2022 Survey Results

Struck-by Hazards, Barriers, and Opportunities in the Construction Industry

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CONTENTS PAGE NUMBERS

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EXECUTIVE SUMMARY

Introduction

Struck-by incidents involving an object forcibly impacting a person are a leading cause of fatal and nonfatal injuries in the construction industry. To find ways to raise awareness of struck-by hazards and ways to prevent them, the National Institute for Occupational Safety and Health's (NIOSH) National Occupational Research Agenda (NORA) established a Struck-by Work Group (Work Group). CPWR – The Center for Construction Research and Training is supporting the Work Group by developing and providing access to materials and new information through an online resource, planning and hosting webinars, exploring new approaches to influence safety practices, and fielding surveys.

Since 2020, CPWR has conducted two surveys on behalf of the Work Group. The first was administered March 2020 to gain insights into the industry's understanding of struck-by hazards and inform the approach used, and materials developed, for the first Stand-Down to Prevent Struck-by Incidents. Findings from the 2020 survey and Work Group discussions led CPWR to: 1) explore the use of behavioral economics concepts and choice architecture techniques to influence decisions that could prevent struck-by incidents, and 2) begin work on a pilot project to test these techniques and develop and implement a related struck-by prevention planning program. CPWR conducted a second survey in the first quarter of 2022 to inform these efforts.

Purpose, Methods, and Participants

The 2022 survey was conducted to inform CPWR's Research to Practice (r2p) behavioral economics pilot project by: 1) further exploring causes of struck-by injuries, barriers to prevention, and ways to raise awareness and ensure use of safe practices; 2) learning about measures being taken to protect workers and the barriers to implementing controls for common struck-by hazards; and 3) gaining insights into knowledge of struck-by hazards, the role of planning in prevention, and the motivators, resources, and support needed to prevent incidents. Survey questions were developed with input from and tested by Work Group members and CPWR staff. The survey was administered online using Qualtrics® to a convenience sample of industry stakeholders between February 7th and March 4th, 2022. A total of 208 individuals participated in the survey. Participants worked most frequently in commercial construction (44.7%) and were employed by a contractor (77.9%). The majority (88.0%) had more than 10 years of industry experience and most identified as a safety and health professional (69.7%). The number of responses to each question varied because participants were not required to answer questions that were not applicable to their work and some participants did not complete the survey (i.e., attrition) – 170 participants completed all applicable questions. All responses are included in the data and analysis in this report.

Results and Discussion

This survey provided new information on barriers to prevention, steps taken to protect workers, the role of planning in prevention, gaps in the knowledge and training needed to address hazards, and ways to raise awareness and influence related safety decisions.

The primary causes of struck-by injuries involved working around heavy (construction) equipment and falling objects. One of the most notable results involved barriers to prevention: barriers that included a lack of understanding of the hazards, time constraints caused by scheduling pressures or an emphasis on

production, and a lack of training on hazard identification and prevention were among the ones selected most often for employers, workers, and each struck-by hazard. **These results suggest there may be a benefit to focusing on and considering the connections between these barriers when exploring ways to prevent struck-by injuries and developing related materials for the struck-by prevention planning program.**

There was also little variation in the protective measures taken even when measures specific to the hazard were provided as options, such as use of a full sequential nail gun. Regardless of the struck-by hazard, the protective measures taken most often were training workers, restricting access to work areas, and using personal protective equipment. Planning was also identified as playing a role in prevention. An important finding was the planning activities identified as being used most often (e.g., conduct a job hazard analysis before for begins or before a new task)were also the ones participants said they need more help to carry out: 77.9% said training is needed on how to identify and prevent a struck-by hazard; 72.7% said training is needed on how to conduct a job hazard analysis for struck-by hazards; and 60.5% said information is needed on what is working on other job sites to prevent struck-by hazards. Responses to other questions also highlighted the importance of training and information. While training was said to be one of the most common measures companies take to protect workers and best ways to raise awareness and ensure safe practices, a lack of training and a lack of understanding were among the biggest barriers. **These findings indicate that training and information gaps may be limiting the effectiveness of planning and other prevention activities. Developing a training program that covers struck-by hazard identification, how to conduct job hazard analyses, and best practices for prevention would address the biggest barriers and support more effective planning and decision-making.**

Toolbox talks, which participants selected as the best way to raise awareness of struck-by hazards and ensure safe practices, may be a quick and inexpensive way to begin filling knowledge and training gaps. In addition, **several of the other approaches (e.g., checklists) identified could be used in combination with toolbox talks and a planning-related training program to positively influence decisions. However, given the small number of contractors, site supervisory personnel, and workers that participated in the survey, there is a need to further explore the "best ways to raise awareness and ensure safe practices" with these construction stakeholders.**

Filling knowledge and training gaps does not guarantee that companies and their employees will engage in safe practices. **Consideration should also be given to how the motivators participants selected most often, such as an owner/general contractor requirement, a regulatory requirement, and a workers' compensation premium modification, could be used and expanded to positively influence safety practices.** In terms of enforcement, this survey found that safe practices were often enforced by employees who have stop work authority. **Further exploration of stop work authority's use in the construction industry and how it could be used to reduce struck-by incidents may be warranted.**

Conclusion

The survey findings identified the types of help companies need to improve their ability to develop effective plans to prevent struck-by injuries, information that can inform the selection of choice architecture techniques (e.g., reminders, prompts) and related intervention (e.g., posters) to test through the pilot program, and areas where further exploration may be warranted. As the Work Group moves forward with developing the struck-by prevention planning program and selecting and testing

choice architecture techniques and related interventions, it will be important to consider and address the connections between the biggest barriers to prevention and the planning help needed, and to further explore the best approaches (e.g., checklists, text messages) to influence decisions made by key stakeholders – construction employers, site supervisors/forepersons, and workers.

I. INTRODUCTION

Struck-by incidents involving an object forcibly impacting a person are a leading cause of fatal and nonfatal injuries in the construction industry. From 2011 to 2019, struck-by incidents accounted for roughly 17% of construction fatalities and 22% of nonfatal injuries. In 2019 alone, struck-by incidents resulted in 170 deaths and roughly 16,600 nonfatal injuries.[1] These injuries and fatalities are costly for the industry[2] and take a significant human and financial toll on affected workers and their families.

The National Institute for Occupational Safety and Health's (NIOSH) National Occupational Research Agenda (NORA) established a Struck-by Work Group [Work Group] made up of industry representatives to find ways to raise awareness of struck-by hazards and prevent related fatal and nonfatal injuries in the construction industry. CPWR – The Center for Construction Research and Training is supporting the Work Group by developing materials (e.g., toolbox talks, infographics/posters), providing ready access to materials and new information through an online resource, planning and hosting webinars, exploring new approaches to influence safety practices, and fielding surveys to engage and learn from industry stakeholders (e.g., safety and health professionals, contractors/construction employers).

Since 2020, CPWR has administered two surveys on behalf of the Work Group. The first was conducted during the first two weeks of March 2020 and coincided with the start of the national response to the COVID-19 pandemic. This survey was undertaken to gain insights into the industry's understanding of struck-by hazards and gauge support for conducting a Work Group sponsored Stand-Down[3] to raise awareness of the hazards and ways to prevent related incidents. The results of this survey informed the approach used and materials developed for the first Stand-Down to Prevent Struck-by Incidents held in April 2020.

Findings from the 2020 survey and subsequent Work Group discussions led CPWR to: 1) explore the use of behavioral economics concepts and choice architecture techniques[4] (e.g. reminders, prompts) to influence safety decisions that could prevent struck-by injuries and fatalities, and 2) begin work on a pilot project to test the use of choice architecture techniques and develop and implement a related struck-by prevention planning program. To inform the development of this pilot and what should be included in the planning program, CPWR conducted a second survey in the first quarter of 2022. This survey explored struck-by hazards, measures currently being taken to prevent them, the role of planning in prevention, and ways to raise awareness of struck-by hazards and protect workers. Although the term choice architecture technique was not used in the survey, the response options provided for raising

[1] "Fatal and Nonfatal Struck-by Injuries in the Construction Industry, 2011-2019," CPWR Data Bulletin, April 2021. https://www.cpwr.com/wp-content/uploads/DataBulletin-April2021.pdf

[2] "Preventing Struck-by Injuries in Construction," NIOSH Science Blog, October 1, 2020. https://blogs.cdc.gov/niosh-science-blog/2020/10/01/struck-by-injuries/

[3] A Stand-Down is a dedicated period of time when work is paused and workers, employers, and others focus on a specific hazard and ways to prevent related injuries and fatalities.

[4] Behavioral economics assumes that individuals do not always make fully rational or optimal decisions and uses choice architecture techniques or "*nudges*" (e.g., feedback, prompts, reminders) to move decision-makers toward better choices (decisions). A more detailed explanation of the concepts and techniques can be found in a literature review conducted by CPWR: https://www.cpwr.com/wp-content/uploads/Behavioral-Economics-Literature-Review.pdf.

awareness and protecting workers were examples of related interventions (e.g., hard hat stickers, posters, checklists).

This report presents the findings from this survey and comparisons to select results from the 2020 survey.

