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A Review Of Steel Content Taught In U.S. University Construction Management Programs

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By

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of

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Approved:

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CHAPTER I

INTRODUCTION

Background

Throughout the rocky mountain region there are 18 universities that offer a bachelor's degree in Construction Management (CM). Only two of those universities, Colorado State University and Brigham Young University Idaho, offer an in-depth course on the application of steel in the construction industry. The other universities offer structures courses that teach only the basics of steel in the construction industry, like how to calculate loads using steel beams and columns.

After speaking with Dr. Tim Mrozowski from Michigan State (personal communication, September16, 2013), Dale Mortensen from BYU-Idaho (personal communication, September10, 2013), Dr. Charles Smith from Colorado State University (personal communication, September 9, 2013), and Dr. Kevin Miller from BYU-Provo (personal communication, August 19, 2013) it was discovered that most CM programs across the United States do not have courses dedicated to steel. It appears that one of the main reasons only a few of the universities with CM programs have a course on steel is because of professors that specialize in steel.

The lack of an in-depth knowledge regarding steel on the part of project managers is frustrating for Travis Scott of T & M Manufacturing (personal communication, July 18, 2013) and Craig Madsen of J & M Steel Solutions (personal communication, August 22, 2013), both owners of steel erection companies in Utah. They both agreed that most onsite issues deal with scheduling or erection problems, reflecting on the fact that the

project managers have little knowledge of the steel trade. Scott (2013) noted that working with a project manager that is familiar with steel means a job with far less issues.

A majority of the more recent structural failures, cited on the Occupational Safety and Health Association or OSHA website (OSHA, 2013) where steel was involved, occurred during the construction process, before all the structural components were assembled. If the construction managers had a more in-depth knowledge of steel construction they would be more likely to understand how structures may act in certain situations. With this knowledge they would be able to prevent a greater amount of the problems that can arise during the project erection.

Statement of the Problem

How much content in the area of steel construction is being covered in construction management programs at universities in the United States? Does this content meet industry expectations as put forth by the American Institute of Steel Construction (AISC)?

Purpose of the Study

The purpose of this study was to discover to what extent construction management programs are teaching the topic of steel construction to their students and comparing this with the material that the American Institute of Steel Construction (AISC) deems as important for construction managers to know.

Need

There are four main materials used as structural components in commercial and industrial construction projects. These four materials are soils, concrete, wood and steel. These materials are very important due to their use as structural components. To

properly understand how to correctly manage and coordinate these materials in the construction industry the managers must have an understanding of their properties and how they are used and manipulated in the construction industry. If these materials are not properly understood delays and un-safe situations will likely occur during the building process. Of these main materials this study focused entirely on steel.

Limitations/Assumptions

- Schools surveyed were limited to the four year construction management programs listed on the Associated Schools of Construction (ASC) website (ASC, 2013).
- It was assumed that the program leader that was listed on the Associated Schools of Construction website for each school was knowledgeable enough about their construction management program to accurately answer the questions in the survey.
- It is assumed that the program leaders that responded to the survey responded honestly and accurately so that the responses reflect their current program curriculum being taught.

Definition of Terms

- Construction Manager: term used in this study to denote both project manager and superintendent.
- Superintendent: one who has executive oversight and charge of the activities of the jobsite.

- Project Manager: bridges the gap between the superintendent and the owner's representative. They oversee the superintendents and aid in the organizing and completion of the project.
- Structural Engineer: individual who analyzes, designs, plans, and researches structural components and structural systems to achieve design goals and ensure the safety and comfort of users or occupants. He or she will often visit projects in the construction phase to verify the contractors are adhering to the engineers' stringent guidelines in construction.
- Program Leader: term used to denote the person within each construction management program who oversees the program and the curriculum within each course.
- Steel: alloy of Iron and carbon and often includes other elements to impact the properties of the steel alloy
- Commercial Construction: Construction of building facilities used for business/commerce operations. Commercial construction includes structures for retail shops, medical buildings, professional office buildings, restaurants, etc.
- Industrial Construction: Construction of building facilities used for industrial and manufacturing purposes.
- Residential Construction: Construction that is not considered commercial in nature. The end-use of the structure being built must be used as a home, i.e., a dwelling.

Acronyms

- CM: Construction Management
- AISC: American Institute of Steel Construction
- ASC: Associated Schools of Construction
- ACCE: American Council for Construction Education

CHAPTER II

REVIEW OF LITERATURE

To be an accredited program each CM program has certain guidelines that it must follow when putting together the curriculum. All the CM programs in Utah and most of those in surrounding states adhere to the standards put forth by The American Council for Construction Education or ACCE. Document 103, also called the Standards and Criteria for Accreditation of Post-Secondary Construction Education Degree Program, gives general guidelines of what topics any CM program should include (ACCE, 2013, pp. 1). The document leaves some room for movement between the topics and emphasis. This is apparent in the following statement:

> It is recognized that no construction education degree program either at the Baccalaureate or Associate degree level can offer every course or experience which, justifiably, could be suggested for the education of a Constructor. Further, it may be desirable in some instances to develop curricula in one or more areas of construction specialization. Such specialties may be developed as the only program or as part of a multi-option program. It is assumed that each unit will develop its own program goals and objectives and particular emphasis, and will prescribe the number of courses for graduation, sequencing of study, course numbers, and titles. (ACCE, 2013, pp.8)

It is important that each university has the ability to adapt and adjust its program while following the guidelines of the accrediting agency. Some programs have a higher emphasis on residential construction, while others emphasize commercial or industrial construction. Students looking to work in residential construction will for the most part find knowledge of steel to be unnecessary, whereas students looking to work in the commercial or industrial sectors will find an understanding of steel invaluable.

