Developed Technology and Equipment for Collecting Beach Cast Macroalgae

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Tasks of the research

Our task was to find optimal design of grate buckets for collecting beach cast macroalgae. Collecting beach cast macroalgae has its own specific problems, mainly sand contamination, and high moisture, as well as time constraints when it comes to collecting a significant amount of macroalgae.

To determine the most efficient algae collecting tools , two design grate buckets were tested on Liepaja beach , October 2020.

Following tasks were solved during research

1. Testing the worldwide experience - to find the most efficient method of collecting beach cast algae in autumn 2020, on Liepaja beach two front loader buckets were tested. Grate bucket was chosen because in research made in Treleborg, Sweden the grate bucket was mentioned as one of the most efficient.
2. To find optimal design of grate buckets for collecting beach cast macroalgae.
3. The analysis of the test results was the background for designing of new configuration improved grate. The prototype of improved grate bucket was calculated, designed, made and tested. The comparable tests and calculations were maid.
4. Evaluated opportunities of commercialization for improved grate bucket.

Basic bucket

The first example for tests we had MTM type stone bucket, 1,5 m wide, 18 bar with distance of 90 mm, made from Hardox 450 grade steel, total weight 242 kg. Horizontal bar length – 1m, vertical – 0,52 m, - basic bucket.

Basic bucket tests

Results of basic bucket tests

- Results of the basic bucket tests showed that this design is useful for beach cast algae collection. It provides solution for two main problems – providing dewatering and limiting sand content. However the design of the bucket is not optimal – it has too short vertical branches. This insuficient lengtht limiting the loaded algae amount and overall efficiency.

- To increase efficiency a new bucket was designed.

Operation timing for basic bucket

Table 1. Timing records of algae collection on beach. (basic bucket)

Nbr	Loading	Travel to	Unloading	Travel from	Sum	Volume
	s	s	s	s	s	m^3
1.	8	14	4	17	43	0,3
2.	30	8	7	10	55	0,4
3.	10	11	6	12	39	0,4
4.	12	11	5	15	43	0,3
5.	16	12	6	13	47	0,4
6.	14	16	5	16	51	0,4
7.	12	15	7	16	50	0,4
8.	13	16	6	18	53	0,4
9.	17	16	7	16	56	0,4

Improved bucket

- New details were plotted, using Solid Works software package for design of mechanical parts..
- Details were calculated for determine sufficient structural strength, using same software modules for modelling statical loads and tensions.
- All parts were made using CNC plasma cutting, bending. Assembly of the parts were made by welding. Complete construction was cowered by polyurethane paint.

Prototype of the improved bucket

- Improved bucked has 13 longer vertical branches. This improvement allows to enlarge the capacity of the bucket and increase overall efficiency of collecting process. Mounting fixtures comply to “Euro” (ISO 23727:2009) standard and allows fast mounting/unmounting of grate bucket. All metal parts are manufactured using CNC equipment, from hard steel alloy.

Operation timing for improved bucket

Table 2. Timing records of algae collection on beach. (improved bucket)

Nbr	Loading	Travel to	Unloading	Travel from	Sum	Volume
	s	s	s	s	s	m^3
1.	6	8	6	12	32	0,6
2.	8	15	9	8	40	0,9
3.	7	15	6	8	36	0,5
4.	10	15	6	10	41	0,5
5.	19	12	7	15	53	0,8
6.	5	12	5	10	32	0,7
7.	10	10	10	11	41	0,9
8.	21	13	6	11	51	0,8
9.	3	15	5	10	33	0,6
10.	5	15	5	15	40	0,7
Total	94	130	65	110	399	7
Average	9,4	13	6,5	11	39,9	0,7

Efficiency of improved bucket

Comparative algae collection was performed with a small bucket and a large bucket. A total of 10 trips were made with each cup. Each trip consisted of a total of 4 stages (loading, trip to, unloading, trip from), the duration of which was measured (in seconds). The volume of transferred algae in m^3 was also measured.

Given that the change in fuel consumption was so small that it was not possible to identify it, the productivity of each bucket was calculated by replacing this characteristic with 1, according to the formula of productivity.