II. PURPOSE, METHODS, PARTICIPANTS

Purpose

The 2022 survey was conducted on behalf of the Work Group to:

1) Further explore select questions asked in the 2020 survey concerning stakeholders' perceptions of the primary causes of struck-by injuries, barriers to engaging in practices to prevent them, and ways to raise awareness and ensure use of safe practices.
2) Learn about specific measures currently being taken to protect workers from common struck-by hazards and the barriers to implementing controls for these hazards.
3) Gain insights into knowledge of struck-by hazards, the role of planning in prevention, and the motivators, resources, and support needed to prevent incidents.

Methods

The survey questions were developed with input from and tested by Work Group members and CPWR staff and administered online using Qualtrics®. A link to the survey was distributed by email to a convenience sample of industry stakeholders (e.g., contractors, workers, trainers, safety and health professionals) in CPWR's and the Work Group's networks and participants were given four weeks (February 7th to March 4th, 2022) to complete the survey. Participation was voluntary and all responses were anonymous.

The survey consisted of 43 multiple choice questions, including select questions from the 2020 survey (notable differences in wording and response options are pointed out in the "Results" section) and hazard-specific questions that participants were only prompted to answer if their work involved the hazard. Participants were required to respond to all applicable questions (e.g., hazard-specific questions) to advance through the survey. Skip patterns automatically moved a participant to the next applicable question. Only the final question was optional. However, all the questions, except for those that used scales or were yes/no questions, had an "other" response option with space for the participant to provide descriptive information so participants were not limited to the options given. At the end of the survey, participants interested in being involved in future struck-by prevention activities could voluntarily provide their contact information by clicking on a link to a separate form that was not connected to the survey.

A total of 208 individuals participated in the survey. All participants responded to the first group of questions, including ones from the 2020 survey concerning causes of struck-by injuries and barriers to prevention. The number of participants who responded to the next set of hazard-specific questions varied based on whether the hazard and related questions were applicable to their work and attrition. Overall, 170 participants completed all applicable question in the survey. All responses are included in the data and analysis in this report.

Appendix 1 contains a more detailed description of the methods and Appendix 2 contains the detailed responses for each of the hazard-specific questions.

Participants

All 208 participants responded to the demographic questions.

- Participants said they worked most frequently in commercial construction (44.7%).
- The majority (77.9%) worked for a contractor and had more than 10 years of experience in the construction industry (88.0%).
- Most identified as a safety and health professional (69.7%). The remaining participants identified as a supervisor/manager/foreperson (8.2%), trainer (8.2%), contractor/construction employer (7.7%), construction worker (1.9%), operating engineer/driver (0.5%), engineer (0.5%), or listed another role such as risk manager (3.4%).

The most notable differences between participants in this survey and the 2020 survey were that participants in the current survey were more likely to work for a contractor and less likely to identify as a trainer. These differences are likely due to the targeted outreach by some members of the Work Group to contractors (construction companies) in their networks in 2022.

Charts 1 through 4 in Appendix 1 contain additional details on the survey participants.

III. RESULTS

The following are the survey results and, where appropriate, comparisons to 2020 survey responses.

Causes of Struck-by Injuries (Comparison 2020 to 2022)

As shown in Table 1a, participants identified the primary causes of struck-by injuries as working around heavy equipment or vehicles (35.6%) and falling/flying objects from heights (29.8%) or on the same level (18.8%). Although the current survey included more detailed response options than the 2020 survey (Table 1b), the primary causes of struck-by injuries selected in both surveys involved working around heavy (construction) equipment and falling objects.

Table 1a. 2022 – Primary Cause of Struck-by Injuries* in the Construction Industry

2022 Response Options	Participants	Percent
Working around heavy equipment or vehicles	74	35.6%
Falling/flying objects from work being performed at heights	62	29.8%
Falling/flying objects when working on the same level	39	18.8%
Motor vehicle intrusions into the workspace	17	8.2%
A cave-in/collapse during trenching or excavation work	4	1.9%
Working around a mobile or tower crane	1	0.5%
Working around a load being lifted by a mobile or tower crane	0	0.0%
Collapsing buildings (e.g., when erecting walls)	0	0.0%
Other	11	5.3%
Total	208	100%

** "Incidents" was used instead of "injuries" in the 2020 survey question.*

Table 1b. 2020 – Primary Cause of Struck-by Incidents* in the Construction Industry

2020 Response Options	Participants	Percent
Construction Equipment	54	22.3%
Falling Tools/Objects	48	19.8%
Trucks & Construction Vehicles	43	17.8%
Flying Particles/Objects	36	14.9%
Motorists/ Intrusions	32	13.2%
Other	29	12.0%
Total	242	100%

** "Injuries" was used instead of "incidents" in the 2022 survey question.*

Measures Taken to Protect Workers by Struck-by Hazard

To gain insights into the steps currently being taken to protect workers from struck-by hazards, participants were asked if their work involved a specific hazard and, if it did, they were then asked what their company currently does to protect workers. As shown in Table 2, regardless of the struck-by hazard and the number of participants whose work involved the hazard, the measures taken most often were to train workers (6 hazards), limit access to the work area (6 hazards), and use personal protective equipment (4 hazards). Appendix 2 contains additional information on the number of participants who responded and specific measures taken to protect workers for each hazard.

Table 2. 2022 – Measures Taken Most Often by Companies to Protect Workers from Specific Struck-by Hazards

Struck-by Hazard	Participants Who Identified Measures *	Measures Taken Most Often to Protect Workers (Percent)**		
Falling/flying tools, materials or other objects from heights	172	Use personal protective equipment (90.7%)	Train workers (77.9%)	Use rope, tape, or other lines to mark a restricted area (72.1%)
Falling/flying tools, materials, or other objects on the same level	143	Use personal protective equipment (81.1%)	Train workers (81.1%)	Use rope, tape, or other lines to mark a restricted area (65.0%)
Heavy equipment or vehicles	172	Use personal protective equipment (83.1%)	Use back-up signals/ alarms (83.1%)	Use spotters [restrict access] (79.1%)
Motor vehicles intruding into the workspace	99	Use personal protective equipment (86.9%)	Train workers (76.8%)	Develop and implement a traffic control plan (76.8%)
Mobile/tower cranes or the loads being lifted	135	Train workers (88.9%)	Clear the area of all personnel not involved in a lift [restrict access] (78.5%)	Put up warning signs and markers [restrict access] (74.8%)
Collapsing trench walls or materials or equipment falling into a trench	137	Install a trench box (86.1%)	Train workers (83.9%)	Slope walls (82.5%)
Collapsing building (e.g., when erecting walls)	42	Train workers (90.5%)	Restrict access to areas where walls are being erected (81.0%)	Monitor weather conditions and take corrective actions (78.6%)

** The number of participants who responded varies based on whether their work involved the hazard and attrition.*

*** The percentages are based on the number of participants who said their work involves the hazard and do not add to 100% because more than one response option could be selected.*

Enforcement and Motivators to Protect Workers

One hundred and seventy-eight (178) participants responded to questions concerning how steps taken to prevent struck-by hazards are enforced and what motivates or would motivate their company to take steps to protect workers. Three out of four (74.7%) said a "foreperson or site supervisor/manager" is responsible for enforcement. This was closely followed by an employee who has "stop work authority" (69.1%), a "safety officer or health and safety committee member" (66.3%), and a "competent person" (62.4%). Roughly a fourth (24.2%) said a collective bargaining agreement requirement and 3.4% were not sure.

These participants said their company is currently or would be motivated to take steps to protect workers from struck-by hazards by a "recognition that it is a serious hazard" (61.2%), an "owner/general contractor requirement" (55.1%), a "workers' compensation insurance premium modification" (54.5%), or a "regulatory requirement" (53.9%). These were followed by a "bid requirement" and "evidence of the financial value" (both 48.3%), "scientific evidence of the value" (37.1%), and a "collective bargaining

agreement requirement" (30.9%). The remaining participants selected "other" (6.7%) or said they were not sure (5.6%).

Barriers to Engaging in Practices to Prevent Struck-by Injuries (Comparison 2020 to 2022 and by Hazard)

To understand the barriers to preventing struck-by injuries and protecting workers, participants were provided lists of possible barriers and asked to select the biggest barrier for employers and for workers, and the biggest barriers for specific struck-by hazards. The consistency in the responses was striking. While all of the barriers on the list were selected by some of the participants, barriers that included a lack of understanding to address hazards, time constraints caused by scheduling pressures or an emphasis on production, and a lack of training on hazard identification and prevention were among the ones selected most often for employers, workers, and each struck-by hazard. The following is a breakdown of the results for employers, workers, and by struck-by hazard.

Barriers for Employers (Comparison 2020 and 2022)

For employers, the barrier to engaging in practices to prevent struck-by injuries selected most often – *the biggest barrier* -- was a "lack of understanding/information to address hazards" (26.9%). The next most often selected barriers were "scheduling pressure" (25.5%) and "lack of training (hazard identification and prevention)" (23.1%). As shown in Table 3, these results were consistent with the 2020 survey findings.