Each CM program also has different professors that have different strengths and abilities. Without the ability to adjust a program to capitalize on these strengths and

abilities students would miss out on what strengths the professors have to offer. Each program is necessarily different, and yet the topic of steel and its uses in the industry are missing from the majority of the curriculums. According to the ACCE:

> "The Constructor must have an understanding of the contribution of the design disciplines' processes. The Constructor must be able to communicate with the design professionals, and should be capable of participating during the planning phase of design-build projects. Construction sciences and architectural or engineering design topics selected to facilitate communications with the design disciplines and to solve practical construction problems are to be considered in this category." (ACCE, 2013, pp.13)

This last statement is given under the Construction Science requirement. Teaching students about steel, its properties and how it is used in the construction industry would be a part of this requirement. In order to understand the design and the engineering aspects of most commercial and industrial projects the graduates entering those fields would need a firm understanding of steel.

Traditionally, superintendents and project managers in the construction industry worked up through the trades before being placed in the position of project manager or superintendent (as cited in Gunderson, 2011). Trades, in this proposal, are intended to mean carpenter, steel worker, concrete installer, and construction helper etc; persons that are aiding in the construction but are not in a leadership position. These workers became familiar with the construction industry and the materials being used as they worked their way up from laborers to management. In the construction industry today, it has become increasingly common for an individual to earn a degree in CM, with very little hands on experience, work under an acting manager for a time and then take on the role themselves.

One perceived problem with graduating CM students moving up to management positions quickly is that they are still relatively new to the industry, especially in the commercial industry where the construction processes and materials are vast and complex. In commercial construction there is a high use of steel which, if not understood, can be very difficult to manage. As noted above, a majority of Construction Management programs do not offer courses that help educate their students about the use of steel in the construction industry.

When building multi-story or large steel structures an increased level of understanding is needed of steels so that the superintendents can properly comprehend the forces at play. Most structural failures happen during construction and are due to improperly bracing the steel structures as they were erected. While looking over incident investigation engineering reports from the last 15 years on the Occupational Safety and Health Association or OSHA website, all of the incidents that were reviewed, where steel structures had partially or completely collapsed, the causes were linked back to improper assembly or improper loading during construction (OSHA 2013). In a study that analyzed the findings from many construction failures, one of the recommendations given to help reduce structural failures was to educate the superintendents in structural bracing and stability (Lockley et al. 2002 p11). In another report Brandon Rupert noted:

> It often is not possible for structural engineers to be involved in means and methods during construction so it is pertinent to touch on the people on site being more knowledgeable of how structures act in certain situations. (Rupert, 2013)

A key part of understanding the means and methods of steel erection is to understand the properties of steels and how those properties react to different environments.

While speaking with Travis Scott at T & M Manufacturing about whether or not project managers and superintendents have enough knowledge of steel to properly manage their projects, Scott (the owner) commented on how difficult it is as a sub-contractor to work with project managers and superintendents that do not understand the steel industry. When issues arise on a project these same managers do not offer any direction and often do not have the knowledge to help find solutions, instead they push the problems back on the sub-contractor and tell them to get the job done or they will go find someone else who will. Scott also said that it seems as if these managers are not trying to understand the steel trades so that these jobs can be run with fewer problems (personal communication, July 18, 2013).

Craig Madsen from J & M Steel Solutions agreed with what Scott had to say. Madsen also said that he often has problems with things as seemingly simple as bolt layout and joint geometry (personal communication, August 22, 2013). Both Scott and Madsen did note that on rare occasions when they are able to work with managers that have worked their way up through the trades, the jobs run much more smoothly since there is that underlying knowledge of the trade.

On most projects where steel is involved the steel is part of the critical path, meaning when there is a delay in the steel erection the whole job will be delayed. Issues as simple as superintendents failing to coordinate bolt layout correctly can cost the project days to remedy. When it comes to building design, the structural engineer designs the steel structural members and gives guidelines for the different connection points, but leaves it up to the steel fabricator to detail each joint. After the joints are detailed the details are sent to the engineer for an approval. The reason for this is that many

fabricators and erectors have different preferences and employ different manufacturing processes so the engineer allows the fabricator to design a joint that works with their fabrication processes. This affects the project managers on site since they are not able to look at the main set of engineered drawings to see the joint details (Pelgar, 2013). With this in mind it is easy to see that construction managers should have an understanding of steel, its joining processes and its use in the construction industry.

Currently there are a few universities that offer a course designed to teach construction management students about steel. University of Colorado and BYU-Idaho are two of those universities. Professor Dr. Charles Smith who has been teaching a steel systems/welding course in Construction Management at Colorado State for many years reported that nearly all the students that take the course have almost no experience with steel when beginning the course, but after the course many students change their emphasis from residential construction to commercial construction due to their newly acquired knowledge (personal communication, September 9, 2013).

Dr. Tim Mrozowski from the Construction Management Program at Michigan State University said that having courses within Construction Management programs that teach about steel in the industry are rare. There are two main reasons for this: first, most CM programs do not have someone that is familiar with the steel industry that can teach such a course, and second, most CM programs are already overwhelmed with the amount of topics to teach and have maxed out on the quantity of courses that can be reasonably required by the students. The idea of adding yet another course to the mix to an already overloaded program does not seem reasonable (personal communication, September 16, 2013). Kevin Miller who is a professor at the BYU-Utah Construction management

program echoed this by saying that the Department has requested that they decrease the number of classes the program offers already (personal communication, August 19, 2013). However, in talking with Dr. Tim Mrozowski he expressed that there still is a need for the students to have a better understanding of steel and its use in the construction industry.

Dr. Mrozowski is currently working to alter the structures course that he teaches to the CM students at Michigan State. This course is traditionally geared towards an engineer's perspective, not a construction manager's perspective. He is using more examples of construction failures in the course to help the students better understand the steel connections and assembly procedures at the jobsite (personal communication, September 16, 2013). During another conversation with Dr. Mrozowski he stated that he believes that the CM students graduating at Michigan State University are equally knowledgeable in steel as they are in any other structural material. Michigan State does not have a steel course for the CM students but instead has integrated information about steel in each of their courses. An example of this would be using an example of a steel structure in their scheduling course. Students learn about scheduling and they are able to learn about the additional steps that are needed when steel is involved (personal communication, February 4, 2014).