$$\text{Productivity} = \frac{V_\Sigma}{t_\Sigma} \text{ where:}$$

V_Σ= total volume of transported algae (m^3) = $V_1 + V_2 + ... + V_n$

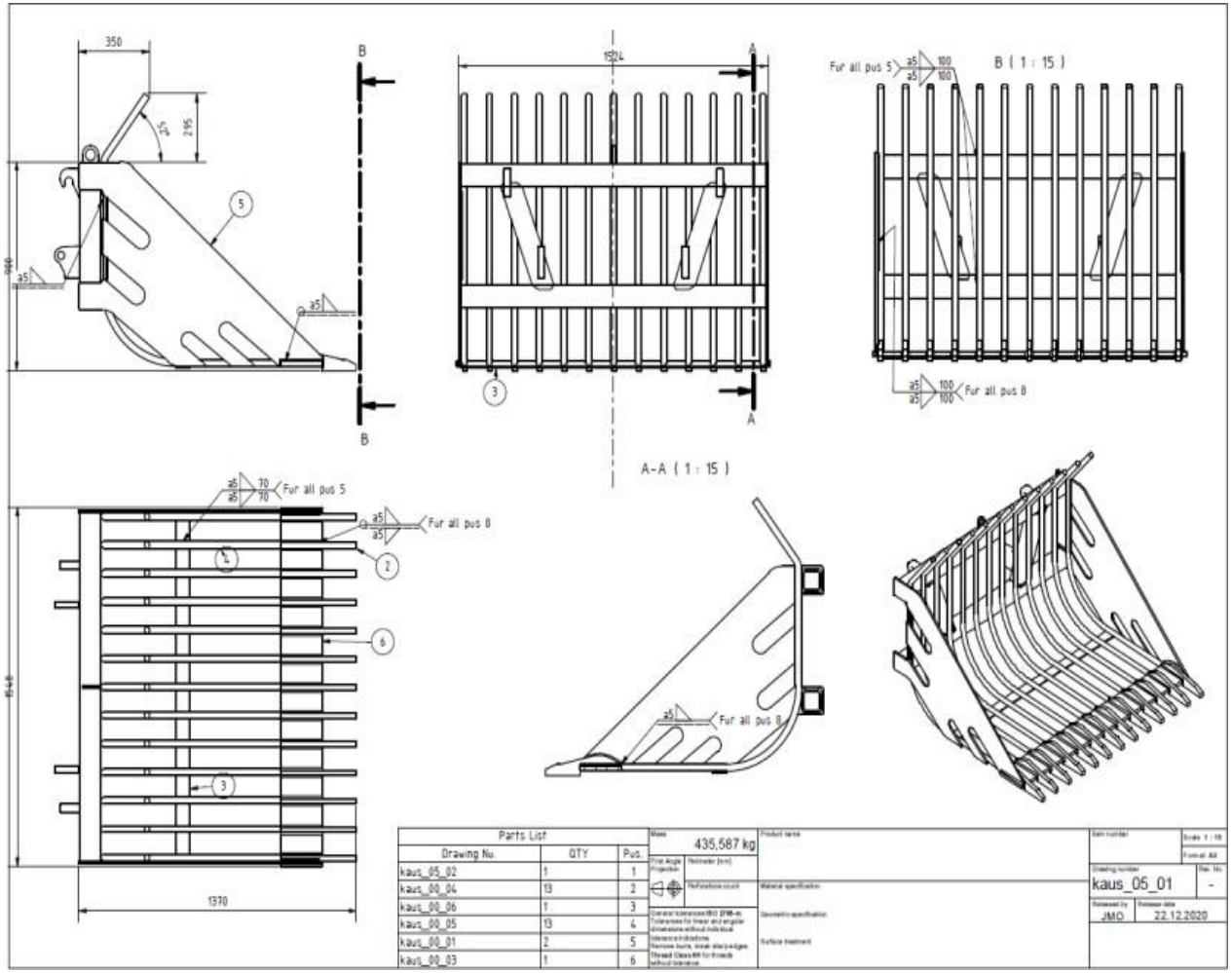
t_Σ = the total amount of resources used (h) = $t_1 + t_2 + .. + t$