Table 3. Biggest Barrier for EMPLOYERS to Engaging in Practices that Prevent Struck-by Injuries *

Response Options	2020		2022	
	Participants	Percent	Participants	Percent
Lack of understanding/information to address hazards	76	31.3%	56	26.9%
Scheduling pressure	63	25.9%	53	25.5%
Lack of training (hazard identification and prevention)	49	20.2%	48	23.1%
Costs associated with implementing controls	41	16.9%	19	9.1%
Not including materials or labor to prevent struck-by injuries in the bid	**	**	13	6.3%
Other (examples of responses: complacency, inattention, management commitment)	14	5.8%	19	9.1%
Total	243	100%	208	100%

** "Incidents" was used instead of "injuries" in the 2020 survey question.*

*** This was not a response option in the 2020 survey.*

Barriers for Workers (Comparison 2020 and 2022)

For workers, a "lack of pre-task planning" was selected most often (30.3%), followed by "emphasis on production" (22.1%) and a "lack of training" on hazard identification and prevention (20.2%). As shown in Table 4, the most notable difference between these results and the 2020 survey results was the inclusion of "lack of pre-task planning" as an option in the current survey and its selection as the biggest barrier for workers.

Table 4. Biggest Barrier for WORKERS to Engaging in Practices that Prevent Struck-by Injuries *

Response Options	2020		2022	
	Participants	Percent	Participants	Percent
Lack of pre-task planning	**	**	63	30.3%
Emphasis on production	67	27.6%	46	22.1%
Lack of training (hazard identification and prevention)	73	30.0%	42	20.2%
Lack of management commitment	65	26.7%	26	12.5%
Lack of safety equipment/tools that could reduce the risk	20	8.2%	9	4.3%
Other (examples of responses: complacency, inattention)	18	7.4%	22	10.6%
Total	243	100%	208	100%

** "Incidents" was used instead of "injuries" in the 2020 survey question.*

*** This was not a response option in the 2020 survey.*

Barriers by Struck-by Hazard

Participants whose work involved a struck-by hazard were asked to identify the biggest barriers to implementing controls to protect workers (they could select more than one from a more detailed list of options than included in the employer/worker questions). As shown in Table 5, regardless of the struck-by hazard, the barriers selected most often were "lack of understanding of how to address the hazard," "schedule pressure/emphasis on production," and "lack of training (hazard identification and prevention)." (Note: the percentage for the most often selected barrier for each hazard is in bold in the Table.)

Additional details on the number of participants who responded and barriers for each struck-by hazard can be found in Appendix 2.

Table 5. 2022 – Biggest Barriers to Implementing Controls to Protect Workers from Common Struck-by Hazards

Struck-by Hazard	Participants Who Identified Biggest Barriers *	Biggest Barriers When the Hazard is Present (Percent)**		
		Lack of understanding of how to address the hazard across different jobs and working conditions	Schedule pressure/ emphasis on production	Lack of training (hazard identification and prevention)
Falling/flying tools, materials or other objects from heights	172	**49.4%**	45.9%	36.6%
Falling/flying tools, materials or other objects on the same level	143	**44.1%**	37.8%	39.9%
Heavy equipment or vehicles	172	39.5%	**40.7%**	35.5%
Motor vehicles intruding into the workspace	99	**40.4%**	31.3%	34.3%
Mobile/tower cranes or loads being lifted	135	34.1%	**39.3%**	34.1%
Collapsing trench walls or materials or equipment falling into trench	137	41.6%	**42.3%**	39.4%
Collapsing building (e.g., when erecting walls)	42	45.2%	38.1%	**57.1%**

** The number of participants who responded varies based on whether their work involved the hazard and attrition.*
*** The percentages are based on the number of participants who said their work involves the hazard and do not add to 100% because more than one response option could be selected.*

Impact of Time Constraints

The impact of time constraints caused by scheduling and production pressures on safety was reinforced in a separate question asking about the priority companies place on safety even when work is behind schedule. Of the 170 participants who responded to this question, only a quarter (24.7%) said that safety is "always" a priority. The remaining participants said: "almost always" (39.4%), "sometimes (half the time)" (31.2%), and "almost never" or "never" (3.5% and 1.2%, respectively).

The Role of Planning in Prevention

Several questions explored the role of planning in addressing struck-by hazards. When asked if their company includes strategies to prevent struck-by incidents when planning projects, the majority (84.1%) of the 176 participants who responded said strategies are included at some stage in the planning process, and most (63.6%) said this planning occurs "both before a project starts and when it is underway." Others said their company only plans "before the project starts" (13.6%) or "when the project is underway" (6.8%). The remaining participants said their company does not "incorporate strategies to prevent struck-by incidents into project planning" (9.1%) or they were "not sure" (6.8%). Common reasons for not planning provided by the 16 participants (9.1%) whose companies do not plan were they "do not have experience planning to identify and prevent struck-by incidents," "contractors have little control over struck-by hazards produced by other contractors on job sites," and "there is no time to identify and prevent struck-by hazards because of production and schedule pressures." These

time constraints were also among the biggest barriers to prevention identified in response to an earlier question.

Planning Activities in Use

Of the 148 participants who said their company incorporates struck-by prevention strategies into their project plans, 147 provided information on the planning activities used. As shown in Table 6, all of the planning response options were selected by more than half of participants; however, the ones selected most often were "conduct job hazard analyses before work begins" (90.5%), "conduct job hazard analyses periodically before a new task or type of work begins," (83.0%), and "conduct/participate in job site meetings before the start of each shift to review struck-by hazards and steps being taken to prevent incidents, including the location and use of safety equipment, work practices, signage, and who to go to if help is needed" (79.6%).

Table 6. 2022 – Planning Activities Companies Use to Prevent Struck-by Incidents

Response Options	Participants (147 responded)	Percent *
Conduct job hazard analyses before work begins	133	90.5%
Conduct job hazard analyses periodically before a new task or type of work begins	122	83.0%
Conduct/participate in job site meetings before the start of each shift to review struck-by hazards and steps being taken to prevent incidents, including the location and use of safety equipment, work practices, signage, and who to go to if help is needed	117	79.6%
Provide/use daily checklists or job hazard analyses before each shift	112	76.2%
Provide/use tools, equipment, and/or work practices to prevent struck-by incidents	109	74.1%
Conduct/participate in training programs on struck-by hazards and prevention	108	73.5%
Conduct/participate in a meeting before the start of each lift or series of lifts with those involved to review struck-by hazards and steps being taken to prevent incidents, including characteristics of the load, methods of attachment, boom and swing angles, communication during the lift, etc.	100	68.0%
Develop and follow job site traffic control plans and internal traffic control plans	98	66.7%
Designate and identify those in charge of and knowledgeable about preventing struck-by incidents on the job site (e.g., identify a lift director before using a mobile or tower crane)	94	63.9%
Review and update plans to prevent struck-by incidents frequently at safety and production meetings with managers/supervisors/forepersons	91	61.9%
Discuss needed protective measures with the project/facility owner	90	61.2%
Include the resources (materials, equipment, labor) that will be needed in the bid	87	59.2%
Other	4	2.7%

** The percentages do not add to 100% because participants were allowed to select more than one response option.*

Motivators to Plan

One-hundred and seventy-two (172) participants responded to a follow-up question asking what motivates or would motivate their company to plan ahead to prevent struck-by incidents on job sites. The responses selected most often were "to protect workers" (73.3%), a "workers' compensation premium modifications" (56.4%), a "regulatory requirement" (54.1%), and an "owner/general contractor requirement" (52.9%). These were followed by "evidence of financial value" (45.9%), "to protect materials, tools, equipment" (44.8%), a "bid requirement" (41.9%), "scientific evidence of value"

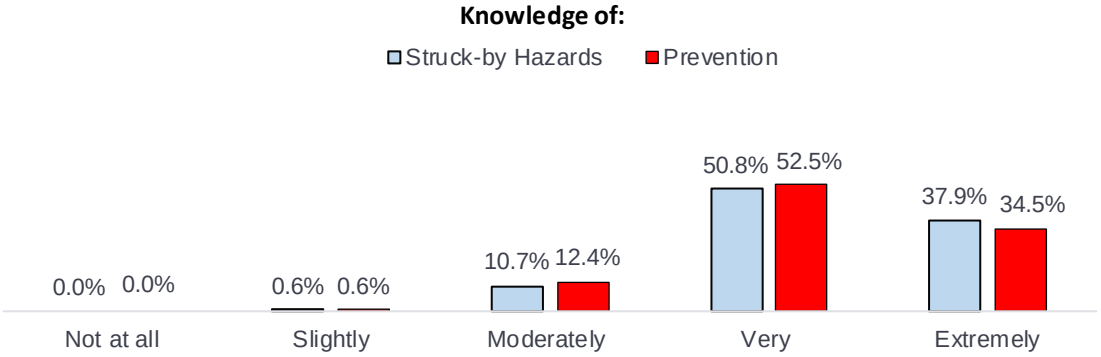
(38.4%), and a "collective bargaining agreement requirement" (29.1%). The remaining participants selected "other" (2.3%) or said they were not sure (7.0%).

Knowledge of Struck-by Hazards and Help Needed to Prevent Struck-by Incidents

While participants believe they are knowledgeable about struck-by hazards and prevention, they also identified several areas where help is needed.

Knowledge of Struck-by Hazards and Ways to Prevent Incidents

As shown in the following chart, the majority of the 177 participants who responded to questions about their knowledge of struck-by hazards and prevention said they were "very" or "extremely" knowledgeable about both struck-by hazards (88.7%) and ways to prevent them (87.0%). None of the participants said they were "not at all knowledgeable."



