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Seamless Jute Bag: a novelty in eco-friendly Packaging

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ABSTRACT
In Bangladesh the annual demand of carrier bag is more than 14.1 million pcs and in the global market it is 500 billion pcs. Lion share of this huge market is occupied by petroleum derived non-biodegradable bag because of its cheap rate. But this market can be predominately occupied by producing seam or stitch less jute bag. The processing cost of this seamless bag will be very low as bag will be produced as like as fabric and no process is to be needed expect cutting. Beside, Jute is 100% biodegradable and able to consume up to 15 tons CO_2 and release 11 ton oxygen during its growing season which indicates its very environment friendly nature. According to our assumption the price of each seamless jute bag (having 63% cover factor) will $0.0683 and each weaving machine having 72 inch width will be able to produce 228 bags per hour.

Keywords: seamless bag, fully fashion bag, carrier bag, green packaging.

1. Introduction

With the growth of population and export items the demand of secondary packaging is increasing day by day. At present poly bag, paper bag are used in the purpose of secondary packaging. Non-woven synthetic bags are also used in large shopping malls. The reasons of the popularity of these bags are because of their low price. But these bags are non- biodegradable and create hazard to the environment. So the world is demanding a substitution of these bags. In this scenario, seamless jute bag would be a good alternative. Seamless means without sewing. The bags will be self stitched/selvedged when it is delivered from the loom. This characteristic will reduce the price of jute seamless bag.

Walter H Deubner invented the first packaging bag and by 1915, he was selling over a million shopping bags a year. The lightweight shopping bag that we see today dates back to the 1960s. From the mid-1980s, the use of plastic bags became common. Plastic bags soon replaced paper bags. [1]. Secondary packaging or carrier bags are classified into following types by Dr.Chris Edwards. [2]**:**

HDPE bags with prodegradant additive: this type of lightweight, plastic, carrier bag is made from HDPE with a prodegradant additive that accelerates the degradation process. These polymers undergo accelerated oxidative degradation initiated by natural daylight, heat and/or mechanical stress and embrittle in the environment and erode under the influence of weathering.

Low-density polyethylene(LDPE) bags: these are thick-gauged or heavy duty plastic bags, commonly known as "bags-for-life". The initial bag must be purchased from the retailer but can be replaced free of charge when returned.

Non-woven polypropylene (PP) bags: This type of bag is made from spun bonded non-woven polypropylene. The non-woven PP bag is stronger and more durable than a bag for life and is intended to be reused many times.

Cotton bags: This type of bag is woven from cotton, often calico. An unbleached cotton with less processing and is designed to be reused many times.

Paper bags: The paper bag was in effect the first "disposable" carrier bag, but was superseded in 1970s by plastic carrier bags which were seen as the perfect alternative as they did not tear when wet.

Biopolymer bags: Biopolymer carrier bags are a relatively recent development. The biopolymers are usually composed of either polylactic acid (PLA), made from polymerization of lactic acids derived from plant-based starch, or starch polyester blends. These biodegradable polymers decompose to carbon dioxide, methane, water, inorganic compounds or biomass. [3].

Woven Polypropylene (PP) bags: this type of bag is produced from woven PP fibres. Similarly to the nonwoven PP and LDPE bag, it is strong and durable and intended to be reused many times. To provide stability to the base of the bag, the bag comes with a semi-rigid insert.

Jute bag: jute bags are made from jute fibres spun into coarse strong strands making a strong and durable carrier bag. The jute bag is intended to be reused many times.

But it is found that High Density Poly Ethylene (HDPE) plastic bag would have a baseline global warming potential of 1.57 kg CO_2 equivalent, falling to 1.4 kg CO_2 if re-used once, the same as a paper bag used four times (1.38 kg CO_2). [4]. Plastic bags are created through the polymerization of ethylene, a gaseous hydrocarbon found in petroleum. While there are different types of polyethylene, all used as different kinds of plastic, the most commonly used for plastic retail bags is high density polyethylene, or HDPE. This

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is manufactured from ethylene, a byproduct of gas or oil refining. [5].