Productivity for the small bucket = $\frac{3,8}{0,135}$ = **28,15 m^3/h**

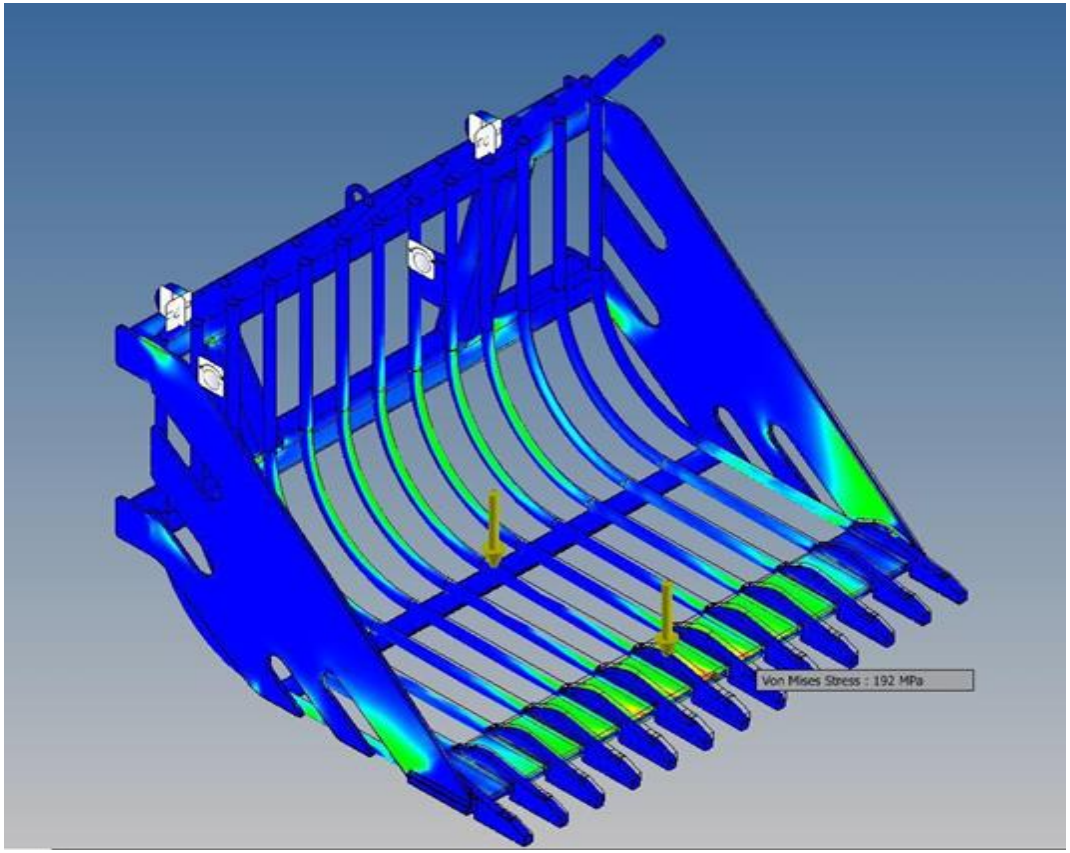
Productivity for the improved bucket = $\frac{7}{0,11}$ = **63,63 m^3/h**

Comparing productivity for a small bucket versus productivity for an improved bucket = $\frac{63,63}{28,15}$ = 2,26, a result is obtained which proves that the productivity of the improved bucket is **2.26** times higher than that of the small bucket.

Bucket design



Check the mechanical strenght



Tensions in force applied areas

Overall description of the collection techniques for algae beach cast biomass

Collecting algae in temporary piles helps to maximally remove the water out of the material and have it collected as much as possible dry. the uniform layer gives good opportunity to pick up algae efficiently and with good productivity

Improved grate bucket allows collect algae from beach and load it to intermediate piles efficiently and in good quality. The collected number of algae is **2,26** times more, comparing to basic bucket. Collected material has less moisture, because improved bucket has bigger volume of loaded algae, its layer is thicker and heavier than in case of basic bucket.

Opportunities of commercialization

Collection of algae using improved grate bucket viable and has potential of commercialization. Improved grate bucket could be used by fisher or farmers, interested in collecting algae. Possibility of use bucket for handling different materials is additional gain. Improved bucket can be used for handling hay, straw, branches, firewood and gravel and small stone collecting. Eventual price for improved bucket (say 700-800 EUR) could be acceptable and economically fair for potential customers. Improved bucket can be made in well equipped metalworking shop who has CNC bending, cutting and welding equipment

Conclusions

- One of the best tools for collecting beach cast algae is front loader, equipped with grate bucket.
- Size of bucket determines the overall efficiency of collecting process. The total wight of the load of macroalgae is lower than the capacity of tractor, so bigger bucket yields higher output.
- To increase efficiency of the bucket, the design of the bucket has changed – vertical branches have been prolonged, increasing its capacity.
- Changing design of the bucket, the mechanical strength must be checked. The most appropriate is to use finite element analysis. The results of the analysis confirmed the mechanical strength of modified design.
- Using designing software package for metal parts “SolidWorks” is possible to create 3D drawings of metal parts, production files for CNC machines and in same time check parts foe mechanical strength.

- Testing the improved grate bucket, the increase of efficiency of collecting of algae by 2.26 comparing to base bucket was observed.
- Collecting algae to intermediate piles lead to efficient moisture drainage and eases the transport schedule planning.
- The design of improved backet allows to make it in metal workshop, equipped with CNC equipment. It determines good commercialization opportunities and fair market price.’
- The commercialization opportunities are increased also by additional use possibilities of handling hay, straw firewood and sorting and transportation of stones

Comunications

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