NEW TYING SYSTEM TECHNOLOGY FOR COTTON BALE PACKAGING

Norman O. Penegar
Cotton and Fiber Industry Sales
Samuel Strapping Systems, Inc.
Smyrna, GA

Abstract

The newly introduced P600 Bale Tying System (patent(s) pending) technology offers unique productivity, reliability and labor savings capabilities for cotton baling operations previously unavailable. Capabilities exhibited and presented here for the system are labor savings at the bale press, increased production (bales per hour) capacities, bale tie ends automatically connected/welded on the ball of the bale, safety, improved bale size control and inherent reliability features when compared to previous bale tying systems. These productivity and labor savings capabilities are such that this bale tying system can be substituted in any gin plant where labor intensive, semi-automatic or manual hand tying methods are being used because other automatic systems do not and have not had the capacity to specifically meet gin production rates that consistently exceed 42 bales per hour. A comparison is made with other types of bale tying systems, and their application in the cotton ginning industry are discussed.

Introduction

Until recently, the selection of bale tying systems for high production rate gin plants (exceeding 42 bales per hour) has been limited to either manually assisted or semi-automatic round wire systems using cut-to-length wire having preformed ends to connect as knots or traditional indexing strapping systems using flat steel or polyester (plastic) bands that have limited production rate capability. For the 1999 crop, a new technology was approved for testing (J.C.I.B.P.C.,1999) that have proven to provide revolutionary improvements to cotton bale tying systems. This new, fully automatic system is designed to use polyester strapping, to provide higher productivity capability opportunities at the bale press, eliminate labor required at the bale press and incorporates certain reliability technologies empirically derived benefiting bale tie performance.

The purpose of this report is to describe those capabilities and technologies incorporated into the Model P600 Bale Tying System, how its operational features relate to gin productivity, labor saving benefits and bale tie performance with particular emphasis on polyester strapping applied with this system. References are also made to alternative tie materials and their methods of application in the Cotton Industry.

Discussion

P600 Compared to Traditional Indexing (Flat Steel or Polyester) Systems

Automatic strapping systems have been used in the fiber baling industries since the early 1960's on synthetic fibers first and later, with the advent of the universal density bale, on cotton. These early systems were designed with six (6) to eight (8) strapping heads to apply all bands at one (1) time. Due to these systems complexity as applied to balers available at the time they were not as reliable as needed for a number of reasons and this concept was displaced with so called indexing head (typically one (1), two (2) or three (3) heads) systems. These indexing systems proved more reliable and efficient than the gang mounting of six to eight heads in the baler's upper sill or in the press doors mentioned above, for example.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:62-65 (2001)
National Cotton Council, Memphis TN

Applied to balers, indexing systems, typically two or three strapping heads, are mounted on a traversing carriage which is powered laterally along the bale length applying the required tie bands by mating up with strap feed chutes mounted in the upper/lower platens and return chutes mounted on the carriages opposite side (Figure-2). With wire or flat strapping, tie end connections are formed on the side of the compressed bale using this type indexing system where as the desired location is proven to be on the ball of the bale.

In cotton gin application, a three (3) head indexing system typically requires 18 to 21 seconds on an up-packing bale press with no doors and 26 to 30 seconds on a bale press with doors to apply six (6) tie pattern, for example. Thus, the expected bale output is generally, under very optimal conditions, 42 to 45 bales per hour for the former and 30 – 34 bales per hour for the latter press design.

Engineering Gin Capacity

From an engineering point-of-view, selection of a cotton bale tying system is generally need based on the following criteria:

1. Gin Productivity - The range of a gins annual bale output, hourly production run rates for which they are designed, and the manpower required to operate under these conditions.
2. Bale Press Design - When measuring the gins' productivity, the baling press design is an integral part of the overall capability assessment. The highest productivity baling presses are generally up-packing designs for which the P600 is specifically designed, with or without doors.
3. Bale Press Output Capability - A given bale presses design output depends on many factors including the supporting hydraulic system, the compression ram piston size, automation features (door opening/closure, etc.) and the manpower assigned to its operation.

Thus, the capability of the tying system and the bale press are very important in the application decision of a given gin to reach or maintain desired output at peak and average production levels.

