MAX

TWINTIER®

SAFETY SOLUTION

REBAR TYING:
Supporting the Concrete Industry with Automation Technology and Ergonomic Solutions

In 2020, American construction demand surpassed levels that haven't been seen since the 2007 housing crash and it hasn't slowed down since. But as demands rise and the availability of skilled labor continues to lull, the construction industry is faced with a production crisis. With health and safety at the top of the list for many job seekers and the cost of work-related injury claims ballooning, construction along with many industry sectors have had to face the physical hazards associated with their operations. For companies who want to capitalize on the construction boom, the need to assess work, identify hazards, and implement flexible solutions is high. In this paper a team of specialists from industrial health and product development assess rebar work to identify tangible best practices that can be implemented across the concrete industry. (Taah, S., 2023).

MSD INJURIES IN CONSTRUCTION

According to the US Bureau of Labor Statistics, in 2019 musculoskeletal disorders (MSDs) accounted for 28% of all cases of reported non-fatal injuries and diseases resulting in days away from work (US Bureau of Labor Statistics., 2021). This includes emergency room visits, hospitalizations and incidents that didn't require a visit to a medical treatment facility.

Because construction operations are physically demanding, MSDs are common in construction and account for more than half of the total injuries and illnesses in the US construction industry (Sobeih et al., 2009).

With today's construction industry facing an aging workforce, MSDs are not helping the industry either. In 2022 the median age of construction and extraction occupations workers was 41.2, and about 45% of construction workers were 45 or older (US Bureau of Labor Statistics., 2023).

Studies have shown in parts of the US that the cost per worker's compensation claims that included MSDs were highest among those aged 45–54 years averaging ($25,932/year) and 54–64 years averaging ($25,572/year) (Center of Disease Control and Prevention, 2021). This does not include the cost of lost workdays. MSDs have a significant impact on the industry financially as well.

Research has shown that MSDs are a common and substantial cause of functional impairments and disabilities among construction workers (Boschman et al., 2012).

Studies in the past have shown that rodbusters and rebar related contractors are specifically at high risk as well due to the nature of the job.

RODBUSTERS AT RISK

Rebar installers have to squat, kneel, bend over, and use their hands to tie and cut the wire, all of which place the workers at high risk of developing MSDs when the work is performed repetitively over a long period of time.

Workers carry, lay out, support, and tie the individual pieces of reinforcement together. Performing this construction work is strenuous, especially when lifting and carrying the heavy reinforcing bars and bending over to place, orient, and tie the reinforcement together repeatedly over long periods of time. As a result, rebar installers who perform the work, also referred to as “rodbusters” and “rodworkers,” are susceptible to sustaining musculoskeletal disorders.

Rebar tying by hand with pliers requires sustained deep trunk bending and rapid, repetitive, and forceful hand-wrist and forearm movements that puts limits on the amount of time workers can safely work (Albers and Hudock, 2007). Manual tying requires repeated awkward hand/wrist postures, such as extension/extension of the fingers, deviation of the ulnar cartilage in the wrist, and supination and pronation of the arm which usually increase risk of MSDs in workers (Antwi-Afari et al., 2018).

Table 9
Estimated Forces on the L5/S1 Disc Using the 3D SSPP[4]

	Trunk	Angle	Total Compression	Total Shear
	Flexion Rotation Lateral	-90° 0° 0°	2427 N	389 N
	Flexion Rotation Lateral	-90° 0° +/-25°	2857 N	306 N
	Flexion Rotation Lateral	-105° 0° 0°	1864 N	419 N
	Flexion Rotation Lateral	-105° 0° +/-25°	2322 N	480 N
	Flexion Rotation Lateral	-115° 0° 0°	1511 N	401 N
	Flexion Rotation Lateral	-115° 0° +/-25°	1930 N	501 N

NIOSH HEALTH HAZARD EVALUATION REPORT

SOLUTION: TIE REBAR WITHOUT BENDING OVER

The **MAX RB401T-E TWINTIER** Stand Up Rebar Tying tool was designed to combat injuries such as MSD among rebar contractors.