The path that Michigan State has taken to help fill the void of knowledge is the same path that other programs can take to better prepare their students. The information that Michigan State uses to teach their students about steel throughout the different courses is provided free of charge from the Associated Institute of Steel Construction (AISC). Several years ago AISC approached Dr. Mrozowski and several other CM

professors and asked them to prepare this information that could be used to educate CM students about steel in the construction industry. This information has been reviewed by the steel industry and by individuals at AISC to verify that it is accurate (AISC 2014). Since this information is comprehensive and free, other CM programs not fully educating their students on steel can alter current courses to a point where the curriculum taught contains more information on steel construction. This will make it possible for students to be more educated on steel and the steel industry without having to create an additional course dedicated to its teaching.

CHAPTER III

METHODOLOGY

Research Design

To evaluate whether or not the selected CM programs were addressing the topic of steel construction within their programs and if this coverage was equal to the information suggested by AISC's teaching aids, an on-line survey was prepared and sent to the program leaders of all the CM programs listed on the Associated Schools of Construction website, a total of 115 identified programs. The on-line survey questions (see appendix A) were created using the Steel Instruction Aids for Construction Management provided on the American Institute of Steel Education's web site as reference (AISC, 2014). Dr. Tim Mrozowski, who teaches at Michigan State University, and who played a role in creating a large portion of the construction management aids on the AISC web site, reviewed the survey to verify that it was valid for its purpose.

Population

The population for the educational professionals (N=115), include all the program leaders of construction management programs for the universities listed on the Associated Schools of Construction website that are located in the United States.

A list of each program leader's information was printed out and reviewed. When reviewing the school information next to each contact person it was noted that some of the schools listed were construction engineering programs instead of construction management programs. The focus of this study is on construction management, so all the schools that were engineering based were removed from the list. This left 115 program leaders and schools to send the survey to.

Instrumentation

A survey was created using Qualtrics research software. This survey consisted of a cover letter with the option to opt out of the study, thirty-six questions and a place for additional comments. The questions were broken down into three types: demographics, steel education, and concrete and masonry education.

The first five questions related to demographics. Program leaders were asked the amount of students to graduate from their program this year, the region of the school's location, and what percent of the graduating students entered into each type of construction field: commercial, residential, or industrial construction.

The remaining thirty-one questions dealt with steel, concrete, and masonry education. Twenty-two of the questions in steel education were created by using the Construction Management teaching aids, supplied by AISC as a guide (AISC 2013). All of these questions were on topics that would be covered in steel education. Individuals were asked to indicate whether or not a topic was covered with theory and practice, theory only, or not covered. The program leader was given the option to mark unsure if they did not know. A response of theory and practice for each of these questions would indicate that a school is thoroughly covering the material presented by AISC within their program.

The remaining nine questions were written to resemble the steel education questions, but were on topics related to concrete and masonry education. These nine questions were added with the sole purpose to help remove bias from those that took the survey. Concrete and masonry are more commonly taught within construction management programs. This meant that those taking the survey would be more likely to

complete all the questions if they were able to indicate that the topic was covered with theory and practice, feeling that they were getting many answers correct.

As a test run the survey was sent to Dr. Tim Mrozowski who teaches at Michigan State University and to Dr. Edward Reeve who teaches at Utah State University to verify that all was functioning as expected.

Prior to sending the survey to the recipients it was determined by Utah State University's IRB staff that this survey was not human subject research requiring IRB approval. A copy of the USU IRB approval letter is provided in appendix B.

Survey Follow-up

The survey was sent out and all data was collected via Qualtrics. The survey was sent to its recipients Tuesday March 18, at 11:00 A.M. MST. Responders were given one week to complete the survey. Tuesday March 25 at 7:00 A.M., and Tuesday April 1 at 7:00 A.M. MST reminders were sent out and on Thursday April 3rd the survey was closed at 7:00 P.M. MST

CHAPTER IV

FINDINGS & DISCUSSION

Introduction

The purpose of this study was to discover to what extent Construction Management programs are teaching steel construction topics. Steel construction topics tested in this study were those that were identified as important by the American Institute of Steel Construction. The survey was sent out to 115 CM program leaders. Of the 115 persons that received the survey, 61 people responded. Of the 61 that responded, 2 declined to answer the survey. Of the 59 people who completed the survey, 45 completed the survey by answering at least 90% of the questions, 3 completed the survey and answered 80% of the questions, and 11 people started the survey but only completed up to 20%. In this study, all responses were counted. The 11 who completed less than 20% of the questions, for the most part, only completed the demographic information and then stopped. At the end of the survey respondents were given an option to give comments, and no comments were given. Though some respondents did not complete all of the questions, each question averaged 47 to 55 responses.

This survey focused on steel education topics in Construction Management programs across the nation. In addition to steel related questions, the survey also asked questions related to concrete and masonry. This helped give the survey a balance of questions and avoided a negative balance that may have occurred by those who do very little steel education in their programs. The results for the concrete/ masonry questions can be found in appendix C.

Findings and Discussion

This study asked four demographic questions related to the number of students who graduate from the programs in each region, and questions related to job placement (i.e., placed in an industrial, residential or commercial setting). Shown in Table 1 are the regions, codes used, and the number of schools in each region. Shown in Table 2 are the results to the demographic questions and they are discussed in chapter 5. Shaded areas indicate the top percentages in the category.

Table 1

Regions, region codes and number of schools per region.

Code	Region Name	# of Schools	States Represented
US	7 Regions	115	The entire United States
NE	North East	20	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia
SE	South East	15	Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Virginia, Tennessee
GL	Great Lakes	20	Illinois, Indiana, Kentucky, Michigan, Ohio, Wisconsin
NC	North Central	12	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
SC	South Central	15	Arkansas, Louisiana, Oklahoma, Texas
RM	Rocky Mountain	18	Alaska, Arizona, Colorado, Idaho, Nevada, New Mexico, Montana, Utah, Wyoming
FW	Far West	15	California, Hawaii, Oregon, Washington

Table 2

Construction Management Program Graduates and Job Placement.

