



COMPRESSION POTENTIAL "DOUBLING ENERGYWOOD LOAD SIZE"

Sustainable Bioenergy Solutions for Tomorrow
(BEST) research program

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Background

- Comminution from roadside landings to terminals => higher
 - utilization rate of machinery
 - delivery reliability of energy
- Problem: low payloads on long distance transport
 - 9/2013 (60 t): 65-70 % of maximum capacity
 - 10/2013 → (64-76 t): down to 50 % of maximum capacity
 - The dryer material the lower payload



Target/Plan

- BEST-program concentrates on terminal-oriented solutions
 - ⇒ This sub-task focuses on finding cost-effective solutions to supply non- or low-refined raw material from road side landing to terminal
- Loose density on long-distance transport is normally 100-150 kg/i-m³
 - Find potential density and solutions on 60-76 t trucks.
 - By compressing slash/stumps during loading
- Compressing must take place integrated on other work stages
 - Cutting/lifting, hauling, loading on truck

Compression study



Original idea by Sakari Mononen & Metsähallitus

- Proto 2011-2012
- Study unit 2012-2013

Study with final prototype



SLASH

- Moisture content 35 %



PINE STUMPS

- Moisture content 24 %

Results on practical conditions

UNCOMPRESSED SLASH

	Truck	Trailer	Both	
# of load cycles	30	78	108	
Loading	21	31	52	min
# of unload cycles	17	45	62	
Unloading	?	17	?	min
Total weight	24540	28300	52840	tn
Tare	18500	14040	32540	tn
Payload	6040	14260	20300	tn

UNCOMPRESSED STUMPS

	Truck	Trailer	Both	
Total weight	25060	29940	55000	tn
Tare	18400	14040	32440	tn
Payload	6660	15900	22560	tn

COMPRESSED SLASH

	Truck	Trailer	Both	
# of load cycles*	48	86	134	
# of bales**	23	33	56	
Loading	36	50	86	min
# of unload cycles	20	46	66	
Unloading	6	14	20	min
Total weight	25600	29780	55380	tn
Tare	18300	14020	32320	tn
Payload	7300	15760	23060	tn
Compression	20,9	10,5	13,6	%

COMPRESSED STUMPS

	Truck	Trailer	Both	
Total weight	25800	31280	57080	tn
Tare	18400	14040	32440	tn
Payload	7400	17240	24640	tn
Compression	11,1	8,4	9,2	%

* from road side pile to compression unit

** from compression unit to load space

Compression study conclusions

- Slash
 - Compression unit works technically as planned
 - No applicable / profitable without major modifications
 - Compression rate (13.6 %) far too low
 - Time consumption of loading increased much more (65 %) than load size
- Stumps
 - Tested compression unit is not suitable or even developable for stump-processing

Compression potential on trucks

# of axles			Total weight, tn			Tare weight, tn			Payload, tn			Height, m	Load space, m ³			Kg/loose-m ³	
truck	trailer	both	truck	trailer	both	truck	trailer	both	truck	trailer	both		truck	trailer	both	truck	trailer
3	4	7	26	34	60	18,5	13,5	32,0	7,5	20,5	28,0	4,2	52	105	157	144	195
3	4	7	26	38	64	18,5	13,5	32,0	7,5	24,5	32,0	4,2	52	105	157	144	233
3	4	7	26	38	64	18,7	13,8	32,5	7,3	24,2	31,5	4,4	56	112	168	130	216
3	4	7	28	36	64	18,5	13,5	32,0	9,5	22,5	32,0	4,2	52	105	157	183	214
3	4	7	28	36	64	18,7	13,8	32,5	9,3	22,2	31,5	4,4	56	112	168	166	198
3	5	8	27	41	68	18,5	14,5	33,0	8,5	26,5	35,0	4,2	52	105	157	163	252
3	5	8	27	41	68	18,7	14,8	33,5	8,3	26,2	34,5	4,4	56	112	168	148	234
4	4	8	31,5	36,5	68	20,0	13,5	33,5	11,5	23,0	34,5	4,2	52	105	157	221	219
4	4	8	31,5	36,5	68	20,2	13,8	34,0	11,3	22,7	34,0	4,4	56	112	168	202	203
4	5	9	34	42	76	20,0	14,5	34,5	14,0	27,5	41,5	4,2	52	105	157	269	262
4	5	9	34	42	76	20,2	14,8	35,0	13,8	27,2	41,0	4,4	56	112	168	246	243
4	5	9	35	41	76	20,0	14,5	34,5	15,0	26,5	41,5	4,2	52	105	157	288	252
4	5	9	35	41	76	20,2	14,8	35,0	14,8	26,2	41,0	4,4	56	112	168	264	234
5	4	9	42	34	76	22,7	11,4	34,1	19,3	22,6	41,9	4,2	70	88	158	276	257
5	4	9	42	34	76	23,0	11,7	34,7	19,0	22,3	41,3	4,4	75	94	169	253	237