Rapid Entire Body Assessment (REBA) method was used to conduct postural analyses by observing, recording, and analyzing workers performing rebar tying. The higher the REBA score, the higher risk level of developing MSD injuries. The analysis revealed that there is convincing evidence that the mean tying REBA score while tying by hand is different than the mean tying REBA score while tying with the stand-up tool (paired t-test, p-value = 0.0035). The mean REBA scores while tying by hand was 9.47 and tying with the stand-up tool was 5.83. Tying with the RB401T-E indicating a lower risk of MSDs by 38%. (Gambatese J.A , Morakinyo O and MAX USA CORP, 2022).

REBA SCORE REDUCED 38%

REBA ASSESSMENT RESULTS

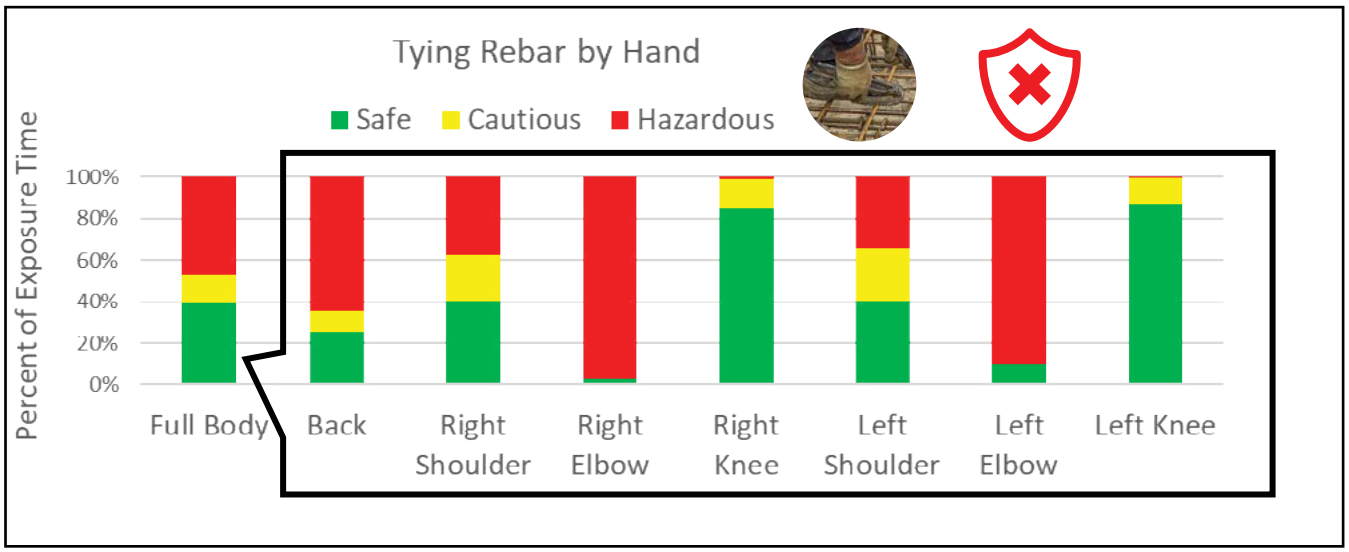
REBA Score		Analysis Results and Interpretation
TYING BY HAND	RB401T-E TWINTIER	
REBA Mean: 9.47	REBA Mean: 5.83	• There is convincing evidence that the mean tying REBA score while tying by hand is different than the mean tying REBA score while tying with the stand-up tool (paired t-test, p-value = 0.0035) • The mean tying REBA score while tying by hand is 3.27 higher on average than the mean tying REBA score while tying using the stand-up tool • With 95% confidence, the mean tying REBA score while tying by hand is between 1.79 and 4.74 higher than the mean tying REBA score while tying with the stand-up tool