The P600 Bale Tying System is a fully automatic machine applicable to most up-packing bale presses capable of producing universal density bales. Unique technical features of the system are:

1. Applicable to gin balers producing 60 (or more) bales per hour.
2. Tie end connections/welds are formed on the ball of the bale.
3. Uses polyester (plastic) strapping that is automatically fed from a single coil into the six (6) tie positions.
4. Strap feeding is accomplished in a straight, flat plane (Figure-1) as compared to other traditional fully automatic indexing systems (strap or wire) which push strapping around a pressed bales' perimeter passing through four (4) 90° corners. This requires the strap or wire to negotiate or jump gaps at each corner as it enters or exists the balers' upper and lower platens from the strapping head (Figure-2).
5. Strap feeding and strap welding mechanisms are two (2) distinct components thus the operation and maintenance of the system is simplified compared to compound head designs used on traditional strapping systems that performs all the feeding, tensioning and welding/sealing functions.

Gin Operational Speed/Output at the Bale Press

Where the gin and gin baler capacity are available, the P600 system has demonstrated the ability to produce up to 61 bales per hour under these conditions. Theoretically, the system, coupled with a high capacity bale press, might reach 65 bales per hour.

The time cycle for the P600 can be matched with any baler output requirement. A 30 bale per hour gin plant would not generally run the baler at 60 bales per hour rate to save wear and tear, for example when its not required. Flow control valves and servo motor controls provide the means for these simple operating speed adjustments.

Compared to traditional indexing systems, how is this new system capable of matching up with these high speed/capacity balers? Traditional indexing systems cannot feed strapping until the balers' compression ram reaches the desired shut height or upper/lower platen separation and must traverse into at least one tie position. In addition, these traditional systems require 90°-corner radius (Figure-2) to allow strap to feed around the pressed bales' four (4) sides or perimeter in a closed loop. Thus, the strap length fed is typically around 36" longer than the desired tie length and that excess must be retracted (tensioned) out of the loop by the strapping heads reversible feed/tension motor before bonding tie ends. So, productive bale press time is lost in each of these added functions.

The unique design of the P600 Bale Tying System allows pre-feeding of all straps in its six (6) tie pattern while a bale is being formed in the baler's tramper box and sheared to the exact, tie length required. Strap is fed from a single continuous coil by an electric feeder drive indexing into the six (6) tie pattern positions and sheared, one at a time. Therefore, no time is lost for the feeding and tensioning of strap as with traditional systems once the bale is compressed to the desired density/ shut height. Additionally, the P600 simultaneously welds all six (6) tie ends at once so that specific time element is cut in half compared to a traditional three (3) head strapping system.

Tie Strength/Enhancement Feature – Welds Formed on Bottom or Ball of the Bale

The P600 system uses a friction welding system to bond strap ends together. To accomplish this, the polyester strap ends are vibrated under pressure at a high frequency for approximately one (1) second. This rubbing action generates the frictional surface heat needed to form a melt pool that when held statically under pressure forms a high strength weld or bond between the two (2) ends of the tie.

These strap end welds are formed or connected on the ball of the bale by the two (2) ends of the tie strap being brought together at the mid point of the compression box inside follow block platen openings provided for this purpose. Empirically, tests have shown that bale tie connections made in this orientation relative to the bales' expansion force direction effectively increases ultimate strength performance as a tie in the range of 10 to 15%. This effectiveness has also been attributed to wire (Jordan, Dr. Andrew, 1996) or flat steel bands.

The P600's friction welding assembly produces a weld or bonding area larger than other systems using polyester strapping resulting in superior tie strength characteristics. Average weld strengths provided by this larger weld area exceed all packaging specifications as defined in the J.C.I.B.P.C. guidelines (pp. 3 and 1.2.3.9) for U.D. baled cotton.

Reliability Focus

With the P600 system destined to meet today's highest production gin plants requirements, reliability refinements have been a focal point in executing this design.

A major design feature of this revolutionary system addresses two (2) areas of weakness in the operation of traditional indexing strapping systems. These weaknesses center on strap feeding reliability, which are affected by:

1. Strap quality (its straightness and flatness)
2. Alignment of the strap feeding heads to strap guide chutes mounted in the upper and lower platens.

For example, poor lint distribution can and does cause random shifting in the compression follow blocks; front to back (Figure-4) or end to end (Figure-3). If the alignment relationship of the baler's upper and lower platens to each other creates a feed path that is not vertically plumb it imposes an angular path for strapping to negotiate (added friction and angular twist imposed during feeding of flat strap – Figure-3) making the probability of mis-feeds or malfunctions more likely.