Besides, on land conventional plastic carrier bags can last as litter for two years or longer before disintegrating, depending on product composition and environmental conditions. Additives in plastic carrier bags can contaminate soil and waterways and if ingested by animals can enter the food chain. Plastic carrier bags may accidentally be ingested by birds, fish, whales and other animals because they confuse them with prey species. Al least 267 species worldwide are affected by ingestion of plastic debris. Entanglement of wildlife (including seals, whales and marine turtles) in plastic carrier bags is also occuring. [5] Entanglement prevents feeding, swimming and reproducing and can cause drowning. The 2011 ICC report indictes that over the past 25 years 404 animals around the world were found entangled in plastic bags [6]. On the other hand paper bag has a limited opportunity to recycle .The disposal of ash from paper production also has an impact on eutrophication and fresh water aquatic eco toxicity. For producing paper bag trees are cut which indicates non eco-friedly nature. So in this scniero Jute bag would be very suitable alternative to the plastic bags. Because One hectare of jute plants can consume up to 15 tons of carbon dioxide and release 11 tons of oxygen during the jute growing season (about 100 days). [7]. Moreover jute is a natural, 100 percent bio-degradable and recyclable, ecological fibre plant.

2. Market analysis

For the last five years (from 2005 to 2009), export of raw jute in the world market has increased by 39.5 per cent, and export of jute products has increased by 57.6 per cent. In 2009, Bangladesh was the largest raw jute exporter with a share of about 85.7 per cent of the total global export. On the other hand, China occupied the topmost position among the exporters of jute goods accounting for 58.1 per cent of the total global export. India accounted for 8.5 per cent and Bangladesh for 6 per cent of export of jute products in the world market. Between 2005 and 2009, China's export of jute goods increased by 181.1 per cent, whilst that of Bangladesh declined by 11.1 per cent, although the benchmark figures for the two countries were significantly different.[9]

Table 1: world top jute and jute goods exporters

Jute goods				
Exporters	2005		2009	
World	2979.9	-	4695.5	-
Bangladesh	318.9	10.7	283.7	6.0
India	398.2	13.4	398.3	8.5
China	970.9	32.6	2729.6	58.1
Raw Jute				
World	139.5	-	194.5	-
Bangladesh	121.9	87.4	166.7	85.5
India	2.9	2.1	7.1	3.6
Tanzania	0.3	0.2	8.6	4.4

(Source: Trade Map Bangladesh) *(Million USD)*

In 2009, Bangladesh exported 322.6 thousand tones of raw jute worth USD 166.7 million. Her export was concentrated in two major markets, both of which were in Asia, Pakistan (32.2 per cent) and China (28.6 per cent). These two together accounted for more than 60 per cent of the raw jute exported by Bangladesh in 2009. **For jute yarn**, Bangladesh's major markets were Turkey, Belgium and India. In 2009, export of yarn has decreased for Belgium by 18 per cent; and for Turkey by 1 per cent and 4 per cent for two HS categories. In contrast, in India the growth was significant (79 per cent**). Export of jute woven fabric** registered very high growth in the markets of India, New Zealand and Korea, with 24 per cent, 120 per cent and 23 per cent respectively in 2009 compared to 2008. Indonesia was the largest market for ropes; however, export was 58 per cent lower compared to 2008. [9].

From this market analysis it is seen that Bangladesh has a very big international market and in exporting raw jute Bangladesh is unrivalled. But she lags behind in exporting jute goods. Capturing world packaging market may give good opportunity of exporting maximum jute goods.

2. 1 Market size

The world packaging market is very big and expanding day by day. The ongoing increasing in grocery items and affordability of inhabitants of developing countries make the packaging market as one of the biggest markets in the global village. Each and every item needs several packaging materials. Normally plastic bag is used for carrying different items. But due to their terrible effect on environment government of different countries are compelled to ban its use. For example: Bangladesh banned polyethylene bag in 2002, china banned the free distribution of plastic bag in 2008, inspiring by china Hong kong also banned the free distribution on plastic bags. Kenya has imposed extra tax on plastic bag and plans to ban ultra-thin plastic bag. Rwanda has banned plastic bags less than 0.1 mm thick, in 2003 South Africa banned the use of plastic bags, Uganda banned plastic bag in 2007 and many other countries impose various forms of bans on plastic bags. [10]. The apathy of using plastic bag will create a big opportunity of seamless jute bags. This bag will not be so cheap like plastic bag but will be cheaper than other alternatives. Jute goods manufacturers in Bangladesh export around 100,000 shopping bags a month on average to different countries. This number will be increased thousands times in near future if we make the shopping bag cheap and attractive.