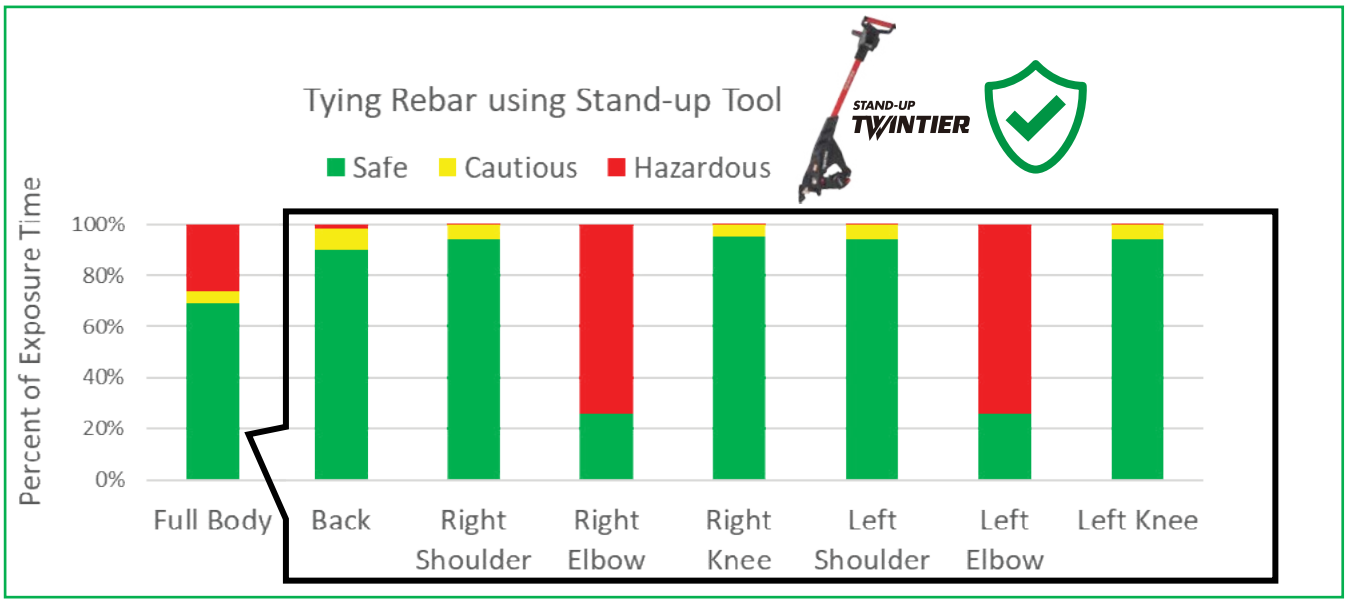
OREGON STATE UNIVERSITY 2021

Oregon State University

RB401T-E REDUCES RISK OF MSD

When comparing the mean exposure percentage while tying rebar by hand to that while tying rebar using the stand-up tool, evidence of a difference in the mean exposure time was found.





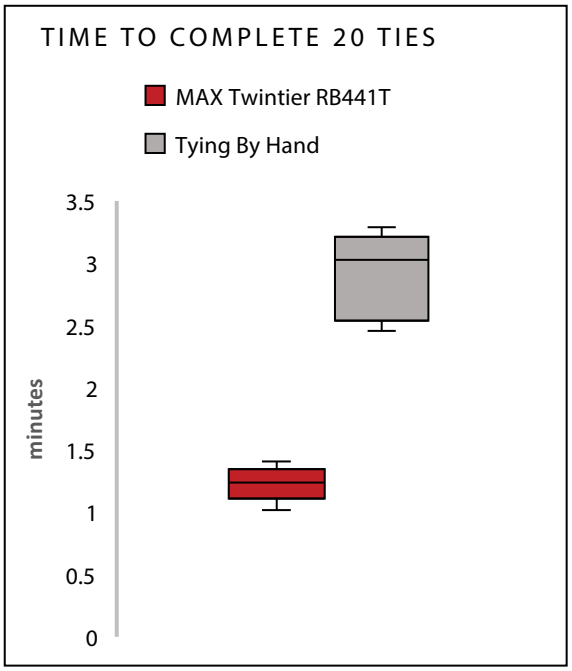
There is convincing evidence that the mean safe exposure time of the back while tying rebar by hand is different from the mean safe exposure time of the back while using the stand-up tool (paired t-test, p-value = 0.0020). It is estimated that the mean safe exposure time of the back while using the stand-up tool is 71% higher than the mean safe exposure time of the back while tying rebar by hand. **Overall, the study showed that use of the RB401T-E stand-up tool reduces worker exposure to MSD risk and improves tying productivity.** (Gambatese J.A , Morakinyo O and MAX USA CORP, 2022).

