

Demonstration intended measure	REBAR TYING TOOL, TWINTIER WALKER MODEL, RB-400T-E SERIES
Demonstration applicant	MAX Co., Ltd.
Demonstration body	Saitama-ken Environmental Analysis & Research Association
Test period	November 4 to November 20, 2020
Purpose of this intended measure	To reduce a risk of lower back pain for the purpose of suppressing industrial injury due to lower back pain in rebar tying work.

1. Overview of Demonstration Intended Measure (For details, see 2. Overview of Demonstration Intended Measure on Pages 4 to 6 of the Demonstration Report.)



Specifications of TWINTIER WALKER MODEL, RB-400T-E SERIES

Dimensions: 322 mm x 408 mm x 1100 mm

Mass: 4.6 kg (battery pack included)

[Mechanism and features]

- The tool nose is provided with a mechanism to pick up a rebar to be tied. When coming into contact with a rebar, a contact switch is turned on by the self-weight of the tool to perform tying.
- With long full tool length and designed to be held by both hands, you can work in a stable standing position.
- Operability of the tool nose has been improved by disposing a battery at hand, the rotational center of operation.

[Effects]

- Capable of reducing a physical burden caused by deeply bending over in manually tying rebars with a hooker.
- Capable of easily aiming at a tying intersection even in a standing position.
- No need to rotate your wrists as you do in manual tying work.
- Aged workers are able to easily perform tying regardless of experience.
- Different from the conventional tools (handgun type tying tools), your finger is free from pulling a trigger switch. (Compared with our own products)

2. Overview of Demonstration (For details, see 4. Testing Method on Pages 7 to 20 of the Demonstration Report.)

2.1 Information on Testing Body and Testing Site

Testing body / testing site	Terrabyte Co., Ltd. / Fujii Bldg., 1-4-4 Ueno, Taito-ku, Tokyo, Japan (Testing laboratory) The Ohara Memorial Institute for Science of Labour / Training office, Toro Branch, Saitama-ken Environmental Analysis & Research Association (1-50-4 Torochō, Kita-ku, Saitama-shi, Saitama, Japan)
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2.2 Demonstration Items and Effects of Demonstration

◆ Testing method ◆

With a simulated rebar tying site prepared, manual tying work with hooker and mechanical tying work by demonstration intended measure were conducted under the same conditions. The effects of reduced physical burden by the demonstration intended measure were confirmed by comparing the results of lumbar disc compressive force by analytical simulation of musculoskeletal model mechanism (3 subjects), ergonomic measurement of myoelectric potential, heart rate, etc. and subjective research on load, burden and fatigue (7 subjects).

Demonstration items	Lumbar disc compressive force, myoelectric potential (erector spinae muscle, trapezius, gluteus maximus muscle, quadriceps muscle (vastus lateralis muscle)), heart rate and grip strength
Reference items	Fatigue evaluation (subjective symptom inspection, fatigue region inspection), performance evaluation (knee/lumbar joint bending and stretching count, tying count, erroneous tying count) and after-the-fact usability evaluation (operability, burden on lumbar, working speed, safety)
Effects	Reduced risk of lower back pain, operability and efficacy

2.3 Demonstration Schedule

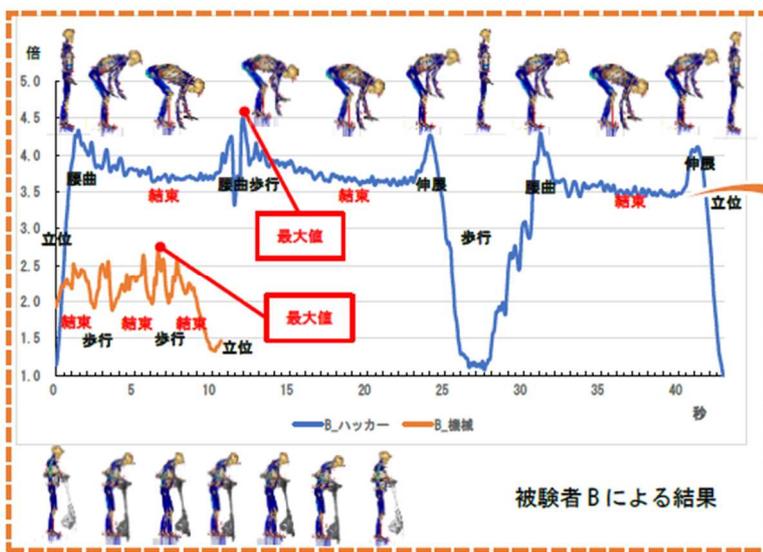
	Aug. 2020	Sep.	Oct.	Nov.	Dec.	Jan. 2021	Feb.	Mar.
Selection meeting	● Selection							● Report on demonstration results
Demonstration review meeting and inspection			● Approval of plan	● Inspection	●		● Interim report	● Approval of report
Planning / Testing / Report	← Planning		▶ Testing and summarization of results			▶ Preparation of draft report		

3. Test Results and Considerations (For details, see 5. Test Results and Considerations on Pages 21 to 45 of the Demonstration Report.)