2.2 Local Market

In Bangladesh, there is significant number of shopping mall, Agro shop, different consumer product retailer shop and chain store. They need of secondary packaging material (various shopping bags, promotional bags, sacks etc) to market their product in local market. These types of shops can be the target customer of seamless jute bag. Bangladesh government has taken

some initiatives for mandatory use of jute in packaging industry. An act name "Mandatory Jute Packaging Act-2010" has been issued. The law went an implementation from January 15 of 2013. [11] The act created a demand of 840 million jute bag for agriculture and non agriculture products. The use of jute in secondary packaging like shopping bags will certainly creates a new arena of jute. If the act is implemented successfully demand of jute bag will be 2,000,000 per day. [12]. Survey report showed that near about 10 million polyethylene bags were used everyday. It was estimated that about 14.1 billion bags were used annually at household levels in Bangladesh. [13]. So if the jute bags are supplied at cheap rate its domestic market demand would be about 10 million pcs per day.

2.3 International Market

The Global consumer packaging market value is $395bn and this value will reach $456bn in 2015.Global packaging market to reach $975 billion by 2018. Global packaging sales are projected to rise by 3% in real terms to $797 billion in 2013 and grow at an annual rate of 4% to 2018, according to a new market report by Smithers Pira. [14]. The global demand for shopping bags is estimated to be 500 billion pieces, worth around $500 billion a year, according to international Jute Study Group (IJSG). [15]. Demand for natural, biodegradable bags will gradually increase as more and more chain shops around the world phase out the use of polythene bags and use bio-friendly natural fiber bags instead. The US, Europe and China would be the biggest markets for shopping bags, once the ban on the use of plastic bags would fully come into force in a few years. [16]. It has been estimated that annual world demand for shopping bags is 500 billion pieces. World famous chain store Wal-Mart, Leading food retailers Tesco, the Co-operative Group, Sainsbury's, Morrison's and the John Lewis-Waitrose partnership are expanding grocery convenience formats. In the UK alone, the grocery market was worth £150.8 billon in 2010, an increase of 3.1 percent from 2009. [17]. In November 2013, the EC proposed an amendment to Directive 94/62/EC that would require MS (member states) to "take measures to achieve a reduction in the consumption of lightweight plastic carrier bags" (with a thickness of less than 50 microns, or 0.05 mm) [18]. So EU can be a large market for Bangladesh. The UAE announced to ban all plastic carrier bags by 2013. Following the decision a market of 9.0 billion pieces of jute shopping bags has been created there. [19]An estimated 99 billion plastic carrier bags were placed on the EU market in 2010 – almost 200 bags for each EU citizen [18]. So it can be told that if we deliver jute bag at bulk production and cheap rate, jute packaging would be a very potential source of foreign currency.

3. Materials and Methods

3.1 Loom

For producing seamless jute bag ordinary dobby or electronic dobby looms may be used. In Bangladesh most jute mills use power loom. For producing decorative weave dobby looms are used while for producing plain or twill tapet looms are used. Automatic looms are very common in cotton weaving but in jute weaving this type of modern looms is yet to be popular. Automatic loom consists of electronic dobby system which is more user friendly and capable of giving high range of figuring capacity. The feasibility of using automatic loom is experimented by Bangladesh Jute Research Institute (BJRI). They are using flexible double rapier loom (PICANOL GTX*Plus*) for producing jute and jute-cotton composite fabric. Picanol GTX*plus* is a versatile machine enabling the weaver to produce a very wide range of fabrics. The GTX*plus* enables operators to obtain good weaving results, even without optimal weaving expertise. The GTX*plus* rapier loom has been specially designed to achieve the best price/performance ratio. The specifications of Picanol GTX*Plus* are as follow:

Name: Picanol GTX*plus.*
Type: Flexible double rapier loom.
Reeded width: 72"
Heald frame capacity: 20
Shedding: Electronic dobby shedding (staubli)
Weft color capacity: 4
Power consumption: 7.5 kw
Machine RPM: 180-190 (theoretically 400)
Weave: any design.
Pattern input system: Digital console board.