Help Needed to Prevent Struck-by Incidents

Although most participants indicated they were "very" or "extremely" knowledgeable about struck-by hazards and ways to prevent them, they identified several areas where additional help is needed to prevent stuck-by incidents. As shown in Table 7, of the 172 participants who responded to this question, most said they need "training on how to identify and prevent struck-by hazards" (77.9%) and "training on how to conduct a job hazard analysis for struck-by hazards" (72.7%). These results are important because, in response to an earlier question, participants said that conducting a job hazard analysis was one of the most common planning activities used. Other types of help selected by half or more of the participants were "information on what is working on other job sites to prevent struck-by hazards" (60.5%), "daily checklists to use on site that list the hazards and equipment, tools, and work practices that will be used to prevent struck-by incidents" (59.9%), "easy access to free information on how to prevent struck-by incidents" (55.2%), and "signs on job sites showing how to prevent a struck-by incident" (50.0%).

Table 7. 2022 Help Needed to Prevent Struck-by Incidents

Response Options	Participants (172 responded)	Percent *
Training on how to identify and prevent struck-by hazards	134	77.9%
Training on how to conduct a job hazard analysis for struck-by hazards	125	72.7%
Information on what is working on other job sites to prevent struck-by hazards	104	60.5%
Daily checklists to use on site that list the hazards and the equipment, tools, and work practices that will be used to prevent struck-by incidents	103	59.9%
Easy access to free information on how to prevent struck-by incidents	95	55.2%
Signs on job sites showing how to prevent a struck-by incident	86	50.0%
Signs showing how to identify a struck-by hazard	85	49.4%
Weekly checklists to use on site that list the hazards and the equipment, tools, and work practices that will be used to prevent struck-by incidents	84	48.8%
Signs on job sites showing where to find equipment/tools to prevent a struck-by incident	75	43.6%
Information on how to prevent struck-by incidents included in bid notifications	71	41.3%
Evidence that it will save money	65	37.8%
Daily text messages to crew members identifying potential hazards and work practices and/or available equipment/tools to prevent struck-by incidents	56	32.6%
Daily email messages to crew members identifying potential hazards and work practices and/or available equipment/tools to prevent struck-by incidents	44	25.6%
Other	6	3.5%

** The percentages do not add to 100% because participants were allowed to select more than one response option.*

Best Ways to Raise Awareness and Ensure Safe Practices (Comparison 2020 to 2022)

In a related question, participants were asked to select the best ways to raise awareness of struck-by hazards and ensure the use of safe practices on job sites. As shown in Table 8, while all of the options provided were selected by the 170 participants who responded to this question, the ones selected most often were toolbox talks (74.7%), training programs (71.2%), and posters/signs at various locations on the jobsite (58.8% in total for all locations highlighted). These results are consistent with the 2020 survey findings, which also identified toolbox talks (78.3%) and posters on job sites (29.9%) among the best approaches. The most notable differences between the current survey and the 2020 survey were:

- A higher percentage of participants selected "training programs" (71.2%) in the current survey than in 2020 (9.5%). This may reflect participants' identification of training needs in response to an earlier planning-related question that was not asked in the 2020 survey.
- The expanded list of response options in this survey that includes checklists, hard hat stickers, equipment stickers/labels, and text and email messages. These new options were included to help inform the selection of choice architecture techniques.

Table 8. Best Ways to Raise Awareness of Struck-by Hazards and Ensure Safe Practices *

Response Options	2020		2022	
	Participants (221 responded)	Percent **	Participants (170 responded)	Percent **
Toolbox talks	173	78.3%	127	74.7%
Training programs	21	9.5%	121	71.2%
Posters on job sites as reminders of safe practices	66	29.9%	***	***
Posters/signs near the hazard	***	***	48	28.2%
Posters/signs at the job site entrance	***	***	19	11.2%
Posters/signs near the job trailer/office	***	***	17	10.0%
Posters/signs near porta potties and break areas	***	***	16	9.4%
Checklists	***	***	37	21.8%
Videos	37	16.7%	34	20.0%
Hardhat stickers	***	***	24	14.1%
Equipment stickers/ labels	***	***	21	12.4%
Text messages	***	***	18	10.6%
Materials in company newsletters	17	7.7%	7	4.1%
Email messages	***	***	7	4.1%
Webinars	3	1.4%	6	3.5%
Other (common responses – job hazard analysis, personal stories)	45	20.4%	8	4.7%

** "Most effective ways" was the phrasing used in the 2020 survey question.*
*** Percentages do not add to 100% because participants could select more than one response option.*
**** This response option was not available in the survey.*

IV. DISCUSSION

The current survey provided new information on barriers to prevention, steps being taken to protect workers, the role of planning in prevention, gaps in the knowledge and training needed to address hazards, and ways to raise awareness and influence related safety decisions. While the make-up of the participants in this survey varied somewhat from the earlier 2020 survey, with fewer identifying as trainers and more saying they worked for a contractor, responses to questions asked in both surveys were fairly consistent, indicating that any uncertainty caused by the ongoing COVID-19 pandemic had little if any influence on participants' responses.

The primary causes of struck-by injuries continued to involve working around heavy (construction) equipment and falling objects. In terms of barriers to preventing injuries, a "lack of understanding/ information on the hazard," "scheduling pressure," and a "lack of training" on hazard identification and prevention continued to be the biggest barriers for employers. For workers, a "lack of pre-task planning," a new response option in this survey, was selected as the biggest barrier, followed by "emphasis on production" and "lack of training." A new and notable result in this survey was barriers that involved a lack of understanding, scheduling/production pressures (time constraints), and a lack of training were also among the top barriers selected for each of the struck-by hazards. These results

suggest there may be a benefit to focusing on and considering the connections between these *biggest* barriers when exploring ways to prevent struck-by injuries and developing related materials for the planning program being created by the Work Group. **Simply put, if construction employers do not have the understanding and training needed to identify and prevent struck-by hazards, then it is unlikely they will have the knowledge required to engage workers in pre-task planning activities that could address time constraints caused by scheduling and production pressures and prevent struck-by incidents. The need to address time constraints (scheduling pressures facing employers and production pressures facing workers) is particularly important because only a fourth of participants said that safety is always a priority even when work is behind schedule.**

Despite the barriers to prevention, participants identified several measures companies are currently taking to address struck-by hazards and protect workers. Regardless of the struck-by hazard, the measures taken most often were training workers, restricting access to areas where hazardous conditions are present, and using personal protective equipment. The majority of participants also identified planning, which is a best practice engaged in by safety-minded contractors,[5] as playing a role in addressing struck-by hazards and preventing injuries. Participants said the most common planning activities being used to prevent struck-by incidents were conducting job hazard analyses and conducting/participating in job site meetings to review struck-by hazards and steps to prevent incidents. It is important to note, however, that participants also said that they lack the training and information required to effectively carry out these activities:

- 77.9% said training is needed on how to identify and prevent a struck-by hazard.
- 72.7% said training is needed on how to conduct a job hazard analysis for struck-by hazards.
- 60.5% said information is needed on what is working on other job sites to prevent struck-by hazards.

The importance of training and having access to information were also raised in response to other questions in this survey. While training was identified as one of the most common measures companies take to protect workers and one of the best ways to raise awareness of and ensure use of safe practices, a lack of training and a lack of information were identified as two of the biggest barriers to engaging in prevention practices. **These findings indicate that training and information gaps may be limiting the effectiveness of planning and other prevention activities currently being undertaken. Developing a training program for those involved in the planning process, which covers struck-by hazard identification, how to conduct job hazard analyses, and best practices for prevention would address the biggest barriers and support more effective planning and decision-making.**

Toolbox talks, which participants selected as the best way to raise awareness of struck-by hazards and ensure safe practices, may be a quick and inexpensive way to begin filling the knowledge and training gaps. While CPWR and the Work Group have already developed some struck-by toolbox talks, new hazard-specific ones could cover topics such as *how to conduct a job hazard analysis*, *ways to address barriers*, and *best prevention practices*. In addition, several of the other approaches for raising awareness and ensuring safe practices could be used in combination with toolbox talks and a planning-

[5] Betit E, Strand J, Dale AM, Chang C, Schneider S, Tiedeman J, Hopwood D, Cain CT, Rempel D. "Engaging construction contractors to identify barriers and promising practices to reduce the risk for occupational injuries associated with manual materials handling." Proceedings of the Human Factors and Ergonomics Society Annual Meeting, Austin, TX, October 9–13, 2017. https://journals.sagepub.com/doi/abs/10.1177/1541931213601721

related training program to positively influence decisions. For example, job site posters or text messages could be used to reinforce key information from the toolbox talks (e.g., a safe practice) with workers, and checklists and email messages could be developed for job site management-level staff to ensure that struck-by prevention strategies included in project plans are used**. While this survey introduced some promising ideas for using choice architecture techniques to influence decisions, given the small number of contractors/construction employers, site supervisory personnel (forepersons, supervisors/managers), and workers who participated, further exploration of the "best ways to raise awareness and ensure safe practices" with these construction stakeholders is needed.**