3.1 Results of Demonstration Items

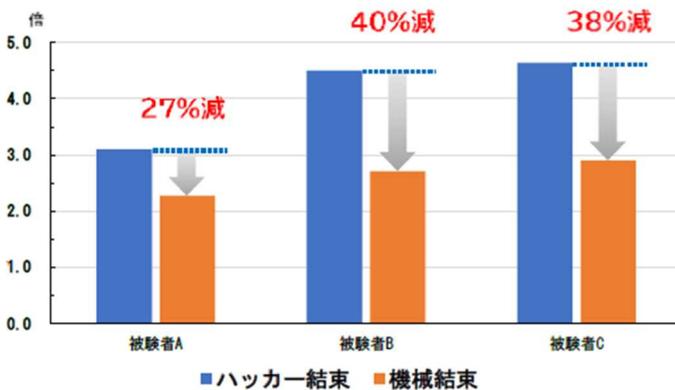
◆ Lumbar disc compressive force (Lumbar load index) ◆

- Compared with manual tying work with the hooker requiring frequent bending and stretching of the lumbar, tying work by the demonstration intended measure capable of tying in a standing position caused less fluctuations of the lumbar disc compressive force, clearly reducing the risk of lower back pain (n = 3).



倍 : Times
 立位 : Stand
 腰曲 : Bend over
 結束 : Tie
 腰曲歩行 : Bend over and tie
 歩行 : Walk
 伸展 : Stretch
 最大値 : Max. value
 B_ハッカー : B_Hooker
 B_機械 : B_Machine
 被験者 B による結果 : Result by subject B

- With lumbar disc compressive force (minimum value) in the standing position being 1.0 in manual tying work with the hooker, each lumbar disc compressive force was compared with that in relative value. In tying work by the demonstration intended measure, the lumbar disc compressive force generally transitioned at 2 to 2.5 times. In tying work with the hooker, however, it transitioned at 3 to 4 times, causing approx. 1.5-time load.



倍 : Times
 27%減 : 27% lower
 40%減 : 40% lower
 38%減 : 38% lower
 被験者 A : Subject A
 被験者 B : Subject B
 被験者 C : Subject C
 ハッカー結束 : Tying with hooker
 機械結束 : Mechanical tying

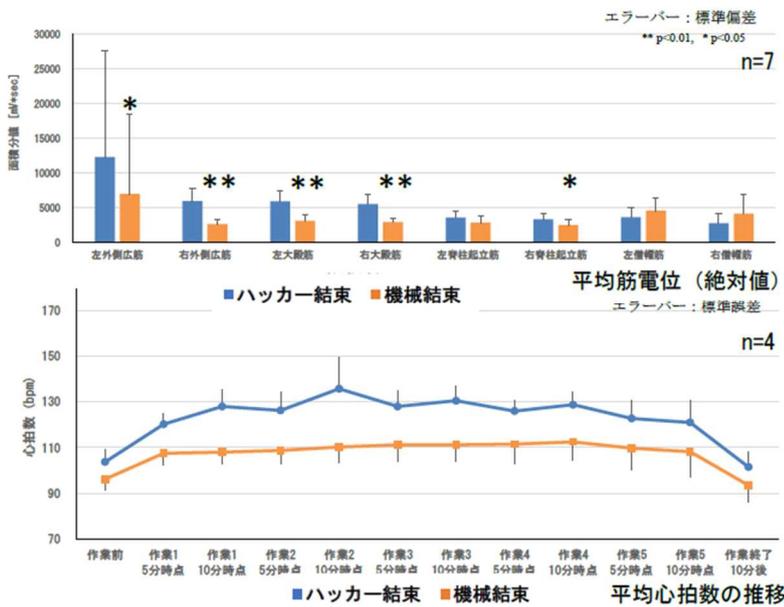
For a reduction rate by comparison of the maximum value, it was confirmed that tying work by the demonstration intended measure had reduced the lumbar disc compressive force by **approx. 27% to 40%** than tying work with the hooker.

* Calculated from the simulation results.