3.2 Raw Materials

100% jute yarn in both warp and weft. Various count of yarn can be used for this bag. Although we suggest to use 8 lbs/spyndle yarn. Cotton, jute or Jute and cotton on warp and weft way also be used for producing seamless bag. For making the price cheap we suggest to use jute in both directions. 8 lbs/spyndle jute yarn can be used for manufacturing seamless bag. According to Bangladesh Jute Mills Corporation (BJMC) the price of CB 8 lbs/spyndle is $0.9 USD/kg or 70 Tk/kg.

3.3 Fabric construction

For producing seamless jute bag the following specification can be used
Here,
Ends/inch (EPI) = 16
Picks/ inch (PPI) or shots = 10
Warp count = 8 lbs/spindle
Weft count = 8 lbs/spindle
Fabric width = 70 inch
Total warp: 70x16= 1120

3.4 seamless bag design

The weaving plan along with drawing and lifting plan is given below:

Drawing process: Here we have to use minimum 6 heald frames. Straight draft is used here. The first 4 warp is drawn through initial 6 heald frames consequently. Then the next 2 warp of the repeat is drawn through 1 and 2 heald frame subsequently. (as shown in weaving plan in fig:1). As the total warp of

the full width fabric is 70 inch (1120 ends). Each bag contains 2" plain (28 warp), 15" double layer (210 warp) and again 2" plain (28 warp), so we have to draw 1st 28 warp through 1st 2 heald frames, then 210 warp through next 4 heald frame and again 28 warp through 1st 2 heald frame. In this way total 1000 yarn will be drawn.

Denting: As we are using 8 lbs/spydle jute yarn so 2 in a dent will be used. The reed count will be 14. In this case the reed with will be 68 inch.

Weaving: The pattern input system of PICANOL GTX*Plus* is very much user friendly and fully computerized. The bag will be produced by simply inputting the lifting plan (as shown in fig:1) will produce the bags.

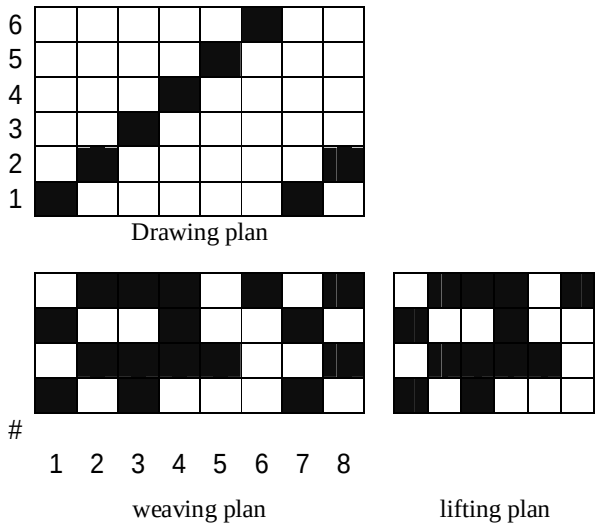

Fig.1 weaving, drawing and lifting plan

3.5 Bag specifications

Length: 19 inch,
Width: 17 inch
Stitched width: 1 inch at both side and bottom
Useable area: 18 inch x15 inch
Useable bag length: 18",
Useable bag width: 15 inch
Total warp / bag= 16x17 = 272,
Bag width: 17 inch
Total weft/ bag = 10x19= 190
Total bag along loom width = 4

Handle making can be possible either automatically or cutting. For automatic handle more 4 heald frame will be needed. For minimizing heald frame number we suggest to use manual cutting.

The 1 inch selvedge will provide sufficient strength from being torn. A simple model of seamless bags is illustrated in the following figure (fig:2). Here the dotted line indicates cutting direction.