OREGON STATE UNIVERSITY 2021

Oregon State University

SOLUTION: REDUCING MSD RISK ON SLAB ON GRADE

For applications the RB401T-E TWINTIER does not apply, the handheld **MAX RB441T TWINTIER** Rebar Tying tools can be versatile in providing similar ergonomic improvements.



In 2022 a study was conducted to analyze a rodbuster team at a commercial construction site that required slab on grad rebar tying with no bar support. Baseline ergonomic risk analysis (Human Tech, 2002) rated hand tying rebar at 50 points or "Very High" indicating that the job needed immediate intervention to prevent serious injury. Most notably, the upper extremities (hands, wrists, elbows, shoulders), neck, and back returned the worst scores due to heavy loads and high repetition. The ergonomic risk analysis of the task decreased to a score of 26 (Medium) when using the RB441T (Taah, S., 2023).

ERGONOMIC RISK REDUCED 30%

ERGONOMIC RISK ASSESSMENT RESULTS

REBAR TYING ERGO Risk Scores

TYING BY HAND	RB441T TWINTIER
ERGO RISK: VERY HIGH 50	ERGO RISK: MEDIUM 26
	

Analysis Results and Interpretation

The majority of the ergonomic improvements occurred as a result of the elimination of the repetitive hand and wrist movements like flexion, extension, and ulnar deviation that occur when tying rebar by hand. In addition, there were improvements due to the elimination of high forces on the elbow and shoulder of the hand operating the gun along with decreased time spent stooping in lumbar flexion.

Athletic Training Solutions 2022

OTHER STUDIES: NIOSH HEALTH HAZARD EVALUATION

STUDY PURPOSE

Evaluate the risk that reinforcing ironworkers have for developing back and hand disorders as a result of hand-tying reinforcement steel on concrete bridge decks and other large concrete slab jobs; and investigate whether the use of reinforcing steel battery powered tying tools can be an effective intervention for the prevention of work-related musculoskeletal disorders (WMSDs) of the upper limbs and back. (Albers, J. & Hudock, S. D., 2009).

RESULT

Using a BPT (Battery Powered Tier) significantly reduced the use of rapid and repetitive hand-wrist and forearm movements characteristic of tying with the pliers, and freed one hand to support the weight of the trunk during tying. The results show that manually tying rebar using pliers involves greater risk of developing a low back WMSD than the BPT. (Albers, J. & Hudock, S. D., 2009).

ACGIH HAL-TLV ASSESSMENT RESULTS

REBAR TYING ACGIH HAL-TLV Scores

TYING BY HAND	RB392 REBAR TIER
CGIH HAL-TLV: MEAN SCORE 2.5	CGIH HAL-TLV: MEAN SCORE 0.5
	

Analysis Results and Interpretation

American Conference of Governmental Industrial Hygienists (ACGIH) Hand Activity Level Threshold Limit Value (HAL-TLV™) scores were calculated using the workers' perceived effort scores (i.e., mean, low and high) for each tying technique. Using the mean scores, the HAL-TLV ™ (0.78) would be greatly exceeded at 2.5 when pliers was used. Use of the BPT alone would not exceed the HAL-TLV™. Scores <0.56 are acceptable; scores >0.78 exceeds the TLV.