Filling knowledge and training gaps does not guarantee that companies and their employees will engage in safe in practices. Companies must also be motivated to do so and take steps to ensure that tools, equipment, and work practices intended to prevent struck-by incidents are available and used. Participants identified several motivators for taking steps to protect workers and planning ahead to prevent struck-by incidents, including an owner/general contractor requirement, a regulatory requirement, and a workers' compensation premium modification. **Consideration should be given to how these types of motivators could be used and expanded to positively influence safety practices associated with each of the struck-by hazards.** This survey also found that steps to prevent struck-by hazards are most often enforced by a foreperson, site supervisor or manager (74.7%) and employees who have stop work authority (69.1%). **Given that stop work authority has been found to be an effective tool in preventing incidents caused by unsafe conditions in other industries,[6,7] further exploration of its use in the construction industry and how it could be used to reduce struck-by incidents may be warranted.**

V. CONCLUSION

The survey findings identified the types of help companies need to improve their ability to develop effective plans to prevent struck-by injuries, information that can inform the selection of choice architecture techniques to test through the pilot program, and areas where further exploration may be warranted. As the Work Group moves forward with developing the struck-by prevention planning program and selecting and testing choice architecture techniques and related interventions, it will be important to consider and address the connections between the barriers selected most often – the biggest barriers – to prevention and the planning help needed, and to further explore the best ways (e.g., checklists, text messages) to influence safety-related decisions made by key stakeholders: construction employers, site supervisors/forepersons, and workers.

[6] Zerarka, S. "Managing Risk through a Combination of Hazard Observation and Stop Work Authority Programs—Lessons Learned." Paper presented at the Abu Dhabi International Petroleum Conference and Exhibition, Abu Dhabi, UAE, November 2012. https://doi.org/10.2118/162246-MS

[7] Gaddis, S. "Stop Work Authority: A Principled-Based Approach." Occupational Health & Safety, December 2, 2019. https://ohsonline.com/Articles/2019/12/02/Stop-Work-Authority-A-Principled-Based-Approach.aspx?Page=1

APPENDIX 1 – ADDITIONAL DETAILS: METHODS, PARTICIPANTS

Methods

The survey questions were developed with input from and tested by Work Group members and CPWR staff. The survey was administered online to a convenience sample of industry stakeholders using the Qualtrics® platform. Email requests with a link to the survey were sent by CPWR and members of the Work Group to industry stakeholders in their networks (e.g., safety and health professionals, contractors/construction employers). Those who received the email were given four weeks to complete the survey and there was one email reminder. Participation was voluntary and all responses were anonymous. The same approach was used to develop and administer the 2020 survey; however, participants in the 2020 survey were only given two weeks to respond.

The survey consisted of 43 multiple choice questions, including ones that allowed participants to select only one response option and ones that allowed participants to select all that applied. The survey included:

- Eight questions from the 2020 survey for comparison. These questions covered participant demographics, the primary causes of struck-by injuries, biggest barriers to preventing injuries, and ways to raise awareness of hazards and use of safe practices. Notable differences in wording and response options between the 2020 and 2022 survey are pointed out in the "Results" section.
- Twenty-four hazard-specific questions covering seven common struck-by hazards identified by the Work Group. These questions included ones to determine if the hazard was applicable to participants' work and ones that participants were prompted to answer if their work involved the hazard. Participants who said their work involved a hazard were asked questions about the measures taken to protect workers and the barriers to implementing controls. Although the response options for the questions asking about the measures being taken to protect workers were tailored for each struck-by hazard, there were similarities in the options that allowed comparisons to be made. For the hazard-specific barrier questions, a more detailed list of response options was used than for the related survey questions asking about barriers faced by employers and workers; however, because there were common response options comparisons could be made. The "Results" section includes these comparisons. Responses to all hazard-specific questions can be found in Appendix 2, including the number of participants who responded to each question.
- The remaining questions covered knowledge of struck-by hazards and ways to prevent them, the role of planning in prevention, and the motivators, resources, and support needed to prevent incidents.

The survey included skip logic that automatically moved a participant to the next applicable question in the survey. Participants were required to respond to all applicable questions to advance through the survey (participants in the 2020 survey could skip questions they did not want to answer). Only the final question in the survey was optional. At the end of the survey, participants interested in being involved in future struck-by prevention activities could voluntarily provide their contact information by clicking on a link to a separate form that was not connected to the survey they had just completed. The same option was provided in the 2020 survey.

A total of 208 individuals responded to the survey (243 responded to the 2020 survey). All participants answered the first eight questions and 170 completed all applicable questions in the survey. The

number of participants who responded to the hazard-specific questions varied based on whether their work involved a hazard and attrition. The response patterns suggest that survey fatigue or time constraints may have contributed to the drop in participation over the course of the survey. Attrition may also be due to participants feeling they lacked the knowledge to respond to questions because of their role or experience in the industry.

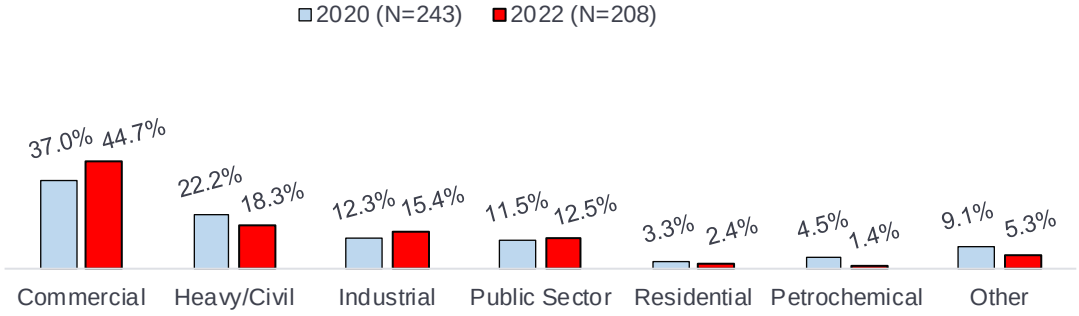
All responses to the general questions and selected responses to the hazard-specific questions are included in the "Results" section.

Limitations of both the 2020 and 2022 surveys include the small sample sizes and the lack of response rates because Work Group members who shared the survey link with their networks could not in all cases provide a precise count of people reached.

Participants

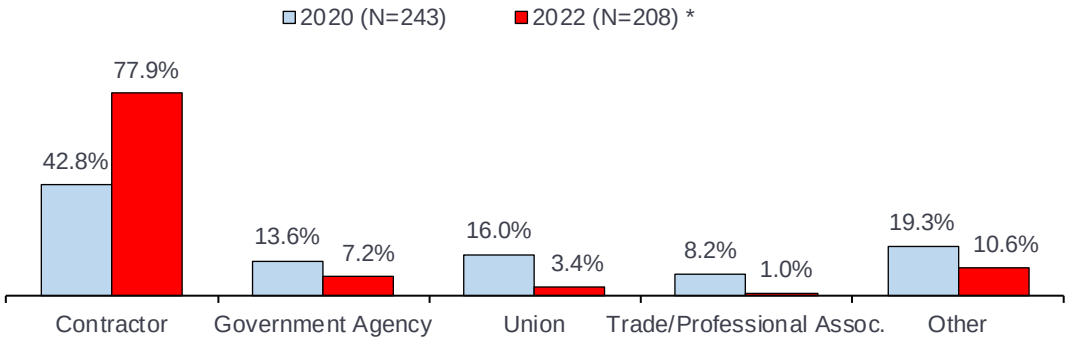
The 208 participants worked most frequently in commercial construction (44.7%). This was followed by heavy/civil, industrial, public sector, residential, and petrochemical construction. As shown in Chart 1, these results were consistent with the 2020 survey results.

Chart 1. Industry Segment Worked in Most Frequently



The majority (77.9%) worked for a specialty trade (51.0%) or general (26.9%) contractor. The remaining participants worked for a government agency, labor union, trade/professional association, or selected "other" (e.g., insurance company, manufacturer, consulting firm, university). As shown in Chart 2, participants in the 2022 survey were more likely to work for a contractor (77.9%) than participants in the 2020 survey (42.8%). This difference is likely due to the targeted outreach by some members of the Work Group to contractors (construction companies) in their networks in 2022.