- On 60-64 t trucks' trailers payload often clearly under carrying capacity (typical loose density < 150 kg/loose-m³)
- For both 68 and 76 t trucks there are combinations, where load space volume and carrying capacity are in balance and 34+ tonnes loads available when compressed

General findings 1

- Slash
 - Lot of loose and smaller particles that must not be dumped to landing (organic waste => energy wood)
 - ⇒ **Compression must take place on/above load space**
 - Varying portion of logs, tops and whole-trees that are hard to arrange tight on load space
 - ⇒ **Compression process should be able to fracture/crack at least thinnest objects (< 10 cm?)**
 - ⇒ **Longest stem parts (> 2,5 m) could also be cut on shorter parts**

General findings 2

- Stumps
 - Lot of debris that must be dumped to landing (if not left on site)
 - ⇒ **At least part of compression process should take place outside load space**
 - Long-shaped stump chunks very challenging to arrange tight on load space
 - ⇒ **Longest roots should be left on site (or broke to shorter parts during loading)**
 - At least dry pine stump chunks surprisingly easy to break on smaller pieces
 - ⇒ **Compression process could possibly be replaced by breaking chunks during loading**
 - ⇒ **Primary shredding with separate machinery might be too heavy and costly treatment**

General findings 3

- Energy wood trucks / load space
 - Carrying capacity and load space volume are not in balance between truck and trailer on typical combination (3-axle truck)
 - ⇒ Trailers biomaterial should be compressed more than 60 % tighter (233 versus 144 kg/l-m³) to maximize total payload (32 t)
 - ⇒ Better balance and maximum benefits (>40 t) can be reached using modern 4-axle trucks for transporting compressed biomaterials

# of axles			Total weight, tn			Tare weight, tn			Payload, tn			Height, m	Load space, m ³			Kg/loose-m ³	
truck	trailer	both	truck	trailer	both	truck	trailer	both	truck	trailer	both		truck	trailer	both	truck	trailer
3	4	7	26	38	64	18,5	13,5	32,0	7,5	24,5	32,0	4,2	52	105	157	144	233
4	5	9	34	42	76	20,2	14,8	35,0	13,8	27,2	41,0	4,4	56	112	168	246	243