The P600 is mounted on (an integral part of) the baler's upper platen assembly (supplied as part of the system). When strap is being fed it follows flat, straight-line guide paths mounted in the supplied upper platen (Figure-1). Inherent manufacturing variables of flat strap or wire, camber or curvature along its longitudinal axis and bundle curve or coiling curl from set taken from winding into coils, are minimized with this feeding system. And, traditional indexing systems necessarily push strap around four (4) 90° corners, is required to jump four (4) gaps (Figure-2) at these corners to enter guide path chutes mounted in the upper/lower platens and contend with "happy medium" mechanical alignments between strap feed chutes mounted on the indexing carriage and those in the follow block or upper platen (baler design without doors) both of which are subject to shifting as mentioned above (Figure-3).

Traditional strapping systems require six (6) strap feed chutes permanently mounted in each of the two (2) follow block platens. These chutes are typically assemblies of spring loaded side guides (to contain strap during feeding that spring open during the tensioning portion of the cycle to allow strap to escape the closed path) and are subject to lint build-up/clogging. Lint accumulation, highest in the follow block area because of gravity, for example, can totally block strap feeding or simply be pushed by the feeding strap's end into the traditional strapping heads creating malfunctions and/or weld failures from lint contamination in the weld melt pool area in the case of polyester strap.

The P600 does not require these follow block strap feed guides and ongoing maintenance associated with them so a major source of system reliability is addressed in its basic design.

Modular Design

Separate, modular strap feeder and welding assemblies simplify the P600 design and further improve system reliability.

Operating on opposite sides of the press box, the strap feeder and welding assemblies are separate modules greatly simplified by their single purpose function. Traditional strapping heads combine these functions plus the strap tensioning mechanism into one(1) large, more complex, compound design electrically and mechanically. For comparison, the P600 welding module weighs 35 pounds each, are held in their operating position by four(4) bolts, and can be removed quickly for repair or replacement as needed. A typical, traditional strapping head weighs in excess of 250 pounds each making the process of replacement much more unwieldy and time consuming.

Safety – Equipment Design

The gin bale press area has been identified as one having the highest incidence of personnel injury (Davis, Larry, Mid-South Gin Injury Data, 1992-1998). A major advantage of automatic bale tying systems is that gin personnel are not required in close proximity to the baler during its operating cycle. The refinements provided to the bale tying process with the P600 design focus previously mentioned has added elements of reliability which contribute to a safer environment where employees necessarily interact with any equipment. Safety walk mats (energized by electrical pulse when mat surface is contacted, e.g. foot pressure) or similar sensory devices are recommended to interlock with and disable the tying system and baler upon personnel intrusion.

Plastic materials have displaced steel, glass, etc. in many applications including packaging for any number of reasons. Generally there are plus and minuses associated with these transitional decisions such as plastic drink bottles displacing glass, doesn't have the shelf life but is safer for children to handle, for example. Today, virtually all baled synthetic fibers are tied with polyester (used in this system) displacing flat steel or wire driven by safety, recyclable disposability, oxidation (rust) contamination eliminated, etc.

For strapping systems, plastics have made them more reliable from an online production efficiency standpoint, less costly to maintain (less wear and tear) and provided consumer preferred packaging.

Bale Size (Density)
The P600 system design automatically pre-feeds and shears a fixed length tie (86" long) as mentioned earlier (J.C.I.B.P.C., 1997, p. 1.2.3.11) while a bale is being formed in the baler's tramper box. Traditional automatic indexing systems feed strap in a loop formed by the upper/lower platen and back guide chute (Figure-2) once a signal is given from the baler circuit, indicating that the follow block (ram) has reached nominal or target closure. However, the follow blocks actual closure position can vary for a number of reasons:

1. Ram stop position affected by sensor switch and hydraulic valve reaction time tolerances.
2. Ram leaks down from nominal stop position.

Under these conditions, strap loop lengths will be variable thus affecting the finished bale size. Another aspect of this variability (ram drift or leak down) can be that the first applied set of three (3) ties end up with shorter lengths compared to the second set of three (3) which results in the first set carrying higher loads from bale expansion since the follow block moved down. This variable tie length condition can also affect the bales' final shape which impact bale warehousing stack stability and space occupied.

The net result is that bales produced with the P600 system are more uniform in size and shape compared to other systems.

Summary

Technologies and refinements designed into this new bale tying system provides greater productivity capacity and labor savings opportunities for the gin plant than tying systems previously available. Together, increased capacity and a reduced labor force, can contribute significantly to lowering a multitude of direct and indirect costs incurred in a gin plant's operation keeping it competitive both domestically and internationally with preferred bale quality.