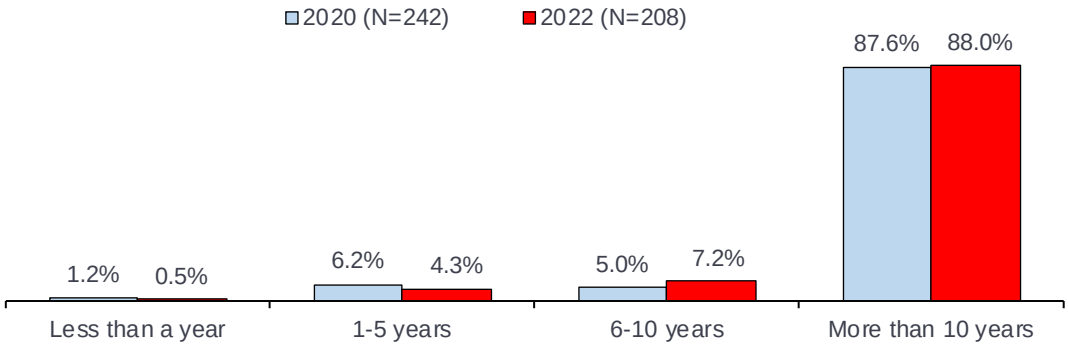
Chart 2. Where Participants Work



** The 2022 "contractor" result reflects participants who said they worked for a specialty trade contractor (51.0%) and a general contractor (26.9%). "Government agency," "union," and "trade/professional association" were not response options in 2022. The 2022 results reflect responses moved from "Other" because the descriptions provided by participants of where they work fit within one of these categories.*

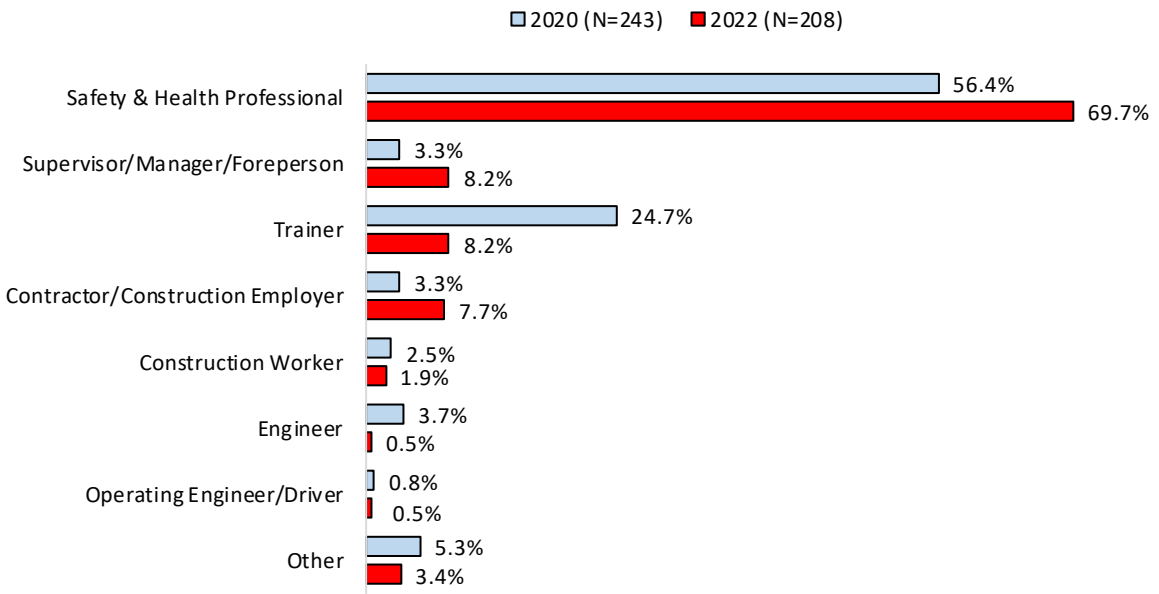
The majority of participants in both the current survey (88.0%) and the 2020 survey (87.6%) had more than ten years of experience in the construction industry, as shown in Chart 3.

Chart 3. Experience in the Construction Industry



Most identified as a safety and health professional (66.9%). As shown in Chart 4, the remaining participants identified as a supervisor/manager or foreperson, trainer, contractor/construction employer, construction worker, operating engineer/driver, engineer, or listed another position (e.g., risk manager). The most notable difference between this survey and the 2020 survey was the lower percentage of participants who identified as a trainer in the 2022 survey. Again, this difference likely reflects the targeted outreach to contractors (construction employers) by members of the Work Group for the 2022 survey.

Chart 4. Current Position Held



To get a sense of the number of workers contractors employ on individual job sites who would potentially need to be reached with struck-by information, participants who identified as a supervisor/manager/foreperson or a contractor/construction employer in the 2022 survey (33 or 15.9%) were asked how many workers their company typically employs on a job site. Although the small number of responses limits its generalizability, two-thirds (22) said their company typically employs 19 or fewer workers on a job site and, of these, 17 said their company typically employs 10 or fewer.

APPENDIX 2 – COMMON STRUCK-BY HAZARDS: MEASURES TO PROTECT WORKERS AND BARRIERS

The following are the results of questions asked in the 2022 survey for the seven common struck-by hazards identified by the Work Group. The purpose of these questions was to learn more about measures taken and barriers to implementing controls to protect workers when these hazards are present on job sites. The number of participants who responded to each question varied based on whether their work involved the struck-by hazard and attrition. Attrition could be due to participants feeling they lacked the knowledge to respond to these questions because of their role or experience in the industry or survey fatigue. The questions included ones that allowed only one response option to be selected and ones that allowed participants to select all that applied. The following is a summary of the responses for each struck-by hazard. Select results are also included in the "Results" section.

A. Falling or Flying Tools, Materials or Other Objects When Working at Heights

One hundred and eighty-seven (187) participants said they or their employees perform work at heights, as shown in Table A-1.

Table A-1. Work at Heights

Response Options	Participants	Percent
Yes	187	89.9%
No	21	10.1%
Total	208	100%

Of those, 186 identified the types of surfaces worked on when performing tasks at heights. The most common work surfaces were scaffolds (71.5%), roofs (61.8%), and decking (61.3%). These were followed by steel beams (25.3%) and bridges/overpasses/flyovers (23.1%). "Other" responses (15.6%) included, for example, aerial lifts and ladders. As shown in Table A-2, of those who identified a work surface, the majority (96.2%) said they or their employees use tools, materials or other objects that could slip or fall off the surface.

Table A-2. 2022 – Use Tools, Materials or Other Objects that Could Slip or Fall Off the Surface

Response Options	Participants	Percent
Yes	179	96.2%
No	7	3.8%
Total	186	100%

Of the (179) participants who said tools, materials, or other objects are used that could slip or fall off the surface, 172 identified ways their company prevents this from happening. The most common responses were use of toeboards (80.2%), followed by guardrails (65.1%), and tethers (61.0%). These were followed by decking and debris/safety nets (26.7% in both cases), catch platforms (12.2%), and canopies (11.0%). A few (7.6%) participants listed "other" options, for example, barricades, tool buckets, and restricting access to the work area.

These (172) participants also identified measures their company takes to protect workers from falling/flying tools, materials, or other objects when working at heights and barriers to implementing controls.

As shown in Table A-3, "personal protective equipment (e.g., hard hats, safety goggles)" was the measure taken most often (90.7%), followed by training "workers on potential hazards and the equipment, tools and/or work practices that will be used to prevent an incident" (77.9%), and restricting access using "rope, tape, or other lines to mark a restricted area" (72.1%). These were closely followed by two other ways to restrict access – "physical barriers" (65.1%) and "warning signs" (53.5%).

Table A-3. Measures Companies Take to Protect Workers from Being Struck by Falling/Flying Tools, Materials, or Other Objects when Working at Heights

Response Options	Participants (172 responded)	Percent *
Use personal protective equipment (hard hats, safety goggles, etc.)	156	90.7%
Train workers on potential hazards and the equipment, tools and/or work practices that will be in place to prevent an incident	134	77.9%
Use rope, tape, or other lines to mark a restricted area	124	72.1%
Use physical barriers to restrict access	112	65.1%
Put up warning signs	92	53.5%
Store materials six feet or more from floor openings or wall edges	88	51.2%
Stack materials to prevent sliding, falling or collapse	73	42.4%
Inspect hand tools before each shift to ensure parts cannot fly off	71	41.3%
Other	2	1.2%
None of the above	2	1.2%
Not Sure	2	1.2%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

As shown in Table A-4, the biggest barriers to implementing controls to protect workers from being struck by falling/flying tools, materials or other objects when performing work at heights were "lack of understanding of how to address the hazard across different jobs and working conditions" (49.4%), "schedule pressure/emphasis on production" (45.9%), and "lack of training (hazard identification and prevention)" (36.6%).

Table A-4. Barriers to Implementing Controls to Protect Workers from Being Struck by Falling/Flying Tools, Materials or Other Objects When Working at Heights

Response Options	Participants (172 responded)	Percent *
Lack of understanding of how to address the hazard across different jobs and working conditions	85	49.4%
Schedule pressure/emphasis on production	79	45.9%
Lack of training (hazard identification and prevention)	63	36.6%
Lack of management commitment	58	33.7%
Lack of information on how to address the hazard	53	30.8%
Not required or paid for by the project/facility owner	34	19.8%
Not a bid requirement	29	16.9%
Too costly to implement controls	25	14.5%
Too difficult to enforce	22	12.8%
Would put the company at a competitive disadvantage when bidding work	18	10.5%
Safer equipment/tools/work practices to reduce the risks are not available	18	10.5%
Not allowed by project/facility owner	6	3.5%
Other	14	8.1%
Not Sure	5	2.9%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

B. Falling/Flying Tools, Materials or Other Objects When Working on the Same Level

The 179 participants who said they or their employees use tools, materials, or other objects when working at heights that could slip or fall off the surface (section A, Table A-3) were also asked if tools or equipment are used that could result in struck-by hazards from falling/flying parts, materials, or other objects (e.g., nails from nail guns misfiring) when performing work on the same level. As shown in Table B-1, 148 participants said "Yes" they do.