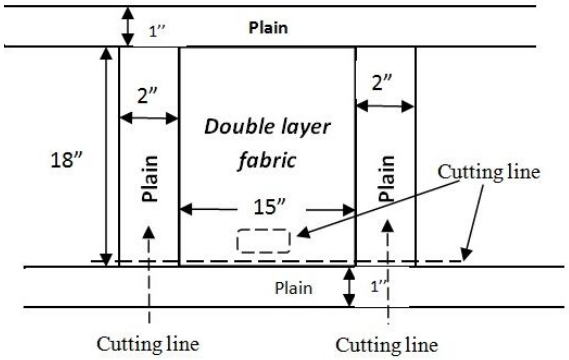

Fig.2 schematic diagram of seamless bag

4. Discussion of Results:

4.1 Production flow chart of ordinary jute bag: the process of conventional jute bag is illustrated below:

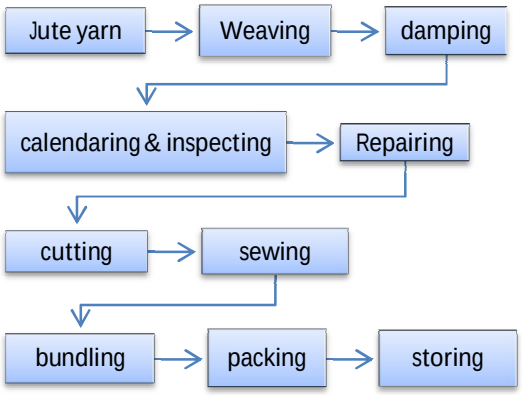

Fig.3 production process of ordinary jute bag [20]

Damping: water is added on the cloth for calendaring and to maintain desired moisture level in the final product.

Calendaring & inspecting : the cloth is pressed and heat is applied for the removal of crease and making the surface smooth and lustrous.

Cutting: the calendared roller is cut into pieces of required sizes to manufactured jute bag.

Sewing : sewing is done to produce bag of definite shape and size by sewing open ends of cut fabric

4.2 Production process of seamless jute bag

The process flow chart of seamless jute bag is as follow:

Warp way cutting: the warp way cutting may be performed either through mechanical cutting or manual cutting. Here 5 cutters are needed to make 4 bags simultaneously.

Weft way cutting: along the weft the fabric should be cut manually. Because this action should be performed after fabric withdrawal.
Handle making: to make a handle for carrying a dice can be used. So that it can be make at minimum effort.
Turing over: to stop the fraying of jute fabric. The bag should be turned over because jute yarn are coarser and very liable to fraying.

The flow process of seamless bag is illustrated below:

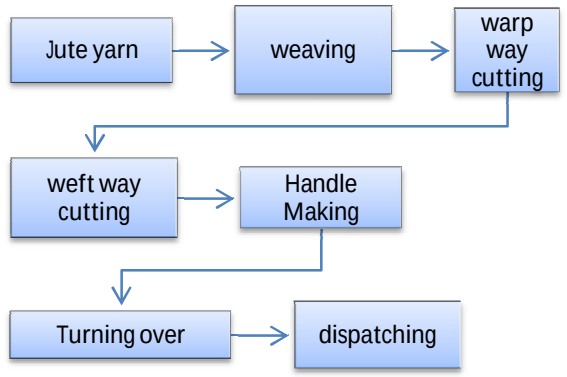

Fig.4 production process of seamless bag

4.3 Comparison:
If the two processes are compared then we see, in seamless bag there are no other processes except cutting whereas in conventional process sewing is needed to make bag along with cutting. So the cost of sewing, sewing yarn, time etc is saved. In the following graph (fig.5) a price comparison is illustrated (the price of seamless jute bag based on assumption) .