◆ Myoelectric potential, heart rate and grip strength (Muscle activity, cardiovascular system and arm load index) ◆

- It was made clear that a burden on the lower limbs is reduced by using the demonstration intended measure. On the other hand, there is a possibility of receiving a load to the arm because an about 5-kg tying tool has to be carried.
- A heart rate increase in tying work by the demonstration intended measure was lower than that in tying work with the hooker, indicating that a burden on the cardiovascular system is less in tying work by the demonstration intended measure.
- There were concerns about a decrease in grip strength as a result of a load applied to the arm, but a

statistically significant decrease in grip strength was not found out, compared with conventional work.

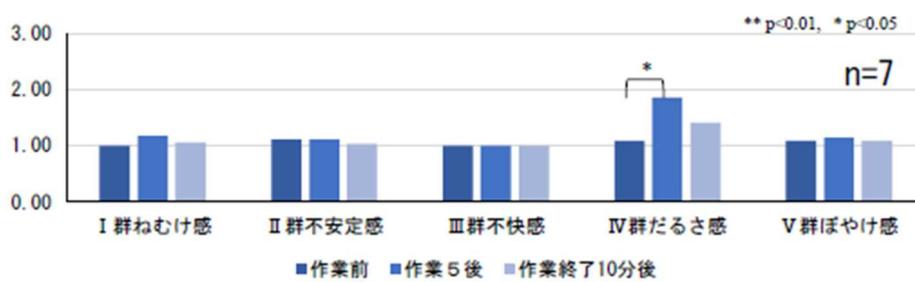


面積分値: Surface integral value
 左外側広筋: Left vastus lateralis muscle
 右外側広筋: Right vastus lateralis muscle
 左大殿筋: Left gluteus maximus muscle
 右大殿筋: Right gluteus maximus muscle
 左脊柱起立筋: Left erector spinae muscle
 右脊柱起立筋: Right erector spinae muscle
 左僧帽筋: Left trapezius
 右僧帽筋: Right trapezius
 平均筋電位 (絶対値): Average myoelectric potential (Absolute value)
 エラーバー: 標準偏差: Error bar: Standard deviation
 ハッカー結束: Tying with hooker
 機械結束: Mechanical tying
 心拍数: Heart rate
 作業前: Before work
 作業 1、5 分時点: Work 1 in 5 min.
 作業 1、10 分時点: Work 1 in 10 min.
 作業終了、10 分後: In 10 min. after work
 平均心拍数の推移: Transition of average heart rate
 エラーバー: 標準誤差: Error bar: Standard error
 ハッカー結束: Tying with hooker
 機械結束: Mechanical tying

3.2 Results of Reference Items

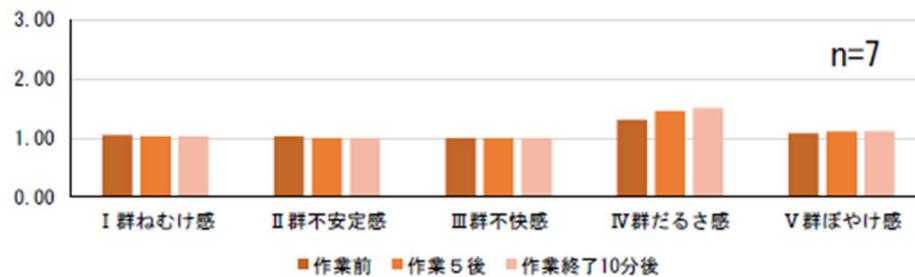
◆ Fatigue evaluation (Subjective symptom inspection, fatigue region inspection) ◆

- Group IV “Dullness after Work 5”, highest score in tying work with the hooker, was significantly high, compared with “before work”. Seeing the symptoms of Group IV, the symptom “dull legs” showed a significantly high value, compared with “before work”.
- There was no significant difference in tying work by the demonstration intended measure. Concerning Group IV “Dullness”, however, fatigue tended to accumulate after work as well.