Question: Indicate the approximate number of students that will graduate in your construction management program this year									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	1--25	27%	50%	50%	27%	0%	29%	63%	0%
2	26--50	47%	38%	38%	55%	75%	29%	25%	83%
3	51--75	15%	0%	0%	9%	25%	29%	13%	0%
4	76+	11%	13%	13%	9%	0%	14%	0%	17%
	Responses per area	55	8	7	11	8	7	8	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	48%	40%	47%	55%	67%	47%	44%	40%

Question: Indicate the percent of your graduates that typically enter the industrial construction field									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	0% -19%	71%	75%	43%	82%	50%	100%	75%	67%
2	20% -39%	22%	13%	57%	18%	50%	0%	0%	17%
3	40% - 59%	4%	13%	0%	0%	0%	0%	13%	0%
4	60% - 79%	2%	0%	0%	0%	0%	0%	13%	0%
5	80% -100%	2%	0%	0%	0%	0%	0%	0%	17%
	Responses per area	55	8	7	11	8	7	8	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	48%	40%	47%	55%	67%	47%	44%	40%

Question: Indicate the percent of your graduates that typically enter the residential construction field									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	0% -19%	75%	75%	57%	91%	63%	86%	88%	50%
2	20% -39%	20%	13%	29%	9%	38%	14%	13%	33%
3	40% - 59%	2%	0%	14%	0%	0%	0%	0%	0%
4	60% - 79%	2%	13%	0%	0%	0%	0%	0%	0%
5	80% -100%	2%	0%	0%	0%	0%	0%	0%	17%
	Responses per area	55	8	7	11	8	7	8	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	48%	40%	47%	55%	67%	47%	44%	40%

Question: Indicate the percent of your graduates that typically enter the commercial construction field									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	0% -19%	7%	13%	0%	0%	13%	0%	25%	0%
2	20% -39%	5%	0%	14%	0%	0%	0%	13%	17%
3	40% - 59%	35%	25%	29%	27%	75%	29%	25%	33%
4	60% - 79%	38%	38%	43%	64%	13%	57%	13%	33%
5	80% -100%	15%	25%	14%	9%	0%	14%	25%	17%
	Responses per area	55	8	7	11	8	7	8	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	48%	40%	47%	55%	67%	47%	44%	40%

In this study, 22 steel-related questions were asked to find out each school's implementation of the selected topics. The 22 questions have been broken down into eight sub topics. These sub topics are presented in Tables 3 through 10. In each table, the shaded data indicates the question with the highest percent of responses. The data provided for each question gives both a national U.S. perspective, and a regional perspective. The abbreviations use for each region are explained in Table 1

The questions in Table 3 dealt with onsite project coordination. Most respondents responded at a level of "Theory Only" for all but the last question. The first three questions in Table 3 are more specific to steel. The last question is on jobsite layout, logistics and equipment. This is a topic that must be understood regardless of the type of construction being completed. A contractor building a home out of timber should understand the principles behind this question. Due to its importance to all types of construction it should be no surprise that a majority of responders selected "Theory & Practice."

The group of questions in Table 4 dealt with composite construction. Composite construction is the use of different types of material to form the structural element of a building. The most common composite construction uses steel and concrete. When both steel and concrete are used the full strength of the structure cannot be achieved until the concrete has been properly integrated into the steel structure. The responses for both questions in Table 4 were the same. The majority of schools in the US are teaching this topic at a "Theory Only" level.

Table 3

Onsite Project Coordination

Question: Knowledge of equipment requirements and mobilization processes for structural steel construction

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	37%	14%	33%	22%	50%	14%	60%	67%
2	Theory Only	42%	43%	33%	56%	38%	71%	20%	33%
3	Not covered	18%	43%	17%	22%	13%	14%	20%	0%
4	Unsure	2%	0%	17%	0%	0%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: How to coordinate between the structural steel contractor and the construction manager and/or general contractor

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	35%	14%	17%	33%	63%	29%	40%	50%
2	Theory Only	54%	71%	67%	67%	38%	43%	60%	33%
3	Not covered	9%	14%	0%	0%	0%	29%	0%	17%
4	Unsure	2%	0%	17%	0%	0%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: Responsibilities of industry participants in steel construction

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	21%	14%	0%	25%	25%	17%	0%	67%
2	Theory Only	56%	43%	83%	63%	63%	67%	40%	33%
3	Not covered	19%	43%	17%	13%	0%	17%	40%	0%
4	Unsure	5%	0%	0%	0%	13%	0%	20%	0%
	Responses per area	46	7	6	8	8	6	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	40%	35%	40%	40%	67%	40%	28%	40%

Question: On site layout, logistics and equipment

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	60%	43%	60%	67%	100%	43%	40%	67%
2	Theory Only	35%	57%	20%	33%	0%	43%	60%	33%
3	Not covered	5%	0%	20%	0%	0%	14%	0%	0%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	47	7	5	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	33%	45%	67%	47%	28%	40%

Table 4

Composite Construction

Question: Details of composite steel construction, the components that are used, and how they are installed									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	34%	29%	17%	33%	38%	33%	20%	67%
2	Theory Only	54%	71%	83%	56%	63%	33%	40%	33%
3	Not covered	10%	0%	0%	0%	0%	33%	40%	0%
4	Unsure	2%	0%	0%	11%	0%	0%	0%	0%
	Responses per area	47	7	6	9	8	6	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	45%	67%	40%	28%	40%
Question: Impacts that composite steel construction may have on project schedule, cost, sequence and overall management									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	27%	29%	33%	11%	50%	29%	0%	40%
2	Theory Only	43%	43%	50%	56%	50%	43%	40%	20%
3	Not covered	30%	29%	17%	33%	0%	29%	60%	40%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	47	7	6	9	8	7	5	5
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	45%	67%	47%	28%	33%

The following two questions in Table 5 were on cambered beams. Cambering a beam is the process of pre-bending a beam prior to its installation. Often beams that will be carrying large loads will be bent or cambered so that when they are installed in a structure the middle sits higher than the outer ends. When loads are then applied the beam will bend strait. Without the camber the beam will sag in the middle when the large load is applied. The results in Table 5 showed the majority of responders selecting "Theory Only." However, un-like most other questions in the survey, less than eight percent of the responders selected "Theory & Practice." It is not known if this is due to a perceived difficulty of teaching it to a higher level or if there is another reason.