Table B-1. Use Tools or Equipment that Could Results in a Struck-by Hazard from Falling/Flying Parts, Materials, or Other Objects When Performing Work on the Same Level

Response Options	Participants	Percent
Yes	148	82.7%
No	31	17.3%
Total	179	100%

Of these (148) participants, 143 identified measures their company takes to protect workers and barriers to implementing controls. As shown in Table B-2, "personal protective equipment (hard hats, goggles, etc.)" and "train[ing] workers on the hazards and equipment, tools and/or work practices that will be in place to prevent an incident" were the measures taken most often (81.1% in both cases). These were followed by restricting access by using "rope, tape, or other lines to mark a restricted area" (65.0%) and putting up "warning signs" (60.1%).

Table B-2. Measures Companies Take to Protect Workers from Being Struck by Falling/Flying Tools, Materials, or Other Objects When Performing Work on the Same Level

Response Options	Participants (143 responded)	Percent *
Use personal protective equipment (hard hats, safety goggles, etc.)	116	81.1%
Train workers on potential hazards and the equipment, tools and/or work practices that will be in place to prevent an incident	116	81.1%
Use rope, tape, or other lines to mark a restricted area	93	65.0%
Put up warning signs	86	60.1%
Inspect hand tools before each shift to ensure parts cannot fly off and strike the user or others nearby	86	60.1%
Use physical barriers to restrict access	84	58.7%
Stack materials so they are stable and self-supporting	64	44.8%
Stack materials on level, firm surfaces to prevent sliding, falling or collapse	59	41.3%
Store materials in areas that have sufficient clearance for access and handling without blocking entrances/exits or other pathways	57	39.9%
Limit height of stacked materials	51	35.7%
Stack heavy materials on the bottom	43	30.1%
Use full sequential trigger nail guns	22	15.4%
Other	2	1.4%
None of the above	0	0.0%
Not Sure	2	1.4%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

As shown in Table B-3, the biggest barriers to implementing controls to protect workers from falling/flying tools, materials, or other objects when work is being performed on the same level were "lack of understanding of how to address the hazard across different jobs and working conditions" (44.1%), followed by "lack of training (hazard identification and prevention)" (39.9%), and "schedule pressure/emphasis on production" (37.8%).

Table B-3. Barriers to Implementing Controls to Protect Workers from Being Struck by Falling/Flying Tools, Materials or Other Objects When Performing Work on the Same Level

Response Options	Participants (143 responded)	Percent *
Lack of understanding of how to address the hazard across different jobs and working conditions	63	44.1%
Lack of training (hazard identification and prevention)	57	39.9%
Schedule pressure/emphasis on production	54	37.8%
Lack of information on how to address the hazard	45	31.5%
Lack of management commitment	44	30.8%
Not required or paid for by the project/facility owner	24	16.8%
Too difficult to enforce	21	14.7%
Not a bid requirement	21	14.7%
Too costly to implement controls	15	10.5%
Would put the company at a competitive disadvantage when bidding work	15	10.5%
Safer equipment/tools/work practices to reduce the risks are not available	15	10.5%
Not allowed by project/facility owner	4	2.8%
Other	9	6.3%
Not Sure	11	7.7%

* Does not add to 100% because the 143 participants who responded were allowed to select more than one response option.

C. Heavy Equipment or Vehicles

As shown in Table C-1, 179 participants said they or their employees work around heavy equipment or vehicles on job sites.

Table C-1. Work Around Heavy Equipment or Vehicles

Response Options	Participants	Percent
Yes	179	91.8%
No	16	8.2%
Total	195	100%

Of these (179) participants, 172 identified measures their company takes to protect workers from being struck-by heavy equipment or vehicles and barriers to implementing controls. As shown in Table C-2, use of "personal protective equipment, such as retroreflective vests" and "back-up signals/alarms" were selected most often (83.1% in both cases), followed by using "spotters" to restrict access (79.1%) and "train[ing] workers on how to work safely around heavy equipment and vehicles" (78.5%).

Table C-2. Measures Companies Take to Protect Workers from Being Struck by Heavy Equipment or Vehicles.

Response Options	Participants (172 responded)	Percent *
Use back-up signals/alarms	143	83.1%
Use personal protective equipment, such as retroreflective vests	143	83.1%
Use spotters	136	79.1%
Train workers on how to work safely around heavy equipment and vehicles	135	78.5%
Use flaggers	109	63.4%
Put up warning signs and markers	104	60.5%
Conduct pre-shift meetings to discuss traffic patterns, restricted areas, signs, traffic control devices, etc. that will be used	103	59.9%
Train heavy equipment/vehicle operators on how to prevent struck-by incidents	103	59.9%
Develop and implement a traffic control plan	102	59.3%
Designate routes for work vehicles and heavy equipment (i.e., internal traffic control)	101	58.7%
Use physical barriers to restrict access to areas where heavy equipment/vehicles will be moving	99	57.6%
Use proper lighting when working at night	93	54.1%
Establish speed limits	88	51.2%
Limit where materials can be delivered to the job site	59	34.3%
Use heavy equipment with impact attenuators (crash cushions)	32	18.6%
Other	7	4.1%
None of the above	0	0.0%
Not sure	3	1.7%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

As shown in Table C-3, the biggest barriers identified by these participants (172) to implementing controls to protect workers from being struck-by heavy equipment or vehicles on job sites were "schedule pressure/emphasis on production" (40.7%), "lack of understanding of how to address the hazard across different jobs and working conditions" (39.5%), and "lack of training (hazard identification and prevention)" (35.5%).

Table C-3. Barriers to Implementing Controls to Protect Workers from Being Struck by Heavy Equipment or Vehicles

Response Options	Participants (172 responded)	Percent *
Schedule pressure/emphasis on production	70	40.7%
Lack of understanding of how to address the hazard across different jobs and working conditions	68	39.5%
Lack of training (hazard identification and prevention)	61	35.5%
Lack of information on how to address the hazard	44	25.6%
Lack of management commitment	42	24.4%
Not required or paid for by the project/facility owner	30	17.4%
Not a bid requirement	27	15.7%
Too difficult to enforce	24	14.0%
Too costly to implement controls	17	9.9%
Would put the company at a competitive disadvantage when bidding work	15	8.7%
Safer equipment/tools/work practices to reduce the risks are not available	12	7.0%
Not allowed by project/facility owner	6	3.5%
Other	15	8.7%
Not Sure	14	8.1%

* Does not add to 100% because the participants who responded were allowed to select more than one response option.

D. Motor Vehicle Intrusions

As shown in Table D-1, 100 participants said they or their employees perform work in areas at risk of motor vehicle intrusions into the workspace (e.g., sides of roads).

Table D-1. Perform Work in Areas at Risk of Motor Vehicle Intrusion

Response Options	Participants	Percent
Yes	100	53.5%
No	87	46.5%
Total	187	100%

Of these (100) participants, 99 identified measures their company takes to protect workers from being struck-by motor vehicles intruding into the workspace and barriers to implementing controls. As shown in Table D-2, the measures selected most often to protect workers were use “personal protective equipment, such as retroreflective vests” (86.9%), “develop and implement a traffic control plan” and “train workers on potential risks from motor vehicle intrusions and prevention” (76.8% in both cases). These were followed by two measures to restrict access – “use flaggers” and “put up warning signs and markers” (73.7% in both cases).

Table D-2. Measures Companies Take to Protect Workers from Being Struck by Motor Vehicles Intruding into the Workspace

Response Options	Participants (99 responded)	Percent *
Use personal protective equipment, such as retroreflective vests	86	86.9%
Develop and implement a traffic control plan	76	76.8%
Train workers on potential risks from motor vehicle intrusions and prevention	76	76.8%
Use flaggers	73	73.7%
Put up warning signs and markers	73	73.7%
Conduct pre-shift meetings to discuss traffic patterns, restricted areas, signs, traffic control devices, etc. that will be used	69	69.7%
Use physical barriers to restrict access to work areas	69	69.7%
Use spotters	65	65.7%
Use proper lighting when working at night	61	61.6%
Other	2	2.0%
None of the above	1	1.0%
Not sure	2	2.0%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

As shown in Table D-3, the barriers selected most often were "lack of understanding of how to address the hazard across different jobs and working conditions" (40.4%), "lack of training (hazard identification and prevention)" (34.3%), and "schedule pressure/emphasis on production" (31.3%).

Table D-3. Barriers to Implementing Controls to Protect Workers from Being Struck by Motor Vehicles Intruding into the Workspace

Response Options	Participants (99 responded)	Percent *
Lack of understanding of how to address the hazard across different jobs and working conditions	40	40.4%
Lack of training (hazard identification and prevention)	34	34.3%
Schedule pressure/emphasis on production	31	31.3%
Lack of information on how to address the hazard	29	29.3%
Lack of management commitment	23	23.2%
Not required or paid for by the project/facility owner	18	18.2%
Not a bid requirement	18	18.2%
Too costly to implement controls	15	15.2%
Not allowed by project/facility owner	10	10.1%
Safer equipment/tools/work practices to reduce the risks are not available	10	10.1%
Too difficult to enforce	9	9.1%
Would put the company at a competitive disadvantage when bidding work	8	8.1%
Other	10	10.1%
Not Sure	12	12.1%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

E. Mobile or Tower Cranes and Loads Being Lifted

As shown in Table E-1, 137 participants said mobile or tower cranes are used on their job sites.

