to be surveyed (14 design professionals and 9 construction management professionals) for a total response rate of 42.%. Considering the fact that it was a construction industry questionnaire, this response rate was considered encouraging. The questionnaire was sent to the 23 professionals and all responses were received within a period of one month.

The respondents had varied backgrounds representing a variety of disciplines, employment positions, and durations of work experience. Of the 23 survey responses there were four architects (17%), three structural engineers (13%), three civil engineers (13%), two mechanical engineers (9%), two electrical engineers (9%) and nine construction managers (39%). Of the fourteen design professionals surveyed, eight (57%) were employed by design firms and the remaining six (43%)were employed by design-build firms. Of the nine construction management professionals surveyed, three (34%) were employed by owner firms, two (22%) were employed by design-build firms, two (22%) were employed by construction management contractors and the remaining two (22%) were employed by general contractors.

The size of the firms represented by the respondents ranged from medium to large (based on their annual turnover and number of employees). The design experience of the design professionals who responded ranged from five to twenty six years (mean=18.5 years; median=21 years). In addition to their design experience, the respondents were asked how much construction experience they had accrued. Construction experience was defined as actually performing construction work, e.g., carpentry, roofing, plumbing, etc. The construction experience of the respondents ranged from two to ten years with a mean of 3.1 years.

The construction management experience of the respondents ranged from five to twenty eight years (mean=20.1 years; median=22 years). In addition to their construction management experience, the respondents were asked how much design coordination and review experience they possessed. Design coordination and review experience was defined as experience in constructability review, design coordination and value management. The design coordination and review experience of those who responded ranged from three to twenty three years with a mean of 5.7 years. Almost all of the construction managers had design coordination and review experience. Additionally, construction management professionals were also asked about their construction experience. Almost all of the construction managers had construction experience of more than three years.

7. RESULT HIGHLIGHTS

Of those having the most years of design experience, 23% considered safety in their design efforts and cited that design practice does not incorporate safety knowledge, resulting in their own initiatives in addressing worker safety through design, as with the use of a checklist. This is not uncommon as most designers stated that the responsibility for safety rested with the contractor and that of their subcontractors. Over 70% of responding architects, engineers and construction management staff viewed the contractor as having the greatest influence over project safety. Further implications arise out of concern for motivational factors in promoting designing for safety, designer's knowledge of concepts, available tools, specific redesign guidelines and ultimately liability exposure.

Approximately 63% of the participants have contributed to improving construction worker safety in some way or another. When asked if there was a formal process for this effort, many replied negatively and some expressed a desire to learn more. The concept being new is not well penetrated in the industry and professionals have either very little or no knowledge about it.

Of all participants, 90% claimed that they contributed to improving construction worker safety by utilizing OSHA's guidelines as a checklist for assistance with their design efforts and had incorporated a self-devised checklist indicating that there are no formal design for safety guidelines that can be followed. OSHA guidelines at the present are

related to construction phase safety, thus indicating that even those who are affirmative that they consider safety are not well equipped.

Regarding concerns about designing for worker safety nearly 40% felt that the level of importance was not considered. That is, their management does not place due importance on design for worker safety.

When asked about the importance of management acceptance of safety concerns and training, less than 15% stated they were exposed to training or discussions about worker safety. This means there is very little importance placed on educating people about designing for safety.

All of the respondents had concerns with the legal implications involving failed safety designs but admitted that improved safety, quality and productivity can be achieved through DFCS. When asked if construction health and safety consultants were used in the project design phase, 9% responded with assent. It indicates that a majority of the projects do not incorporate the ideas of safety professionals (or construction management in other words) at the beginning of the project which could be quite beneficial to achieve overall safety for the project.

The best approach to introducing information flow to the design is through construction management as it monitors, inspects and is involved directly with all other constructors on the job site. Emphasis should be placed on the entire tripod if DFCS is to be employed. Regardless of the procurement method, relationships or the contracting parties, the owner may assume the liability for the designer's performance, or lack thereof. This places both the owner and designer at risk for designs not incorporating safety design practices. The revised tripod (see Fig. 3) reflects this change with the added benefit of shared information flow and CM involvement.

