DEVELOPMENT OF A DEVICE TO REPLACE BROKEN BALE TIES

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Abstract

A portable device was developed to enable replacement of broken bale ties after initial packaging at the gin. The device can be operated by one person and can repair bales in 5-10 minutes. The device returns the bale to its original density and a standard length tie is installed. The device can be operated in the vertical or horizontal mode. It can be installed on a trailer or it can be positioned with a forklift to meet operational needs. The low-cost device provides a solution to replacing bale ties at the gin or in subsequent shipping or storage operations.

Introduction

The cotton industry is plagued by occasional problems with failure of the restraining ties (straps/wires) that encircle a bale of cotton and produce bales similar to the bale in Figure 1. The failure may be caused by a number of problems such as insufficient compression density, insufficient relaxation of the bale caused by ties that are not matched to the compression density, failure to engage the joint properly, insufficient moisture in the cotton, poor lint distribution in the bale press, improper handling after the bale is removed from the press, defective bale ties, improper storage, etc. A 500-lb bale of cotton is usually compressed at a cotton gin by a hydraulic press capable of delivering 750,000 to 1,000,000 pounds of force over a cross-sectional area of about 1,080 inches (20" by 54"). Six or eight ties (wire, cold-rolled steel straps, or polyester straps) with specified break strengths at the connection (joints) are used to restrain the packaged bale.

About 0.4% of the bales produced in the United States experience broken ties, although some gins may have failures on over 50% of the bales produced. One warehouse reported that 13.6% of their more than one million bales required repair for the 1995 crop year. Another warehouse reported a failure rate of 0.8% for the same crop year. Typically, from one to four ties break per bale causing the bale to 1) expand in the defective area from its original 28-30" up to 38-40", 2) occupy more shipping space, 3) become more susceptible to contamination, and 4) face rejection by the mill customer. This breakage may occur at the gin in seconds or days after packaging, in days or months at the warehouse, during transit, during subsequent storage, and during shipping or handling. When breakage occurs at the gin, the bale can be unpacked by removing all the restraint materials, placing it in the bale press by hand, recompressing, and applying new restraint materials in a costly and time-consuming operation. About 30 minutes are required per bale as compared to the 1-minute required initially. Entire bales may also be placed in a press, recompressed, and the defective ties replaced. However, this procedure may cause damage to the press. The repair also requires that the gin cease normal ginning operations. When this breakage occurs after the bale leaves the gin, the bale must be returned to a gin or facility that has a press for repackaging. Repair costs range from $10 to $45 per bale depending on the availability of a bale press. For a 20 million bale crop, about 800,000 bales require repair at a potential cost of $8 to $28 million. The purpose of this investigation was to develop a method to replace broken bale ties.

Discussion

When four ties are broken on a gin universal density bale of cotton, it expands to about 40" in thickness. Recompressing the bale in the defective area requires forces to increase exponentially in a manner similar to that indicated in the Cotton Ginners Handbook (USDA 1994). Tests with a 4" wide platen that had a 1" groove in the center indicated force requirements as shown in Table 1. Similar tests with a 0.875" by 21" platen with a 0.25" groove in the center are shown in Table 2. A platen separation of 19.75" was achieved with 20 tons of force on the 0.875" platen whereas only a platen separation of 22.81" was achieved with the 4" wide platen. Thus, analysis of the above data suggests that the compressive area should be as small as possible. Other tests with a wedge-shaped platen disclosed that the tie was very difficult to apply because the wedge was so deeply concealed in the bale.

Based on analysis of the data, an inexpensive, mobile device was developed to recompress the bale only in the area of the defective ties to allow replacement of individual or multiple ties. The device uses a "compressive platen" that is only 0.75" wide and 21" long with a 0.25" groove on the top in the center to allow the tie to exit after the pressing operation. This provides a pressing area of 15.75 rather than 1,080 square inches. The platen is 4"deep and is reinforced with a 4" x 2" steel bar. The tie is inserted in the platen via a 1" diameter hole that runs the full length of the platen. The ends of the platen reinforcing bar are lined with brass and slide in a guide to maintain placement and alignment. The proper amount of compression force (typically 60,000 pounds) to allow placement of the tie and to preclude subsequent tie breakage is applied to the bale in the affected area and the ends of the steel tie are connected. The platens are pressed to a 20" separation which produces a density of about 40 lb/ft^3. The connection is then rotated to the rounded side of the bale to take advantage of the

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lower resilient forces that usually occur on the top of the bale.

Steel channel beams are used to construct the frame and cross beams of the device. The top two feet of the vertical channel beam frame has 1" diameter holes drilled every four inches to allow the top cross beams to be adjusted vertically to accommodate different sized bales. The top cross beams are welded together so that they form a box that is 0.125" wider than the vertical beams. The boxed beams provide rigidity in the horizontal direction, and enable pins to be used for vertical adjustment and greatly facilitate operation.

