Bachelor's Thesis Engineering Technology

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Stacking and drying machine of tiles with integrated control of dimensions and quality

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Specialization Electromechanical Engineering Technology

1. Situation

This bachelor thesis is conducted in collaboration with Ebema. Ebema was founded in 1948 and today has more than 220 employees [1]. The company has two branches in Zutendaal and Rijkevorsel and an annual turnover of almost 49 million euro. Ebema sells concrete products for public areas but also for gardens, terraces and driveways.
This bachelor thesis focuses on the production process of a so-called smooth stone (Figure 1).
This is a fragile concrete stone with a very soft surface.

Ebema has asked us to design a machine to dry, measure and stack the stones (steps 9, 10 and 11).
Figure 2 shows the production process of the smooth stone.

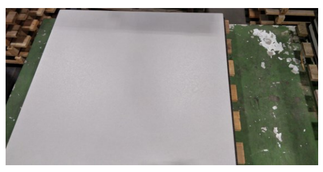

Figure 1: Smooth stone

Step 9 is drying the tiles after they have been coated. In step 10, the tiles are checked for thickness and quality (no stains, correct colour). In step 11, the stones are stacked according to their thickness. If a tile has a thickness of 0 to 3 mm above the nominal value, it is placed on the plus stack. If a tile has a thickness from 0 to 3 mm below the nominal value, this tile is placed on the minus stack. The tiles that are outside the 3 mm tolerance are rejected and removed. The tiles are stacked on a pallet with an isolation layer between each tile for protection, whereby one stack consists of ten tiles.

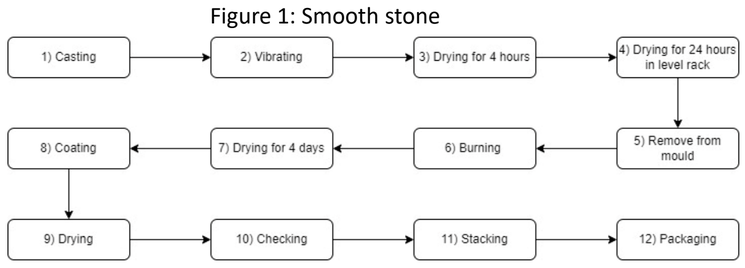

Figure 2: Production process

2. Problem statement

The problem is that the existing process no longer meets the criteria, so we have been given the task of making process steps 9, 10 and 11 more efficient and automatic.
Now, drying takes place through one 6-metre heat tunnel. Then, the thickness is checked manually with a caliper and the quality is examined (such as colour, roughness, damages, stains). Finally, stacking takes place using a manually operated crane. Figure 3 and 4 shows these 3 process steps.

The problems that occur are as follows:

- the coating on the tiles is insufficiently dry, so that the tiles stick together after destacking + the number of tiles that can dry at the same time is too low;
- Manual removal of the bad tiles;
- checking with calipers can give measuring errors + this is a slow process;
- the manual clamping of the tiles for stacking is too slow;
- the supply of pallets on the conveyor belt is done manually (bad for ergonomics);
- there is no buffer of plus and minus stacks, so the forklift truck must pick up these stacks each time before the process can continue.

Figure 3: Step 9 heating tunnel

Figure 4: Step 10 checking + step 11 stacking

3. Objective

The objectives are as follows:

1. tiles must be completely dry after coating + more capacity to dry simultaneously,
2. automation of the control of the thickness and the quality of the tiles,
3. automation of removal of bad tiles,
4. automation of tile stacking,
5. buffer system of plus and minus stacks,
6. buffer system of pallets,
7. buffer system of isolation layers.

These seven numbers are used to represent the different parts of the overall design as shown in figure 5.