I 群ねむけ感: Group I, Sleepiness
 II 群不安定感: Group II, Unsteadiness
 III 群不快感: Group III, Discomfort
 IV 群だるさ感: Group IV, Dullness
 V 群ぼやけ感: Group V, Fuzziness
 作業前: Before work
 作業 5 分後: After work 5
 作業終了 10 分後: In 10 min. after work

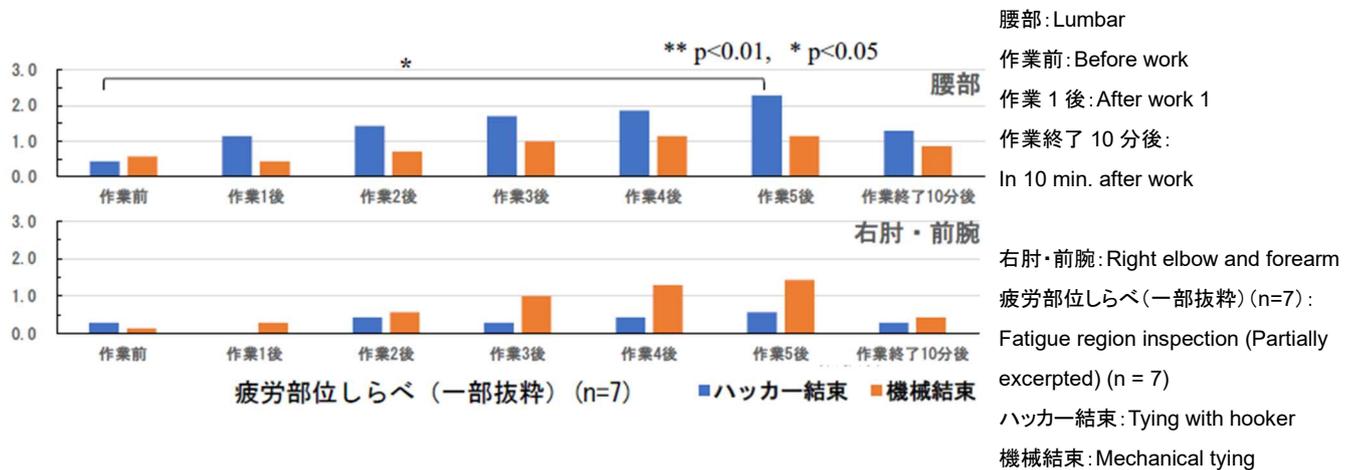
Subjective symptom inspection in tying with hooker (By group)



I 群ねむけ感: Group I, Sleepiness
 II 群不安定感: Group II, Unsteadiness
 III 群不快感: Group III, Discomfort
 IV 群だるさ感: Group IV, Dullness
 V 群ぼやけ感: Group V, Fuzziness
 作業前: Before work
 作業 5 分後: After work 5
 作業終了 10 分後: In 10 min. after work

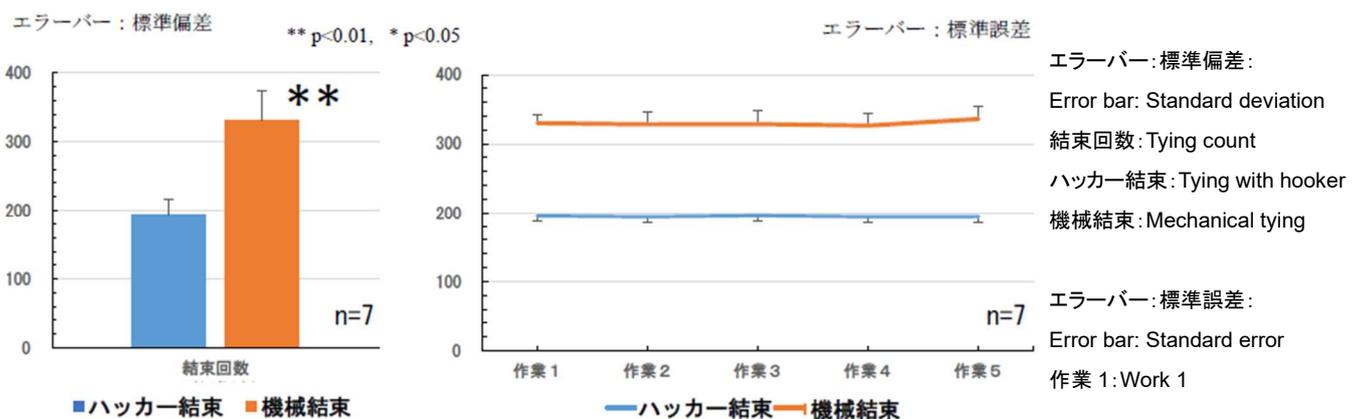
Subjective symptom inspection in tying by demonstration intended measure (By group)

- The demonstration intended measure was effective for reducing the fatigue of the “lumbar”, “buttock”, “thigh”, and “knee and lower limb” regions noticeable in tying work with the hooker. On the other hand, there was no significant difference as to the elbow and forearm regions, but there was a tendency of increasing fatigue as work progresses.