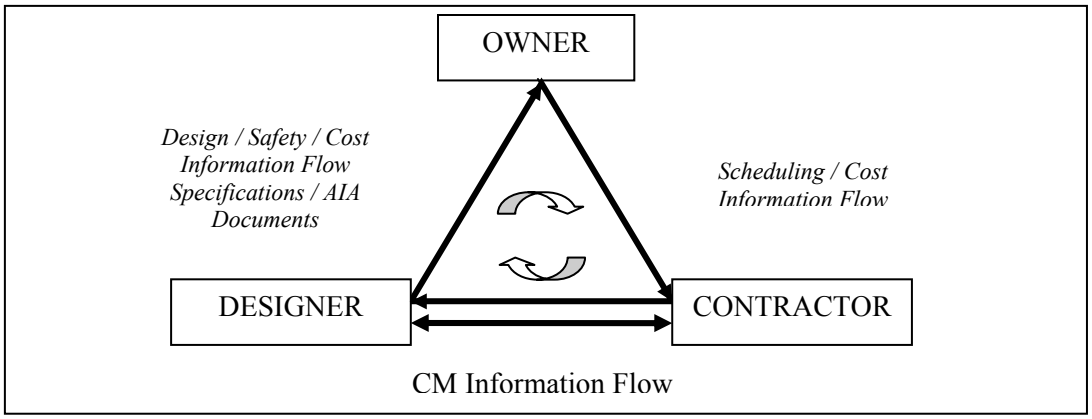

Fig. 3: Modified Tripod

As proposed in the CM constructability review process and by the flow of information in the modified tripod, CM can provide a very sensible and sustainable approach to DFCS.

8. PROPOSED MODEL FOR A CONSTRUCTION MANAGEMENT APPROACH TO DFCS

The Safety Decision Hierarchy model developed by Gambatese (2004) was used as a platform to develop a *CM model to DFCS* tool to serve the designer and constructor (contractor, consultants, trade contractors, construction management) in their evaluation of safety risk.

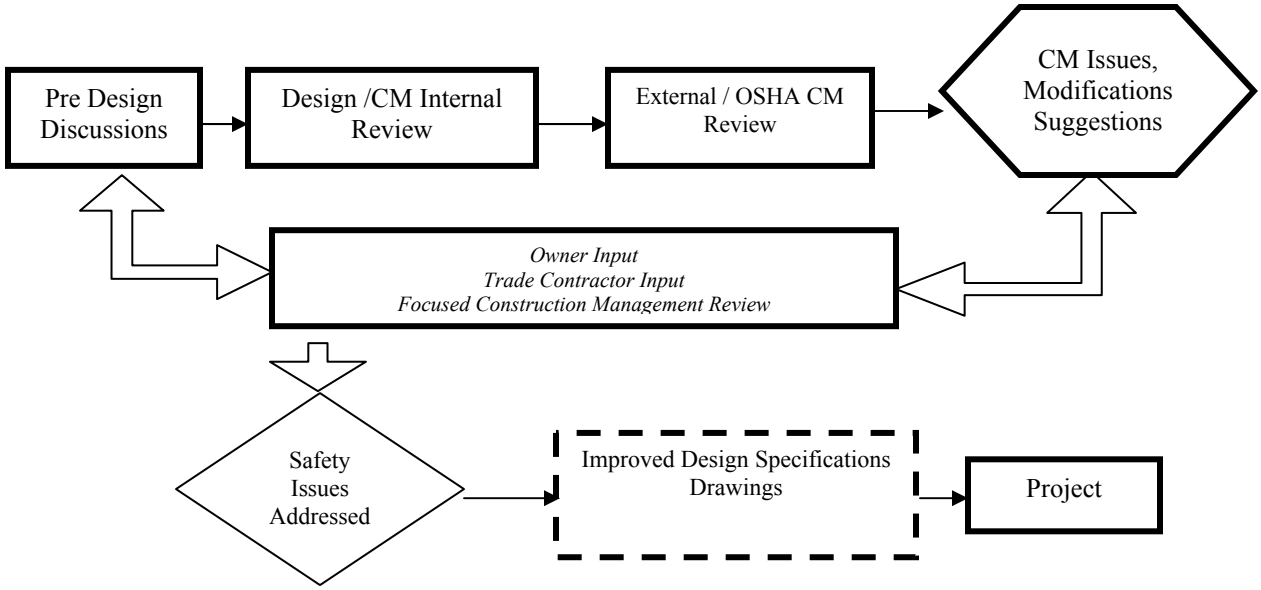

Fig. 4: Proposed Model for a Construction Management Approach to DFCS

The proposed model (Fig. 4) incorporates interaction between all parties involved in project delivery including construction management. Consistent with design phase reviews, designing for safety should address the documentation and construction management side of construction. Construction management is tasked often with the challenges of building a project that is based on flawed designs. This translates to constructors having to make field decisions that can also affect construction worker safety.

The *pre design discussion phase* establishes the standard by which safety expectations will be based. It includes the construction and operational information flow and can serve as a depository for the entire safety design process and associated tools.

The role of construction management is to evaluate the constructability of the project through impacts on scheduling, estimating, risk assessments, and safety concerns and finally project delivery. The CM can provide construction experience, project collaboration, and knowledge into the design phase and may provide alternatives to means and methods of construction. During the *design and internal review* portion of the

model, trade contractors, subcontractors, and construction management provide input regarding overall safety concerns of the design as they will be the ones directly impacted. During the *External - OSHA Standards / CM phase,* drawings and specification are to be developed based on discussions and standards and are made part of the project construction documents. These documents will provide better details relating to safety enhanced details and notes.