ACGIH HAL Scores for Mean Hand-Wrist Effort Tying Rebar Using Pliers, BPT, BPT+E

EFFORT	PLIERS	BPT	BPT+E
MEAN	2.5[c]	0.5[d]	0.8[c]
LOW	1.0[c]	0.3[d]	0.3[d]
HIGH	3.5[c]	1.0[c]	1.2[c]

*BPT used for this study was the RB392, which was discontinued in 2005.

*BPT+E is RB392 used with the extension arm, also available (JE400 Extension Arm).

ACGIH HAL-TLV SCORE REDUCED 80%

CDC/NIOSH 2005

OTHER STUDIES: CONSTRUCTION SAFETY ASSOCTIATION OF ONTARIO

STUDY PURPOSE

Determine the potential reduction in the risk of musculoskeletal injuries to rod workers when using an automatic rebar tying machine, and to determine the efficacy of the rebar tying machine as a rehabilitation device for the purpose of assisting injured workers in an early return to work program (Almeida, T. and Vi., P., 2004).

RESULT

Studies consistently showed a reduction in awkward posture of the trunk, wrist, and arms when rod workers worked with the rebar-tying machine. The reduction in awkward wrist/hand motion and static awkward trunk poster can lead to a reduction in the risk of musculoskeletal injuries. Working with the rebar-tying machine significantly decreased peak loading in the lower back at the L4/L5 disc joint. The cumulative loading on the back was also significantly less than during manual tying with pliers. (Almeida, T. and Vi., P., 2004).

Peak Low-Back Compression Force Results

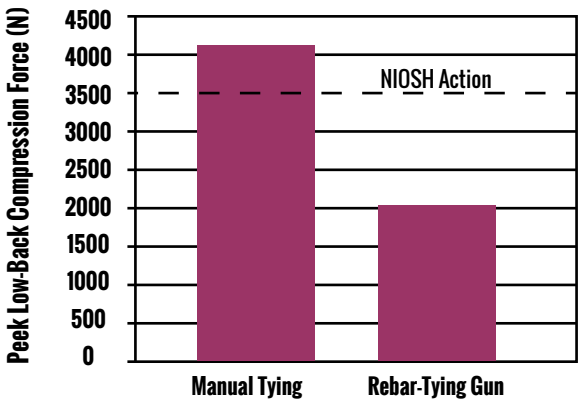


Figure 7: Tying with rebar tying gun resulted in significant (p=.018) decrease in peak loading on the lower-back (1/4:L5 disc). Manual tying exposed workers to peak compression force loading that is greater than NIOSH Action Limit (3400 N).

Peak Low-Back Compression Force Results

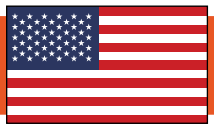
Peak Low-Back Compression Force Scores		Analysis Results and Interpretation
TYING BY HAND	RB392 REBAR TIER	
PEAK LOW-BACK COMPRESSION FORCE: 4300N	PEAK LOW-BACK COMPRESSION FORCE: 2000N	Tying with a rebar tying gun resulted in a significant (p=.018) decrease in peak loading on the lower-back (L4/L5 disc). Manual tying exposed workers to peak compression force loading that is greater than the NIOSH Action Limit (3400 N). Concrete reinforcement workers have a high rate of musculoskeletal lost-time claims. The high rate of lost-time injuries may be due to the high frequency of static awkward posture and repetitive heavy manual material handling activities.

REDUCED BY 55%

CSAO 2004

INTERNATIONAL ACCEPTED REBAR TYING SOLUTIONS

MAX invented the world's first rebar tying tools in 1993 and has been improving rebar tiers ever since. The health and safety benefits of our latest models, the TWINTIERs, have been acknowledge by various global organizations:



CPWR Construction Solutions

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Athletic Training Solutions (MAX RB441T)

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Oregon State University (MAX RB401T-E)

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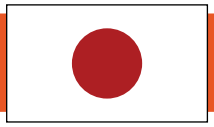
Construction Safety Association of Ontario:

Click Here For The Full Report



Japanese Ministry of Health

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BG BAU

Click Here For The Full Report

CONTACT MAX FOR JOINT CASE STUDIES AND OTHER RESEARCH

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