demonstrated that meaningful knowledge and greater understanding of one's role within an organization is acquired through repeated application, reflection, and discussion with others (Gherardi et al., 1998). Furthermore, perceptions of risk are not limited to work at elevation. The risks associated with truss installation also include the storage and movement of materials, the removal of packaging, material handling, setting the trusses, installing temporary bracing, hoisting, "rolling the trusses" (i.e. setting by hand), bracing and blocking, cutting the truss tails and installing fascia. In the analysis of 654 non-fatal construction incidents involving framing contractors, truss related activities were shown to be among the most hazardous, including 138 roof truss-related incidents and 15 floor truss related incidents (Mitropoulos and Guillama, 2010). A special emphasis is placed on the bracing of truss structures, as a part of both the temporary and permanent structures (Iwicki, 2010; McMartin et al., 1984; Salinas et al., 1985; Galambos and Xykis, 1991; SBCA, 2011). The SBCA publication is particularly comprehensive in this regard, providing detailed recommendations and diagrams for bracing, handling, installing and restraining trusses.

There are extensive standards of practice related to the setting of trusses. The Occupational Safety and Health Administration (OSHA) Code of Federal Regulations 29, Part 1926 (C.F.R. 29, Part 1926), Safety and Health Regulations for Construction has defined safe work practices pertaining to many aspects of truss installation, including scaffolds (subpart L), fall protection (subpart M), cranes, derricks, hoists, elevators and conveyors (subpart N), steel erection (subpart R), demolition (subpart T), and power transmission and distribution (subpart V). While the OSHA construction regulations are often used as the primary protocol for job site safety in the United States, references to truss installation are intermittent, and in searching for best practices, the information must be first drawn together and synthesized. Furthermore, subpart M, 1926.502 (k) is somewhat vague, stating that a "fall protection plan" is an acceptable alternative to personal fall arrest systems (PFAS), guardrails or safety nets, should the employer be able to demonstrate that conventional means of fall protection are infeasible, or constitute a greater hazard (OSHA Construction Industry Regulations). This is particularly relevant to the installation of trusses in residential settings, in that there is an obvious limitation to the use of Personal Fall Arrest Systems (PFAS), and other conventional means of fall protection are often perceived to be cost prohibitive. There is also a common perception that the enforcement of the OSHA regulations (1926) is comparatively lax in the residential sector and that experience and common sense adequately address potential safety concerns. It has been shown that work experience plays an important role in hazard recognition and in the avoidance of accidents (Jeong, 1998). However, we must acknowledge that proper safety training and protocol are essential to job site safety. If training methods are absent or ineffective (Kaskutas et al., 2009b), and the dynamics of the dangers are not fully understood (Mitropoulos and Guillama, 2010), further research is certainly justified. Hence, this study was initiated in the interests of further clarifying the risks associated with truss installation, and as a basis for improved safety protocols. It is believed that an analysis of truss-related incidents in the OSHA fatality and catastrophic incident database will help to achieve this research objective.

2. Method

Data were extracted from the OSHA fatality and catastrophic incident database for the years inclusive of 1990–2009. The database includes descriptions of over 15,000 incidents investigated over a twenty-year period. Truss-related fatalities were noted in the narrative descriptions of 211 incidents. These incidents were analyzed according to the following variables:

- truss characteristics,
- number of fatalities per incident,
- activity taking place at the time of the accident,
- release of the hoisting equipment,
- initiating factors,
- bracing materials,
- location of the incident,
- type of accident (fall, caught-in/between, struck by, or electrocution),
- year the fatality occurred.

Narrative descriptions of each incident were coded according to a fixed set of variables. For example, truss materials were coded as wood, steel, or unknown (if the material was not specified). Descriptive statistics were used to categorize the data. It should be noted that the OSHA database rarely includes non-fatal incidents. Rather, major injuries are only reported in this database in groups of three or more, or when coinciding with a fatality. Similarly, the number of near misses is not reported. It is therefore acknowledged that the analysis of such incidents could reveal trends not reported in this study.

3. Results

3.1. Summary findings

3.1.1. Type of construction

Eighty-nine incidents specified the type of construction project. Fifty-nine (66%) of these incidents occurred in a residential construction setting, twenty-five (28%) occurred in commercial construction, and five (6%) in industrial construction. This distribution does not seem to reflect the number of employees in each sector of the construction industry. According to the United States Department of Labor, an estimated 1.6 million people are employed in the construction industry, with approximately half employed in residential construction specifically (USDOL, 2013). There are perceived differences in the implementation of job site safety requirements from sector to sector. Safety protocols in the commercial construction sector are often stricter than they are in the residential sector. Similarly, it is often suggested that residential firms have limited resources for safety, and generally speaking, residential construction sites present distinct hazards from those present on commercial sites.

3.1.2. Number of fatalities

Of the 211 incidents examined in the OSHA database, there were 205 incidents of single fatalities, four with two fatalities per accident, one accident involving three fatalities, and one with four fatalities. While most fatality incidents pertaining to truss work involved a single fatality, the data indicate some potential for multiple fatality incidents. For example, the four-fatality incident in the study involved the collapse of 34 trusses, each 69 feet (~21 m) in length. The incident description does not explicitly refer to any kind of temporary bracing. However, it can be concluded that considerable quantities of heavy material were involved, and that the materials were not fully stabilized. The three-fatality incident report describes the temporary and loose fastening of truss and structural roof material. Two separate (single fatality) incidents describe a "domino" effect where temporary bracing was found to be inadequate. These incidents identify temporary bracing as a common element and one of the most important safety control measures in truss installation. Temporary bracing is especially important in