Issues that arise out of the CM Issues / *Modification / Suggestions phase* are communicated back to the owner with supporting documentation of cost analysis and scheduling impacts. This information is obtained from the contractor, consultant, design build firms, and construction management, whose responsibility it will be to oversee project construction.

9. IMPLICATIONS AND CONCLUSIONS

In summary, this paper has explored DFCS, a growing trend in construction safety and its impact given the project delivery method chosen. Engineers, architects, owners and constructors must adopt a standard not centered exclusively on profits but rather on designer responsibility in the design of structures. This is achieved through enhanced means and methods and CM oversight. Regardless of the method used in evaluating the risk, it is often the input of the owner's goals and objectives, project cost, delivery method, construction practices, building codes, design resources, and capabilities, training and education that greatly impact project design and cost. CM is proposed to impact greatly, the successful outcome of projects by assessing construction worker exposure to risk. This proactive approach will reduce injuries, and reduce the cost of construction, which benefits all involved.

Through these efforts of enhanced OSHA regulations, designers and constructor collaboration, training and education, information sharing, risk engineering and CM oversight, there are no limitations of what can be achieved by the full integration of DFCS. The cost of all these factors will impact the project budget and affect methods of construction; however, it will also significantly enhance and improve the health and safety of construction workers.

10. RECOMMENDATIONS

Efforts made in the industry have greatly reduced or eliminated construction accidents by "engineering in" better safety measures through the design and planning phase. Designing for safety has the potential to greatly reduce, if not eliminate construction worker injuries and deaths.

Major universities are at the forefront of providing education and raising awareness for the values of DFCS and have provided numerous studies on the topic. Alliances are being formed by various organizations in addressing construction worker safety through design.

The Department of Labor, OSHA, American Society of Civil Engineers, National Institute for Occupational Safety and Health, Construction Management Association of America, American Society of Structural Engineers, among others have all met to share information on designing for safety. The current OSHA Alliance has created a workgroup to further discuss the topic of training design professionals to recognize and evaluate risk.

Additionally, proposed accreditation through the American Council for Construction Education (ACCE) should require semester hours to be earned in construction safety covering topics such as risk assessment, risk engineering and the use of design tools to assist in the redesign of safety efforts.

OSHA continues to provide leadership through its alliance and met in January and April of 2006 to further develop its case study on the topic. Continued efforts are said to include a 2 – 4 hour DFCS course and a 10-hour training program for engineers as well as efforts to attract others to this very ethical approach to construction safety.

11. REFERENCES

Baker, G., and Barsotti, A., "Procurement Methods to Facilitate Designing for Safety and Health." In Designing for Safety and Health in Construction, Hecker S., Gambatese, J., and Weinstein, M. Editors 920040. Eugene Oregon: University of Oregon Press, pp. 199-205.

Bureau of Labor Statistics, (2006), Bureau of Labor Statistics [On-line]. Available: http://www.bls.gov/

Behm, M., " Legal and Ethical Issues in Designing for Construction Safety and Health." In Designing for Safety and Health in Construction, Hecker S., Gambatese, J., and Weinstein, M. Editors 920040. Eugene Oregon: University of Oregon Press, PP. 165-177

Burke, Vural B., PhD. Construction Management Program Director, Florida Institute for Safety and Construction, 2901 College Ave, Davie, Fl. Florida Atlantic University.

Construction Management Association of America, CMAA [On-line] Available: http://www.cmaanet.org/

Construction Institute, CII [On-line] Available: http://www.construction-institute.org/scriptcontent/more/ir101_2_more.cfm

Electronic Library of Construction Occupational Safety and Health, eLCOSH, [On-Line] Available: http://www.cdc.gov/elcosh/

Gambatese, J.A., Behm, M., and Hinze, J. "Viability of Designing for Construction Worker Safety" *Journal of Construction Engineering and Management*. September 2005. pp 1029-1036.

Hinze, J.W. 1994a. *A Study of the Construction Activity Projections for 1994*. Rosslyn, VA: Associated Builders and Contractors (ABC), January.

Hecker, S., Gambatese, J.A., and Weinstein, M., Editors (2004) "Designing for Safety and Health in Construction", Eugene Oregon, University of Oregon Press, 2004.

Loulakis, Michael C. and Shean, Owen J. (2005) "Trends in Construction and Design Liability" *IRMI 25th Construction Risk Conference, November 7-10, 2005*

NIOSH, National Institute for Occupational Safety and Health. (2006) Centers for Disease Control and Prevention [On-Line] Available: http://www.cdc.gov/niosh/homepage.html

OSHA, Occupational Safety and Health Administration, (2006) U.S. Department of Labor.
[On-Line] Available: http://www.osha.gov/

Szymberski, R. 1997. Construction Project Safety Planning. *TAPPI Journal*, 80(11): 69-74.