References

Joint Cotton Industry Bale Packaging Committee, Specifications For Cotton Bale Packaging Materials, 1996-2000, pp. 3, 1.2.3.9 and 1.2.3.11

Davis, Larry, Safety Director, Mid-South Cotton Gin Injury Data, South Cotton Ginners Association, Memphis, TN, 1992 – 1998

Jordon, Dr. Andrew, Fundamentals of Bale Tie Forces, Report to J.C.I.B.P.C., February 28, 1996

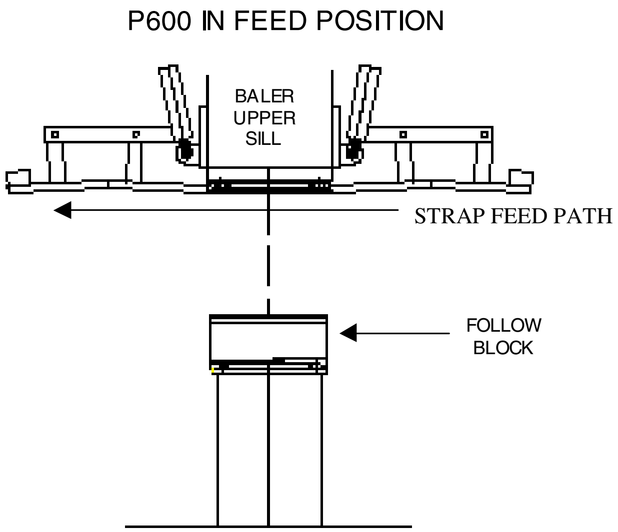

Figure 1. End View of Baler.

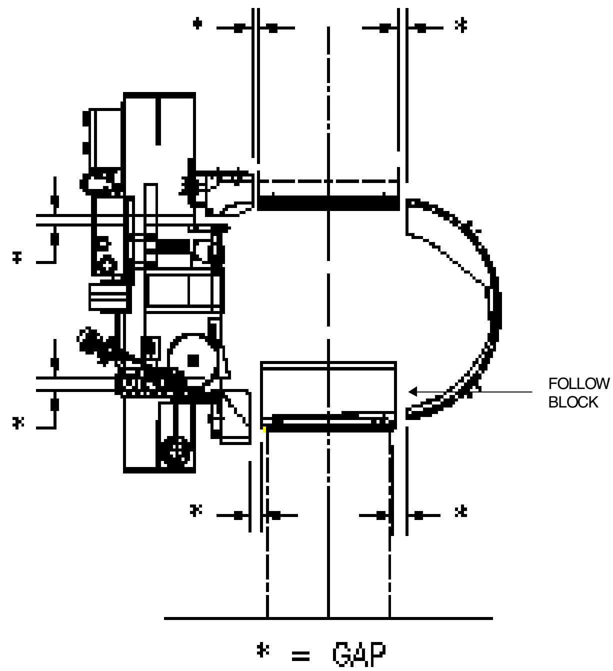

Figure 2. End View of Baler.

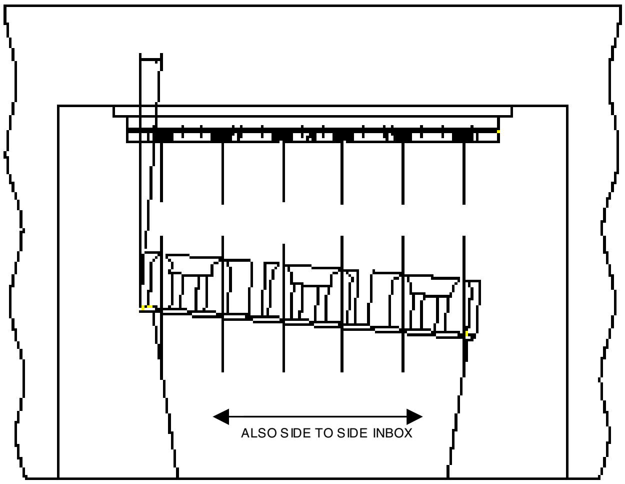

Figure 3. Baler Front View Upper/lower Platen.

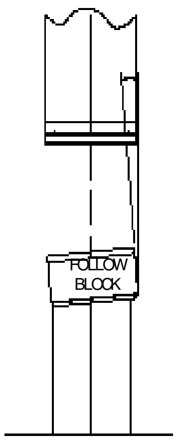

Figure 4. End View of Baler.