◆ Performance evaluation (Tying count, erroneous tying count, knee/lumbar bending count) ◆

- A tying count during an identical time of 10 minutes was 194.9 times on the average (equivalent to 1.4 sections (approx. 10.2 m²) of the simulated rebar tying site in demonstration test) in the case of tying with the hooker and 330.0 times (equivalent to 2.4 sections (approx. 17.5 m²)) in the case of tying by the demonstration intended measure.
- Since an incidence of erroneous tying in initial mechanical tying work by the demonstration intended measure was 0.7%, it was presumed that workers would be able to get accustomed to handling the tying tool in a relatively early stage and adapt themselves to work. There was no occurrence of mechanical erroneous tying (mechanical error) due to defects of the demonstration intended tool.
- It was found out that the demonstration intended measure allowed tying work without frequently bending the lumbar and knees as before.



Average tying count and transition

◆ After-the-fact usability evaluation (Operability, burden) ◆

➤ As a whole, there were very satisfactory responses, indicating that the demonstration intended measure is acceptable to aged workers. Among evaluation comments, there were requests for further weight reduction of the tool and fine adjustability of the length according to the stature, etc.



3.3 Operation and Maintenance Items

Management item	Description
User-friendly instruction manual	Maintenance such as daily inspection is not particularly troublesome. However, it is a precision tool, and in case it fails to function properly, it is necessary to stop using it and consult its manufacturer. It is available for daily usage, requiring no special skills, etc.
Easily replaceable tie wire	
Easy daily inspection	

3.4 Findings (Considerations)

Item	Finding
Effect of reducing the risk of lower back pain	Concerning rebar tying work which has been manually done in a forward bending position so far, the demonstration intended measure combined with automated mechanical work allows easier work without assuming an uncomfortable posture. It is highly expected to reduce the risk of lower back pain of aged workers.
Operability and efficacy	The demonstration intended measure requires no high skills and is easily acceptable to aged workers and effective for improving work efficiency.
Labor required for operation and maintenance	As operational notes for an on-site supervisor who supervises aged workers, it is necessary to properly set a daily work volume (scope of work) and work hours and give a sufficient break time between work because the demonstration intended measure may accumulate a burden on the arms.

4. Reference Information (For details, see Reference Information on Pages 46 and 47 of the Demonstration Report.)

Note: This information has been presented by an applicant for demonstration of safety and hygiene control measures for age workers at its responsibility and cited from that information. It is excluded from the scope of demonstration.

4.1 Safety and Hygiene Control Data for Aged Workers

Item		Filled in by applicant for demonstration			
Measure name / Type		REBAR TYING TOOL, TWINTIER WALKER MODEL / RB-400T-E-B2C/1440A			
Manufacturer (seller)		MAX Co., Ltd.			
Contact	Address	6-6 Nihonbashi Hakozaki-cho, Chuo-ku, Tokyo, Japan			
	Department	Mr. Takanori Ban, RB Business Promotion Office			
	Phone / Fax	Phone: +81-3-3669-8120 / Fax: +81-3-5695-7916			
	URL	https://www.twintier.global/jp/			
	E-mail	t-ban@max-ltd.co.jp			
Intended purpose for introduction		Prevention of lower back pain of aged workers engaged in reinforcement work			
Ancillary equipment		None			
Rough cost estimation (yen)		Expense item	Unit price (yen)	Quantity	Total (yen)
* Information assuming a buyer		* Standard retail price			
In the case of tying about 7,050 times (D13 x D13 equivalent) per unit on a monthly basis		Initial cost			320,000
		Main body	320,000	1 unit	320,000
		Monthly running cost			10,100/month
		Exclusive tie wire TW1060	9,600/c/s	1c/s	9,600/month
		* Maintenance cost	6,000/year	Once a year	500/month

4.2 Other Information from Manufacturer

- MAX has developed the rebar tying tool “TWINTIER WALKER MODEL” allowing anyone to perform tying work in a standing position. We believe that this rebar tying tool will greatly contribute to reduction of industrial injury due to lower back pain and improvement of production efficiency.
- “TWINTIER WALKER MODEL” is an unprecedented advanced tying tool capable of tying in a standing position while reducing a physical burden and without impairing workability.
- This construction tool can easily aim at a tying intersection, requires no rotation of your wrists as you do in manual tying work, frees your finger from pulling a trigger switch as is the case with the conventional tools, reduces a physical burden of deeply bending over, thereby allowing even a new aged worker to easily handle it without skills. Highly reputed as the TWINTIER SERIES having been marketed since 2017, it features a tying force, tying speed and short twisting allowance.