Table E-1. Mobile or Tower Cranes Used

Response Options	Participants	Percent
Yes	137	73.7%
No	49	26.3%
Total	186	100%

Of these (137) participants, 135 identified measures their company takes to protect workers from being struck-by mobile or tower cranes or the loads being lifted and barriers to implementing controls. As shown in Table E-2, the measures selected most often were "train[ing] workers on how to work safely around mobile/tower cranes" (88.9%), "clear[ing] the area of all personnel not involved in a lift before the lift is performed" (78.5%), and "put[ting] up signs and markers" to restrict access (74.8%). It is interesting to note that while training workers on how to work safely around mobile or tower cranes was identified as one of the top measures that companies take to protect workers, training the "operators on how to prevent struck-by incidents" was selected least often (56.3%). **This suggests a possible gap in the training provided to operators.**

Table E-2. Measures Companies Take to Protect Workers from Being Struck by Mobile/Tower Cranes or the Loads being Lifted on Job Sites

Response Options	Participants (135 responded)	Percent *
Train workers on how to work safely around mobile/tower cranes	120	88.9%
Clear the area of all personnel not involved in a lift before the lift is performed	106	78.5%
Put up warning signs and markers	101	74.8%
Use physical barriers to restrict access to areas where mobile/tower cranes are in use	100	74.1%
Plan ahead for load dimensions, contents, pick points, and center of gravity	96	71.1%
Conduct pre-shift meetings to discuss use of mobile/tower cranes on the job site, restricted areas, signs and signals that will be used to communicate, etc.	96	71.1%
Ensure all workers are properly licensed and/or certified, if appropriate	95	70.4%
Follow equipment load limits	94	69.6%
Use spotters	93	68.9%
Restrict use of mobile/tower cranes in hazardous wind/weather conditions	92	68.1%
Inspect mobile/tower cranes before each shift to make sure all components (brakes, chains, lift hooks, slings, etc.) are in good working order	89	65.9%
Clear work areas (remove materials, debris, etc.) around mobile/tower cranes before work begins	81	60.0%
Train mobile/tower crane operators on how to prevent struck-by incidents	76	56.3%
Other	0	0.0%
None of the above	1	0.7%
Not sure	3	2.2%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

As shown in Table E-3, the biggest barriers to implementing controls to protect workers from being struck-by a mobile/tower crane or the loads being lifted were "schedule pressure/emphasis on production" (39.3%), a "lack of training (hazard identification and prevention)," and "lack of understanding of how to address the hazard across different jobs and working conditions" (34.1% in both cases).

Table E-3. Barriers to Implementing Controls to Protect Workers from Being Struck by Mobile/Tower Cranes or the Loads being Lifted on Job Sites

Response Options	Participants (135 responded)	Percent *
Schedule pressure/emphasis on production	53	39.3%
Lack of training (hazard identification and prevention)	46	34.1%
Lack of understanding of how to address the hazard across different jobs and working conditions	46	34.1%
Lack of management commitment	35	25.9%
Lack of information on how to address the hazard	29	21.5%
Not required or paid for by the project/facility owner	18	13.3%
Not a bid requirement	12	8.9%
Too difficult to enforce	9	6.7%
Too costly to implement controls	8	5.9%
Not allowed by project/facility owner	7	5.2%
Would put the company at a competitive disadvantage when bidding work	6	4.4%
Safer equipment/tools/work practices to reduce the risks are not available	6	4.4%
Other	9	6.7%
Not Sure	17	12.6%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

F. Trenching and Excavation Work

As shown in Table F-1, 137 participants said that trenching and excavation work is performed on their job sites.

Table F-1. Perform Trenching and Excavation Work

Response Options	Participants	Percent
Yes	137	74.5%
No	47	25.5%
Total	184	100%

These (137) participants identified measures taken by their company to protect workers from being struck-by collapsing trench walls or materials or equipment falling into a trench and the biggest barriers to implementing controls to protect workers. As shown in Table F-2, "install[ing] a trench box" (86.1%), "train[ing] workers on working safely in and around trenching and excavation work" (83.9%), and "slop[ing] walls" (82.5%) were the measures selected most often.

Table F-2. Measures Companies Take to Protect Workers from Being Struck by Collapsing Trench Walls or Materials or Equipment Falling into a Trench

Response Options	Participants (137 responded)	Percent *
Install a trench box	118	86.1%
Train workers on working safely in and around trenching and excavation work	115	83.9%
Slope walls	113	82.5%
Shore up walls	111	81.0%
Restrict access to areas where trenching and excavation work is being performed	109	79.6%
Assign a competent person to monitor the work	109	79.6%
Ensure there are safe entry and exit points	106	77.4%
Bench walls	104	75.9%
Inspect the trench each shift before work begins	104	75.9%
Require tools, materials, and equipment to be located at least 3 feet away from the edge of the trench	92	67.2%
Use spotters	51	37.2%
Other	3	2.2%
None of the above	2	1.5%
Not Sure	4	2.9%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

As shown in Table F-3, the biggest barriers to implementing controls to protect workers from being struck-by collapsing trench walls or materials or equipment falling into a trench were "schedule pressure/emphasis on production" (42.3%), "lack of understanding of how to address the hazard across different jobs and working conditions" (41.6%), and "lack of training (hazard identification and prevention)" (39.4%).

Table F-3. Barriers to Implementing Controls to Protect Workers from Being Struck by Collapsing Trench Walls or Materials or Equipment Falling into a Trench

Response Options	Participants (137 responded)	Percent *
Schedule pressure/emphasis on production	58	42.3%
Lack of understanding of how to address the hazard across different jobs and working conditions	57	41.6%
Lack of training (hazard identification and prevention)	54	39.4%
Lack of management commitment	34	24.8%
Lack of information on how to address the hazard	32	23.4%
Too costly to implement controls	15	10.9%
Not required or paid for by the project/facility owner	12	8.8%
Not a bid requirement	12	8.8%
Safer equipment/tools/work practices to reduce the risks are not available	11	8.0%
Too difficult to enforce	9	6.6%
Would put the company at a competitive disadvantage when bidding work	9	6.6%
Not allowed by project/facility owner	3	2.2%
Other	14	10.2%
Not Sure	14	10.2%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

G. Collapsing Buildings (e.g., when erecting walls)

As shown in Table G-1, only 42 participants said they or their employees are at risk of being struck-by collapsing buildings (e.g., when erecting walls).

Table G-1. Building Collapse (e.g., when erecting walls)

Response Options	Participants	Percent
Yes	42	22.8%
No	142	77.2%
Total	184	100%

These 42 participants identified measures taken by their company to protect workers and barriers to implementing controls. As shown in Table G-2, the measures selected most often to protect workers were "train[ing] workers on working safely during construction of walls" (90.5%), "restrict[ing] access to areas where walls are being erected" (81.0%), and "monitor[ing] weather conditions and tak[ing] corrective actions for high winds or surface run-off that could impact a wall's stability" (78.6%). These were followed by "shor[ing] up structures until permanent support elements are secured" (73.8%) and "test[ing] concrete for support strength before placing loads on structures" (50.0%).

Table G-2. Measures Companies Take to Protect Workers from Being Struck by Collapsing Buildings (e.g., when erecting walls)

Response Options	Participants (42 responded)	Percent *
Train workers on working safely during construction of walls	38	90.5%
Restrict access to areas where walls are being erected	34	81.0%
Monitor weather conditions and take corrective actions for high winds or surface run-off that could impact a wall's stability	33	78.6%
Shore up structures until permanent support elements are secured	31	73.8%
Test concrete for support strength before placing loads on structures	21	50.0%
Other	0	0.0%
None of the above	1	2.4%
Not Sure	2	4.8%

* Does not add to 100% because participants who responded were allowed to select more than one response option.

As shown in Table G-3, the biggest barriers to implementing controls to protect workers from being struck-by collapsing buildings (e.g., when erecting walls) were "lack of training" on hazard identification and prevention (57.1%), "lack of understanding of how to address the hazard across different jobs and working conditions" (45.2%), and "schedule pressure/emphasis on production" (38.1%).

Table G-3. Barriers to Implementing Controls to Protect Workers from Being Struck-by Collapsing Buildings (e.g., erecting walls)

Response	Participants (42 responded)	Percent *
Lack of training (hazard identification and prevention)	24	57.1%
Lack of understanding of how to address the hazard across different jobs and working conditions	19	45.2%
Schedule pressure/emphasis on production	16	38.1%
Lack of management commitment	15	35.7%
Lack of information on how to address the hazard	13	31.0%
Too difficult to enforce	5	11.9%
Too costly to implement controls	4	9.5%
Would put the company at a competitive disadvantage when bidding work	4	9.5%
Not a bid requirement	4	9.5%
Safer equipment/tools/work practices to reduce the risks are not available	4	9.5%
Not required or paid for by the project/facility owner	1	2.4%
Not allowed by project/facility owner	1	2.4%
Other	2	4.8%
Not Sure	4	9.5%

* Does not add to 100% because participants who responded were allowed to select more than one response option.