Table 5

Cambered Beams

Question: Process of creating camber and why cambered beams are used									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	8%	14%	0%	11%	13%	0%	0%	17%
2	Theory Only	64%	43%	50%	67%	75%	86%	80%	50%
3	Not covered	22%	29%	33%	22%	0%	14%	20%	33%
4	Unsure	6%	14%	17%	0%	13%	0%	0%	0%
	Responses per area	47	7	6	9	7	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	45%	58%	47%	28%	40%

Question: Knowledge of situations where cambered beams should and should not be used, and how using cambered beams might affect a project									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	6%	0%	0%	11%	13%	0%	0%	17%
2	Theory Only	52%	57%	50%	56%	50%	57%	60%	33%
3	Not covered	30%	29%	33%	33%	13%	29%	20%	50%
4	Unsure	13%	14%	17%	0%	25%	14%	20%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

All of the questions found in Table 6 dealt with project management. The first three of the four questions are on scheduling. Of these three questions a majority of respondents selected the “Theory Only” response. The last question on estimating had a high majority of schools select “Theory & Practice.” If a school teaches its students how to estimate steel it should also teach them how to schedule the activities associated with steel, but apparently this is not the case. The failure to understand either estimating or scheduling of steel components could be costly for a project.

Table 6

Project Management

Question: Scheduling of a multi-level steel structure

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	42%	43%	33%	33%	86%	43%	20%	33%
2	Theory Only	46%	14%	67%	56%	14%	43%	80%	50%
3	Not covered	12%	43%	0%	11%	0%	14%	0%	17%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	47	7	6	9	7	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	45%	58%	47%	28%	40%

Question: Types of steel connections used in steel construction and insights into the impacts of each type of connection on design and schedule

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	15%	14%	0%	22%	25%	14%	0%	33%
2	Theory Only	67%	57%	83%	56%	75%	86%	80%	33%
3	Not covered	10%	14%	0%	22%	0%	0%	20%	17%
4	Unsure	7%	14%	17%	0%	0%	0%	0%	17%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: Knowledge of steel fabrication related activities, steel erection related activities and the durations associated with each activity

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	30%	29%	33%	44%	38%	14%	0%	50%
2	Theory Only	53%	57%	67%	44%	38%	71%	60%	33%
3	Not covered	14%	14%	0%	11%	25%	14%	20%	17%
4	Unsure	3%	0%	0%	0%	0%	0%	20%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

31. Quantity take-off of steel components and cost estimation of materials and labor

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	68%	71%	50%	67%	100%	57%	80%	50%
2	Theory Only	21%	14%	50%	22%	0%	29%	0%	33%
3	Not covered	8%	14%	0%	11%	0%	14%	0%	17%
4	Unsure	3%	0%	0%	0%	0%	0%	20%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Table 7

Joining Process of Bolting and Welding

Question: Types of bolts and their installation methods in steel construction

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	31%	29%	33%	25%	13%	67%	0%	50%
2	Theory Only	58%	57%	67%	63%	88%	17%	100%	17%
3	Not covered	9%	14%	0%	13%	0%	17%	0%	17%
4	Unsure	2%	0%	0%	0%	0%	0%	0%	17%
	Responses per area	46	7	6	8	8	6	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	40%	35%	40%	40%	67%	40%	28%	40%

Question: Types of bolted joints used for structural steel

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	30%	0%	33%	33%	13%	71%	0%	60%
2	Theory Only	58%	83%	67%	56%	88%	29%	60%	20%
3	Not covered	7%	17%	0%	11%	0%	0%	20%	0%
4	Unsure	6%	0%	0%	0%	0%	0%	20%	20%
	Responses per area	46	6	6	9	8	7	5	5
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	40%	30%	40%	45%	67%	47%	28%	33%

Question: Welding terminology including weld symbols, weld types, and welding processes

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	23%	0%	33%	25%	13%	50%	20%	17%
2	Theory Only	57%	71%	50%	38%	63%	50%	60%	67%
3	Not covered	16%	29%	0%	38%	25%	0%	20%	0%
4	Unsure	5%	0%	17%	0%	0%	0%	0%	17%
	Responses per area	46	7	6	8	8	6	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	40%	35%	40%	40%	67%	40%	28%	40%

Question: Knowledge of common weld inspection methods and considerations associated with field welding

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	10%	0%	0%	11%	25%	14%	0%	17%
2	Theory Only	51%	57%	67%	56%	50%	43%	20%	67%
3	Not covered	32%	43%	17%	33%	25%	29%	80%	0%
4	Unsure	7%	0%	17%	0%	0%	14%	0%	17%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

The questions in Table 7 were on the joining process of bolting and/or welding. The majority, or 50% to 60% of responders, selected the "Theory Only" response for all four questions. The most significant difference between the responses of the four

questions is the percent of respondents that selected the "Theory & Practice" option for the last question. The first three questions had 23% to 31% of responders select "Theory and Practice", whereas the last question had only 10% of responders indicate that their school taught common weld inspection methods and the field considerations to the level of "Theory & Practice." It is not known why so few schools are teaching this material to that level. Perhaps it is due to the faculty's lack of expertise in the weld inspection methods or maybe it can be attributed to lack of access to equipment or materials.