Two operational modes are available--manual (Figure 2) and automated (Figure 3). The manual mode uses three, hand-operated hydraulic jacks rated at 30 tons each with a 7" stroke. Two jacks are mounted in series on the bottom of the device while the third is mounted on the top section. The series jacks are restrained by encircling tubing welded to the frame to prevent leaning. The entrance and exit to the press are provided by rollers mounted on a table so that only one operator is required after the bale is placed on the table (Figure 3). The bale is positioned with the platens near one of the defective areas, the jacks manually activated to compress the bale to a platen separation of 20" and the tie applied. The jacks are placed off center across the 30" width of the press to allow adequate space for the connection of the tie to be made on one side of the bale. A channel is also provided on the narrow side of the upright channel to hold the tie in place during compression of the bale and to guide the tie. After the tie connection is made and the joint rotated, the jacks are released sufficiently to allow the bale to roll to the next defective location, and the process repeated.

The automated version simply requires replacement of the manual jacks with hydraulic cylinders capable of delivering 30 to 50 tons of force. The primary benefits are the reduction of manpower requirements, fatigue, and an increase in the speed of ram travel that reduces cycle time. The automated version replaces 1 to 4 bale ties in 5 to 10 minutes.

The press provides a means to repair a defective bale of cotton onsite with a portable device. Repair of a bale with the vertical version of the device is shown in Figure 3. The device works equally well in the horizontal mode or the vertical mode. It can also be mounted on a trailer for even greater flexibility (Figure 4). Two prototypes have been built and are being tested by a private company during 1997 and 1998. One operator is required for 5 to 10 minutes to replace 1 to 4 ties as compared to four operators for 30 minutes for the current method that also requires a press that currently markets for more than $300,000. The repair can also be done without stopping the ginning operation; it can be done at a warehouse or textile mill that does not have an available standard bale press.

Summary

The failure of ties on cotton bales typically occurs on about 0.4% of the U.S. cotton crop. Repair of the bales may cost as much as $45.00 each representing a major cost to the cotton industry. As a partial solution to the problem, a portable device that compresses a bale of cotton with broken ties to its original density and allows the required tie to be emplaced was developed and tested. One operator is required for 5 to 10 minutes to replace 1 to 4 ties as compared to four operators for 30 minutes for the current method that also requires a conventional bale press. The repair can also be done without stopping the ginning operation; it can be done at a warehouse or textile mill that does not have an available standard bale press. Results with four prototype presses clearly indicate the advantage and usefulness of the portable device. A patent application was filed and the device will be available to the public in the near future (Anthony 1997).

Disclaimer

Mention of a trade name, proprietary product, or specific machinery does not constitute a guarantee or warranty by the U.S. Department of Agriculture and does not imply approval of the product to the exclusion of others that may be available.

References

Anthony, W.S. U.S. Patent Application Number 08/876,800. Apparatus and procedure for placement of bale ties. Filed July 1997.

Anthony, W. S. and William D. Mayfield, eds. Cotton Ginners Handbook. U.S. Department of Agriculture, Agricultural Handbook 503, revision. 348 pp. 1994

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Table 1. Force required to achieve given platen separations with a 4" wide platen that had a 1" groove in the center.

Platen separation, in.	Force, tons	Test
26.25	6	1
25.25	10	1
24.375	12	1
23.44	20	1
26.59	0	2
25.03	5	2
23.625	10	2
22.625	15	2
22.19	16	2
26.54	5	3
25.00	10	3
23.88	15	3
22.81	20	3

Table 2. Force required to achieve given platen separation with the 0.875" by 21" platen with a 0.25 groove in the center.

Platen separation, in.	Force, tons	Test
0	0	4
23.25	5	4
21.75	10	4
20.50	15	4
19.75	20	4

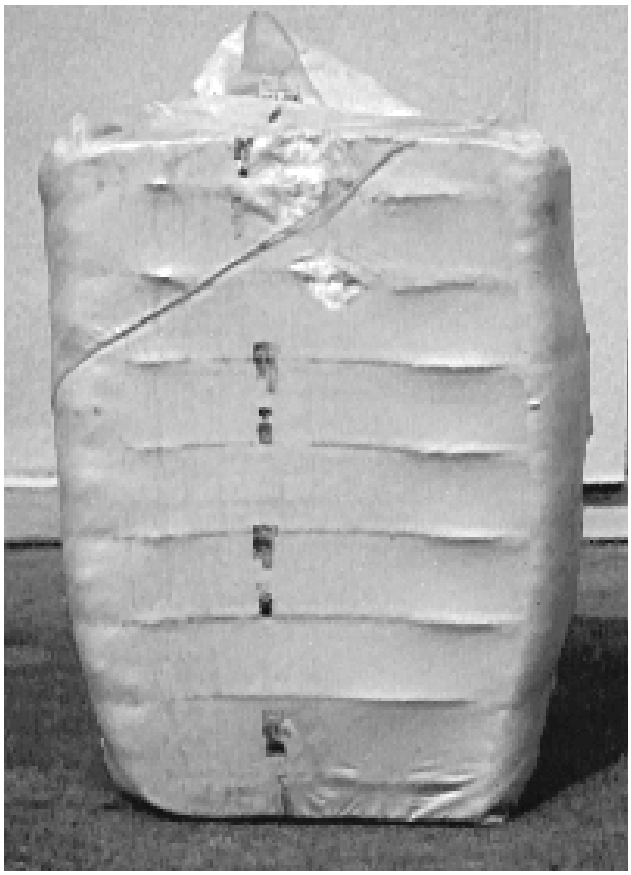

Figure 1. Bale of cotton with broken bale ties.