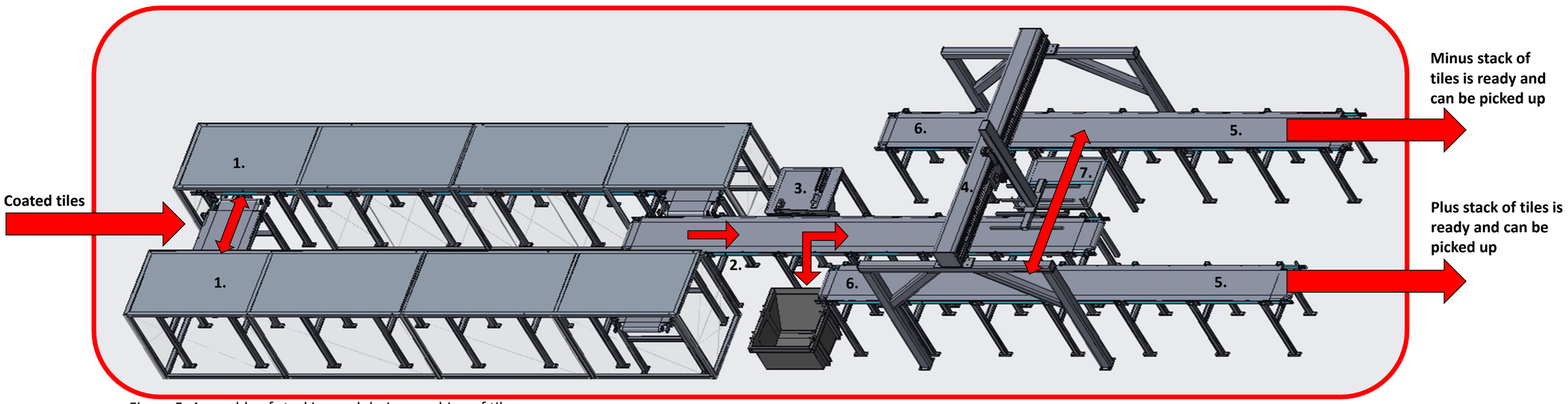

Figure 5: Assembly of stacking and drying machine of tiles

4. Method

The methods used to meet the 7 goals are:

1. two heating tunnels to increase capacity + longer heat tunnel to fully dry the tile;
2. sensor with integrated camera measures thickness + identifies damages or stains;
3. hydraulically controlled pusher arm removes bad tiles by pushing the tiles off the conveyor belt into a container;
4. vacuum system attached to a gantry that can move in x and z direction to stack tiles;
5. the plus and minus stack are each given a separate conveyor belt that buffers 2 stacks and then be removed by a forklift truck;
6. the same conveyors as point 4 also buffers 2 pallets placed by a forklift truck;
7. raised platform to buffer isolation layers where the gantry can pick up the layers.

5. Results/ Conclusions

1) Coated tiles split up using a conveyor belt and pass through a heating tunnel (1. in figure 5). Figure 6 shows a detailed view of the heating tunnel.

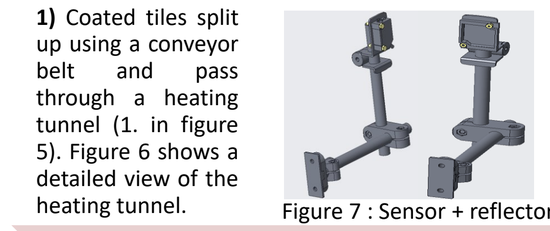

Figure 7 : Sensor + reflector

3) The push arm (3. on figure 5) blocks the tiles and they fall into the container. Figure 8 shows a detailed view of the pusher arm and container.

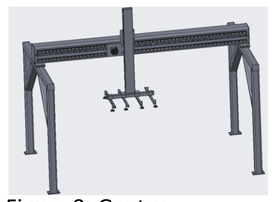

Figure 9: Gantry

5) The buffering of pallets (6. on figure 5) and stacks of tiles (5. on figure 5) consists of one long conveyor belt where there are pallets ready for stacking and space to put the complete stacks as showing in figure 10.

Conclusion: Design is fulfilling every objective.

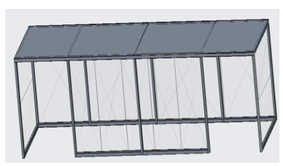

Figure 6: Heating tunnel

2) Sensor (2. on figure 5) checks the thickness + quality of the tile. Figure 7 shows the sensor + reflector.

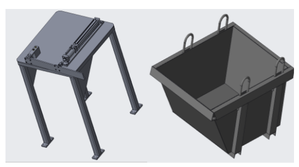

Figure 8: Pusher arm + container

4) A gantry (4. on figure 5) stacks the tiles + takes an isolation layer (7. on figure 5) to put between each tile. Figure 9 shows a view of the gantry.

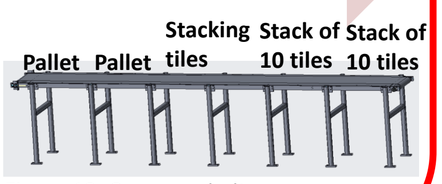

Figure 10: Conveyor belt

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[1] Ebema, „Homepage Ebema,” Ebema stone & style, [Online]. Available: https://www.ebema.be/nl-BE. [Geopend 24 oktober 2021].

Figure 11: Logo Ebema [1]