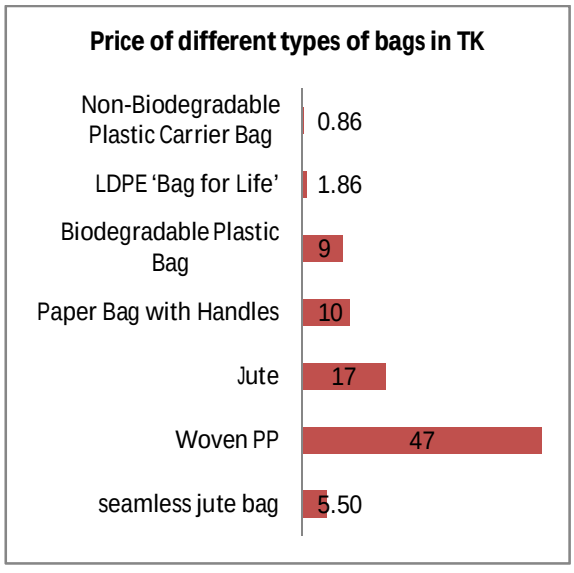

Fig.5 comparative prices of different bags. [21]

4.4 calcualtions

4.4.1 Production calculation

Production calculation formula = $\frac{PPM}{PPI}$ inch/min

= $\frac{PPM \times 60 \times 0.95}{PPI}$ inch/hr [say, machine efficiency is 95%]

= $\frac{190 \times 60 \times 0.95}{10}$ inch/hr

= 1083 inch/hr

= 1083/19 [length of bag = 19 inch]

= 57 × 4 [as 4 bags will be produce across loom width]

= 228 bags/hr

4.4.2 Time consumption

Time required to produce 4 bags simultaneously = $\frac{PPI \times bag\ length"}{PPM}$ min

= (10×19)/190 min

= 1 min

4.4.3 Yarn consumption calculation

Warp yarn consumption=

$\frac{EPI \times width \times \text{lenth} \times count \times crimp\% \times waste\%}{36 \times 14400 \times 2.2046}$ kg

= $\frac{16 \times 17 \times 19 \times 8 \times 1.05 \times 1.06}{36 \times 14400 \times 2.2046}$

= 0.040264 kg

Weft yarn consumption=

$\frac{PPI \times length \times \text{width} \times crimp\% \times waste\%}{36 \times 14400 \times 2.2046}$ kg

= $\frac{10 \times 19 \times 17 \times 8 \times 1.04 \times 1.06}{36 \times 14400 \times 2.2046}$

= 0.0248 kg

Total yarn consumption of a bag = 0.0402+0.0248 = 0.0585 kg

4.4.4 Cost calculation

Raw material cost of a bag = 0.0585 × 0.9 = $ 0.0526
USD = 4.07 BDT
In ordinary jute bag manufacturing, production processing cost is 40-60% of raw materials cost. But as seamless bag has high production and lowest process cost so we may take the weaving charge 30% of raw materials,. So selling price of each bag will be = $0.0526+ $0.0526×0.30= $0.0683 = BDT 5.29 ≈ 5.5 Tk. whereas in present market the price range of a jute bag is 17 Tk- 40 Tk in local market and in foreign market it is about $1.5-$1.7.

4.4.5 Cover factor calculation:

Warp cover, k1= $EPI \times \sqrt{warp count\ in\ lb/spyndle}$

= $16 \times \sqrt{8}$

= 45.25

Weft cover K2 = $PPI \times \sqrt{weft\ cont\ in\ lbs/spyndle}$

= $10 \times \sqrt{8}$

= 28.28

Fabric cover factor = $K_1 + K_2 - \frac{K_1 \times K_2}{120}$

= $45.25 + 28.28 - \frac{45.25 \times 28.28}{120}$

= 73.53 – 10.664

= 63%

Open area = 100-63 = 37%

5. Conclusion:

The present age is the area of consciousness. Each and everybody of this world need to be conscious about the world environment. Especially for Bangladesh because the country has already witnessed two devastating floods of 1998 and 2000 due to polythene bag. Bangladesh is world no. 1 in jute manufacturing; we have a big market in local and international stage. A vast consumer inside the country and different restriction on petroleum derived products throughout the world will make a very big and potential market of seamless bag. So if we utilize this jute in our packaging industry the nation must be benefitted. The proper implementation of seamless jute bag would add a new dimension to this effort.

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