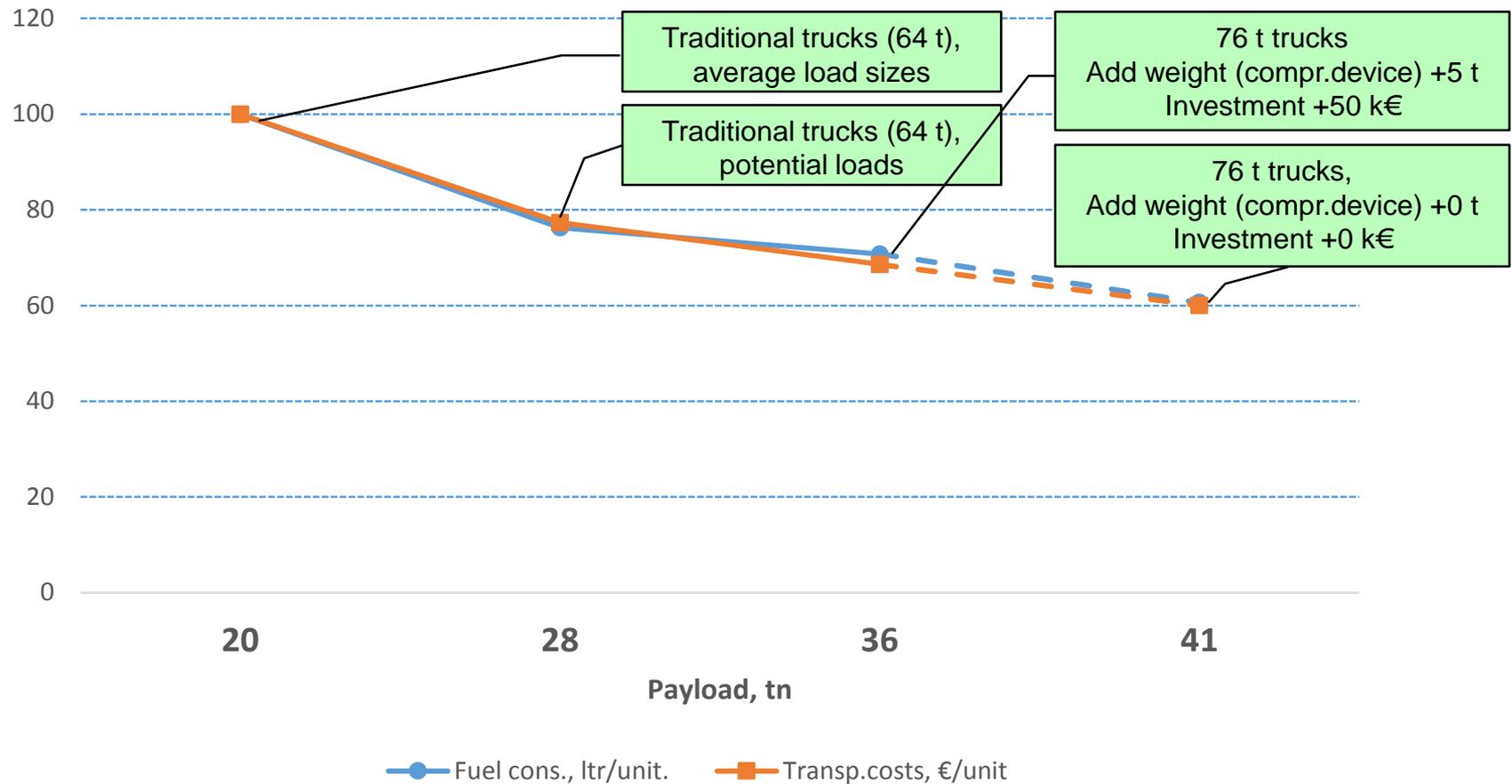
- Hydraulics in traditional telescopic trailers not powerful enough for longitudinal compression
- Side structure sets limits for compression method and force especially in telescopic trailers
 - ⇒ Trailers structure and hydraulics should be sized in line with compression needs
 - ⇒ Removable crossbars might be needed on top of sides to keep load space width on legal limit (2,5 m)

General findings 4

- Energy wood loader / grapple
 - Heavy and long reaching loaders common in energy wood trucks
 - ⇒ **Backside of stump and slash piles still hard to reach (in contrast to roundwood piles)**
 - Often used as "hammer" during loading, that stresses loader, load space sides and operator
 - ⇒ **Compression should be done in more controllable way (hydraulics, adjusted work model)**

Potential savings

Fuelcons. & Tr.costs, 1 shift/day on 80 km distance



Conclusions

- Compression methods for uncomminuted energy wood worth of studying
 - Potential savings are remarkable (20-30 %, or even more)
- Commercial solutions not yet available, mainly because
 - new weight limits were launched just year ago => it takes time that development processes start among manufacturers
 - potential is higher than manufacturers have expected

Remarks

This study was part of the BEST-program launched originally by FIBIC and CLEEN together. The program was funded by TEKES.