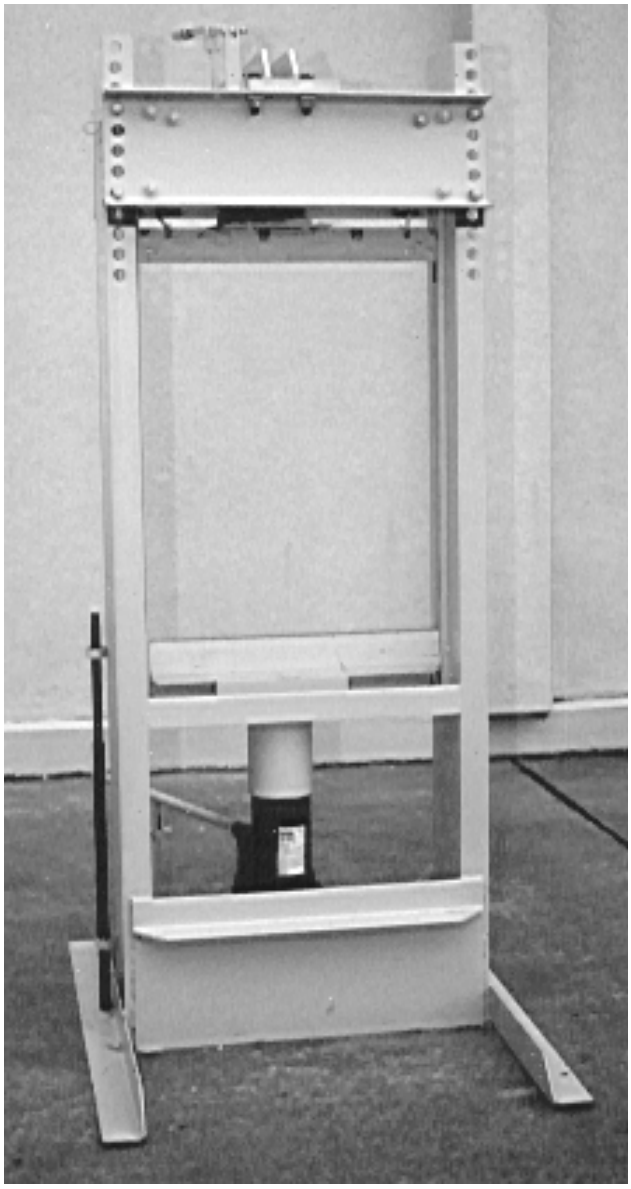

Figure 2. Manual version of the device to replace broken bale ties.

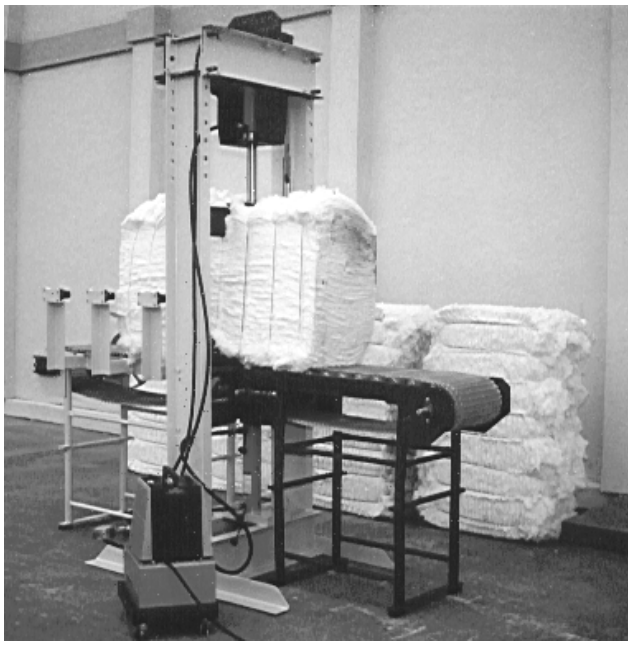

Figure 3. Bale being repaired in an automated version of the device. Feed tables to and from the device are also shown.

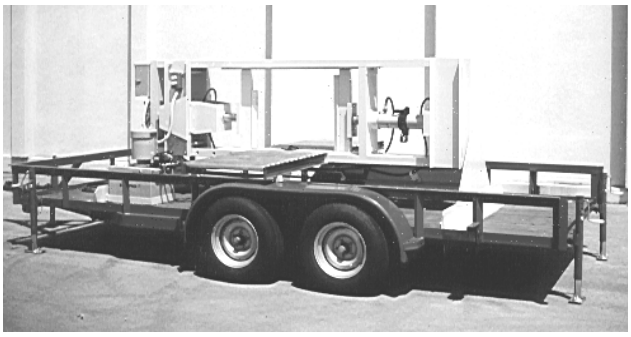

Figure 4. Horizontal, trailer-mounted version of the automated device to replace broken bale ties.