**Detailed Explanation of Layer Assembly, Absorbent Core Integration, and UV-C Sterilization Process**

**Overview**

Sparśa pads are made of four layers:

1. **Top layer**: non-woven cotton
2. **Absorbent core**: compressed banana fiber fluff (“mattress”)
3. **Bottom barrier layer**: compostable PLA film
4. **Adhesive backing**: applied manually during final steps

The top and bottom layers are supplied in rolls, while the absorbent core is produced separately by our mattress-making machine and pre-cut into fixed sizes. Since this core is **not in roll form**, we modified a standard semi-automatic pad assembly machine to integrate both **roll-based materials** and **manually placed absorbent cores**.

**Modifications to Standard Machine**

Most standard pad-making machines (widely available in India and China) are designed for **full-roll inputs** for all layers. These machines are not compatible with discrete core pieces and would misalign or fail to insert the core properly without modification.

To solve this, we:

* Installed a **custom-built feeding conveyor belt** with fixed placeholders
* Integrated **inductive and capacitive sensors** to detect and time core placement
* Fine-tuned machine speed, pressure, and synchronization for precise layer bonding

**How the Machine Works – Step-by-Step**

**1. Loading Materials**

* **Top and bottom rolls** are mounted on holders above and below the conveyor belt.
* We use one roll for the bottom layer and one for the top layer, but the machine has **four holders** (2 above, 2 below) in case additional layers or replacements are needed.
* Roll widths are approx. **20–25 cm**, with consistent thickness (40–50 GSM ideal).

**2. Manual Core Placement**

* The pre-cut banana fiber absorbent cores (approx. 18–20 cm long, 5–6 cm wide, and ~3–4 mm thick) are placed manually onto a **custom conveyor belt** with fixed slots.
* A tray is used to carry and place each core carefully to prevent stretching or deformation.

**3. Sensor-Controlled Synchronization**

* An **inductive sensor** above the conveyor detects when a core is placed.
* A **capacitive sensor** near the sealing roller confirms timing and triggers the feed of the roll layers.
* A **servo motor** drives the belt in sync with roller rotation to ensure precise alignment.

**4. Layer Sealing, Embossing, and Cutting**

The layered materials move through a **five-stage roller system**:

* **Roller 1, 3, and 5**: rubber-coated compression rollers
* **Roller 2**: ultrasonic sealing and embossing roller
* **Roller 4**: cutting roller with custom die

The **ultrasonic sealing unit** includes:

* A **horn booster** beneath Roller 2 that emits ultrasonic frequencies
* This causes **molecular friction** and localized heat, bonding layers together without added glue
* Sealing pressure is adjusted visually by checking the embossing pattern quality on the top layer

**5. Shaping and Cutting**

* Roller 4 houses the **cutting die**, which determines the pad’s final shape and size.
* Dies are interchangeable to allow different pad dimensions if needed.

**6. UV-C Sterilization**

* After sealing and cutting, pads pass through a **UV-C light tunnel**
* This helps reduce microbial load, particularly on the top layer
* While it does **not sterilize** the pad completely, it lowers the bioburden significantly

**7. Final Manual Steps**

* After UV treatment, pads are collected manually
* Adhesive is applied to the bottom side, and each pad is individually packed by hand

**Machine Performance**

* **Speed**: adjustable from **5 to 60 pads per minute**
* We run it at **12–15 pads/min**, aligned with our mattress machine’s output
* Accurate coordination between sensors, belt, and rollers is critical to avoid misalignment or wrinkling
* If the core is misplaced or misshapen during manual feeding, it can cause sealing failure or defects

**Key Components at a Glance**

|  |  |
| --- | --- |
| Component | Function |
| Feeding conveyor | Receives manually placed absorbent cores |
| Inductive sensor | Detects presence of core on conveyor |
| Capacitive sensor | Triggers timed release of top/bottom layers |
| Servo motor | Drives conveyor movement in sync with rollers |
| Roll holders | Holds and unwinds top and bottom layer rolls |
| Five-stage roller system | Compresses, seals, cuts, and shapes the pad |
| Ultrasonic horn booster | Creates heat through vibration to bond layers |
| UV-C tunnel | Reduces microbial load on pad surface |

**Replicator Notes**

1. Material Consistency Matters
Make sure the top and bottom rolls are of consistent width and GSM. Soft, even tension is crucial to avoid curling or jamming during feed.
2. Keep Core Size Fixed and Uniform
Use a template or jig during cutting to ensure each banana fiber core is the same size. Variations lead to placement errors.
3. Train Operators Carefully
Manual placement is the most sensitive step. Deformed or poorly aligned cores will result in defective pads or failed sealing.
4. Visual Inspection is Critical
Monitor the embossing pattern regularly to ensure sealing pressure is even. Adjust roller pressure if patterns are faint or incomplete.
5. Have Spare Dies and Rollers Ready
Cutting dies wear out over time. Keep backups to reduce downtime.
6. Avoid Overloading the Machine
Operating above the mattress output rate will cause misfeeds. Maintain synced speeds between core production and assembly machine.

*For Technical specifications of machine go through titled PDF “Technical Parameter Layers Assembly Machine”*