Table 8

Engineering Systems

Question: Common resisting systems used in steel construction; braced frame, shear wall, and rigid frame, and the application of each system									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	18%	14%	17%	11%	13%	57%	0%	17%
2	Theory Only	67%	57%	83%	67%	63%	29%	100%	67%
3	Not covered	9%	0%	0%	22%	13%	14%	0%	17%
4	Unsure	6%	29%	0%	0%	13%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%
Question: Calculating the loads on beams and the forces caused by applied loads (shear, moment, etc.)									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	66%	83%	50%	67%	43%	86%	80%	50%
2	Theory Only	29%	17%	50%	22%	43%	0%	20%	50%
3	Not covered	6%	0%	0%	11%	14%	14%	0%	0%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	46	6	6	9	7	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	40%	30%	40%	45%	58%	47%	28%	40%

The two questions in Table 8 dealt with resisting systems and calculating loads on structural members. The first question had a majority of responders select "Theory Only" and on the second a majority selected "Theory & Practice." Due to the small percentage

for both questions that have selected "Not Covered" or "Unsure," it appears that a large percentage of schools have elected to teach these topics as part of their requirements or to fulfill the Construction Science requirement for those schools that are accredited by the American Council of Construction Education (ACCE, 2013). It is interesting to note that only six percent of respondents indicate that their school does not require students to learn about or learn how to calculate applied loads. The last question in Table 8 has one of the highest percentages for "Theory & Practice" out of all the questions related to steel.

Table 9

Crane Selection and Use

34. Items to consider when selecting the type of crane to use									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	37%	43%	33%	13%	50%	14%	40%	67%
2	Theory Only	50%	43%	67%	75%	38%	57%	40%	33%
3	Not covered	11%	14%	0%	13%	0%	29%	20%	0%
4	Unsure	2%	0%	0%	0%	13%	0%	0%	0%
	Responses per area	47	7	6	8	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	40%	67%	47%	28%	40%

35. Site conditions to take into consideration when locating and operating a crane									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	37%	43%	40%	11%	50%	29%	20%	67%
2	Theory Only	51%	43%	60%	67%	50%	43%	60%	33%
3	Not covered	12%	14%	0%	22%	0%	29%	20%	0%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	47	7	5	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	33%	45%	67%	47%	28%	40%

The responses for both of the questions in Table 9 are very similar at all levels of response. It appears that if a construction management program teaches about cranes they teach both selecting a crane and locating the crane on a project site.

In Table 10 both questions are on the use of architecturally exposed structural steel. These are the only two questions where a majority of respondents selected "Not Covered." Less than 38% of respondents have indicated that their programs cover this topic with "Theory and Practice." It is not understood why so few schools cover this topic. It may be that architecturally exposed steel is more of a specialty design feature and that it is so closely related to regular non exposed steel that most feel that it is not necessary for construction management programs to include it in their discussions.

Table 10

Architecturally Exposed Steel

36. Impact of architecturally exposed structural steel on cost and schedule									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	8%	0%	17%	11%	14%	0%	0%	17%
2	Theory Only	30%	57%	33%	33%	14%	43%	0%	33%
3	Not covered	46%	29%	33%	44%	29%	57%	80%	50%
4	Unsure	15%	14%	17%	11%	43%	0%	20%	0%
	Responses per area	47	7	6	9	7	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	45%	58%	47%	28%	40%

37. Process of determining the expectations of the designer for architecturally exposed structural steel through mock-ups and other communications									
#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	8%	0%	0%	22%	14%	0%	0%	17%
2	Theory Only	24%	43%	33%	11%	14%	14%	20%	33%
3	Not covered	53%	43%	50%	56%	43%	71%	60%	50%
4	Unsure	15%	14%	17%	11%	29%	14%	20%	0%
	Responses per area	47	7	6	9	7	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	45%	58%	47%	28%	40%

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

The purpose of this study was to determine how much content in the area of steel construction is being covered in construction management programs at universities throughout the United States. Specifically, this study was intended to determine if the content being covered at these universities matched industry expectations as identified in AISC's curriculum for construction management programs (AISC, 2013).

In this study, 55 (48%) out of the 115 people surveyed provided demographic information. The demographic questions were designed to help understand the significance of the steel questions and to help see how one region differs from another. This study showed that throughout the United States, 47% of schools graduate between 26-50 students per year, 27% of schools graduate between 1-25 students per year, 15% graduate between 51-75 students per year and 11% graduate 75+ students per year in their Construction Management programs. It is estimated that the CM programs throughout the United States bring between 3200 and 5200 graduates to the construction industry each year.

In this study, it was shown that 20 (35%) of the 55 schools that responded have 40% to 60% of their students entering into the commercial construction industry. Additionally 21 (38%) of the 55 school that responded have 60% to 80% of their students entering into the commercial construction industry. Currently 41 (75%) schools have 0%-19% of their students entering residential construction and 41 (71%) schools currently have 0%-19% of their students entering into industrial construction. The answers to the demographic questions clearly show that the largest number of graduates on the nationwide level in 2014 will be entering the commercial construction field.

Structural steel is most commonly used in commercial and industrial types of construction. In residential construction it is rare that structural steel is used. The exception is in larger homes where large distances need to be spanned or where local codes require it. This emphasizes the importance of covering the topic of steel in every construction management program's curriculum.

Out of all the questions in the survey there are four topics that stood out more than the others. The first is jobsite layout found in Table 3. Nearly all schools are teaching this concept on a universal level. A contractor building a small residential home needs to understand the concepts of jobsite layout and logistics in order to keep the project moving smoothly and keep the project site in order. This is the most likely reason that this question received such a high level of response.

The second topic that stood out was the questions that asked about scheduling and estimating found in Table 6. In the construction industry students are told that each project should be: under budget, on time, and meet quality requirements. When working with structural steel both scheduling and estimating are equally important in order to be reach two of these goals. The results indicate that more emphasis is placed on estimating of steel than on scheduling or understanding the durations of the tasks in steel construction. Both of these topics need to be understood in order to complete a project on time and under budget.

The third topic was that of calculating loads found in Table 8. The results for this topic were different because all but a very small percentage of schools taught this to their students at "Theory Only" or "Theory & Practice." Across the nation it is felt that construction managers need to understand this in order to properly manage their projects.

Reports discussed in this study suggest that biggest cause of structural failure is problems with or failure to adequately brace the structure during the construction phase. From the results of these two questions it can be clearly seen that CM programs are putting a greater emphasis on calculating loads than on understanding bracing. This is likely the number one reason for structural failures, thus students should not be able to pass through their programs without an understanding this concept.

The fourth and final topic that stood out was architecturally exposed steel. It is apparent from the results in Table 10 that few schools have felt that this topic is important enough to include in a discussion or course within their program. The reason may be that architecturally exposed steel is considered a specialty topic. Or perhaps it is seen as so similar to structural steel in general that the added information is not needed.

Recommendations

The results of this study show that all of the topics presented in the steel related questions, except for architecturally exposed structural steel, are being covered by a majority of the universities to at least a level of theory. In order to reach the level of theory and practice, this study recommends that the schools integrate each of the topics that the American Institute of Steel Construction has indicated are important into the appropriate courses.

The results of this study indicate that a majority of students are being taught about steel construction, however, if even five schools do not cover these topics it could mean up to 100 students per year that are not being prepared to enter the commercial and industrial construction industry. It is recommended that construction management

programs across the United States do all they can to incorporate AISC recommended material to at least the theory level, and preferably to the practice level.

Instructors who teach about steel should include more information about steel in their discussions, homework, tests, and laboratory experiences. If needed, instructors who lack knowledge in the area of steel construction and practices should obtain additional training.

While some steel topics may be a little more difficult to teach at the theory and practice level, most topics can be easily incorporated into current course work. For example, this could be achieved by CM programs in a course that teaches scheduling by having students schedule a building with structural steel elements. Better integration of these topics would provide the students with a more well-rounded experience so that whether they choose to work in commercial, industrial, residential, or some other type of construction area they will be better prepared for the area they choose.

Future study recommendations

1. Create a study to evaluate course of study of the schools that did not respond to this survey to see if the results match matches the results found in this survey. To prove or disprove the accuracy of the responses received in this study.
2. Create a study to evaluate if the topics covered in the curriculum provided by the American Institute of Steel Construction are relevant topics to current industry needs.
3. Create a study to evaluate if those that receive training on steel in their construction management programs perform better as project managers on steel projects than those that have not received training on steel.

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APPENDIX A

CONSTRUCTION MANAGEMENT EDUCATION SURVEY

Construction Management Education Survey

Dear Colleagues:

Here at Utah State University we are conducting a study in the area of construction management education. The purpose of this research is to gain a better understanding of the commonality of certain topics taught within construction management education programs.

You have been invited to participate in this research project because you are currently a part of the construction management education program at your university. Your name and email address was retrieved from ASC's website as the contact person for the construction management program at your university.

This short survey will take approximately 5 minutes to complete. The survey questions will be about construction education topics. Your responses will be kept confidential and as we do not collect identifying information such as your name, email address or IP address. To help protect your confidentiality, the surveys will not contain information that will personally identify you. The results of this study will be used for scholarly purposes only.

If you have any questions about the research study, please contact Jeremy Thompson, Graduate Student Researcher (jeremythompson1998@gmail.com) or Dr. Edward Reeve, Professor

This research survey has been reviewed according to Utah State University IRB procedures for research involving human subjects.

As a "Thank You" to all who are contacted to participate in this study, a summary of the results of the study will be sent to everyone who was contacted to participate in this study.

Participation in this study is voluntary, and if you do not wish to participate in this study, please decline participation by clicking on the "decline" button.

❍ Decline

Please fill out the demographics information below to help us to better analyze the overall results of this survey

- ❑ Northeast Region
- ❑ Southeast Region
- ❑ Great Lakes Region
- ❑ North Central Region
- ❑ South Central Region
- ❑ Rocky Mountain Region
- ❑ Far West Region

Indicate the approximate number of students that will graduate in your construction management program this year

- ❑ 1-25
- ❑ 26-50
- ❑ 51-75
- ❑ 76+

Indicate the percent of your graduates that typically enter the residential construction field

- ❑ 0% -19%
- ❑ 20% -39%
- ❑ 40% - 59%
- ❑ 60% - 79%
- ❑ 80% -100%

Indicate the percent of your graduates that typically enter the industrial construction field

- ❍ 0% -19%
- ❍ 20% -39%
- ❍ 40% - 59%
- ❍ 60% - 79%
- ❍ 80% -100%

Indicate the percent of your graduates that typically enter the commercial construction field

- ❍ 0% -19%
- ❍ 20% -39%
- ❍ 40% - 59%
- ❍ 60% - 79%
- ❍ 80% -100%

Please read each of the topics below, and indicate if each topic is covered with theory and practice, theory only, or not covered in the construction management program where you are currently employed. Mark unsure if you do not know.

Answer Key

Theory & Practice = In-depth coverage through lecture, demonstrations, homework, and/or practice/lab

Theory Only = Covered through Lecture and/or demonstrations

Not Covered = Not addressed or briefly mentioned

Unsure = Do not have sufficient knowledge to properly answer this question

How to coordinate between the structural steel contractor and the construction manager and/or general contractor
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Knowledge of equipment requirements and mobilization processes for structural steel construction
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Knowledge of equipment requirements and mobilization for masonry and concrete construction
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Details of composite steel construction, the components that are used, and how they are installed
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Installation process of concrete in floor applications
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Impacts that composite steel construction may have on project schedule, cost, sequence and overall management
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Use of precast concrete members, impacts on schedule, cost and management
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Scheduling of a multi-level steel structure
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Process of creating camber and why cambered beams are used
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Knowledge of situations where cambered beams should and should not be used, and how using cambered beams might affect a project
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Calculating the loads on beams and the forces caused by applied loads (shear, moment, etc.)
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Proper method of shoring for installation of concrete beams/floors
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Types of bolts and their installation methods in steel construction
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Types of bolted joints used for structural steel
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Welding terminology including weld symbols, weld types, and welding processes
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Knowledge of common weld inspection methods and considerations associated with field welding
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Knowledge of common concrete inspection methods that include slump, air content, compressive strength, etc.
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Types of steel connections used in steel construction and insights into the impacts of each type of connection on design and schedule
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Common resisting systems used in steel construction; braced frame, shear wall, and rigid frame, and the application of each system
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Concrete footing and foundation installation, proper forming practices, installation of steel reinforcement
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Responsibilities of industry participants in steel construction
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Responsibilities of industry participants in concrete and masonry construction
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

On site layout, logistics and equipment
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Knowledge of steel fabrication related activities, steel erection related activities and the durations associated with each activity
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Quantity take-off of steel components and cost estimation of materials and labor
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Quantity take-off of masonry; cost estimation of materials and labor
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Quantity take-off of concrete; cost estimation of materials and labor
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Items to consider when selecting the type of crane to use
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Site conditions to take into consideration when locating and operating a crane
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Impact of architecturally exposed structural steel on cost and schedule
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Process of determining the expectations of the designer for architecturally exposed structural steel through mock-ups and other communications
- ❍ Theory & Practice
- ❍ Theory Only
- ❍ Not covered
- ❍ Unsure

Please feel free to provide any additional comments.

APPENDIX B

REQUEST FOR DETERMINATION OF NON-HUMAN SUBJECTS RESEARCH

UtahState University
OFFICE OF RESEARCH AND GRADUATE STUDIES

Institutional Review Board

USU Assurance: FWA#00003308

Request for Determination of Non-human Subjects Research

Approved

Full Accreditation

FROM: Melanie Domenech Rodriguez, IRB Chair

True M. Rubal, IRB Administrator

To: Jeremy Thompson, Edward Reeve, Jeremy Thompson

Date: March 31, 2014

Protocol #: 5829

Title: Review Of Steel Content Coverage In Selected University Construction Management Programs

Based on the information provided to USU's IRB, it has been determined that this project does not qualify as human subject research as defined in 45 CFR 46.102(d) and (f) and is not subject to oversight by USU's IRB.

APPENDIX C

CONCRETE AND MASONRY EDUCATION QUESTIONS & RESPONSES

Question: Knowledge of equipment requirements and mobilization for masonry and concrete construction

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	47%	43%	33%	44%	63%	29%	60%	60%
2	Theory Only	43%	57%	33%	56%	38%	57%	20%	40%
3	Not covered	7%	0%	17%	0%	0%	14%	20%	0%
4	Unsure	2%	0%	17%	0%	0%	0%	0%	0%
	Responses per area	47	7	6	9	8	7	5	5
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	45%	67%	47%	28%	33%

Question: Installation process of concrete in floor applications

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	55%	57%	50%	44%	63%	43%	60%	67%
2	Theory Only	42%	43%	50%	56%	38%	57%	20%	33%
3	Not covered	3%	0%	0%	0%	0%	0%	20%	0%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: Use of precast concrete members, impacts on schedule, cost and management

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	29%	29%	17%	13%	75%	0%	20%	50%
2	Theory Only	56%	57%	67%	63%	25%	71%	60%	50%
3	Not covered	15%	14%	17%	25%	0%	29%	20%	0%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	47	7	6	8	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	41%	35%	40%	40%	67%	47%	28%	40%

Question: Proper method of shoring for installation of concrete beams/floors

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	33%	17%	50%	25%	38%	29%	20%	50%
2	Theory Only	45%	33%	50%	50%	38%	71%	40%	33%
3	Not covered	15%	33%	0%	25%	13%	0%	20%	17%
4	Unsure	7%	17%	0%	0%	13%	0%	20%	0%
	Responses per area	46	6	6	8	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	40%	30%	40%	40%	67%	47%	28%	40%

Question: Knowledge of common concrete inspection methods that include slump, air content, compressive strength, etc.

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	72%	71%	67%	100%	25%	71%	100%	67%
2	Theory Only	26%	29%	17%	0%	75%	29%	0%	33%
3	Not covered	0%	0%	0%	0%	0%	0%	0%	0%
4	Unsure	2%	0%	17%	0%	0%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: Concrete footing and foundation installation, proper forming practices, installation of steel reinforcement

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	62%	43%	67%	67%	50%	57%	80%	67%
2	Theory Only	38%	57%	33%	33%	50%	43%	20%	33%
3	Not covered	0%	0%	0%	0%	0%	0%	0%	0%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: Responsibilities of industry participants in concrete and masonry construction

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	28%	14%	0%	56%	25%	29%	20%	50%
2	Theory Only	60%	43%	100%	44%	63%	57%	60%	50%
3	Not covered	11%	43%	0%	0%	0%	14%	20%	0%
4	Unsure	2%	0%	0%	0%	13%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: Quantity take-off of masonry; cost estimation of materials and labor

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	78%	86%	67%	78%	100%	71%	80%	67%
2	Theory Only	16%	14%	33%	22%	0%	29%	0%	17%
3	Not covered	2%	0%	0%	0%	0%	0%	0%	17%
4	Unsure	3%	0%	0%	0%	0%	0%	20%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%

Question: Quantity take-off of concrete; cost estimation of materials and labor

#	Answer	US %	NE %	SE %	GL %	NC %	SC %	RM %	FW %
1	Theory & Practice	83%	86%	67%	89%	100%	71%	100%	67%
2	Theory Only	15%	14%	33%	11%	0%	29%	0%	17%
3	Not covered	2%	0%	0%	0%	0%	0%	0%	17%
4	Unsure	0%	0%	0%	0%	0%	0%	0%	0%
	Responses per area	48	7	6	9	8	7	5	6
	Recipients per area	115	20	15	20	12	15	18	15
	Response Rate	42%	35%	40%	45%	67%	47%	28%	40%