



Product report

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Title page

1 8th semester

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3

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32



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Introduction

This report describes the result of an 8th semester industrial design project concerning the design of an excavator concept in cooperation with A/S Hydrema.

The product is presented through functionality as well as the visual expression. The report is mainly targeted at the manufacturer A/S Hydrema, supervisors and censors. A description of the product development process is located in the process report.

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E17

E17 introduces two major functional features: An expandable counterweight and four individual tracks.







E17

4-TRACK

The 4-track system provides:

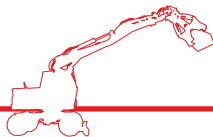
- Manoeuverability on/off-road
- Increased traction
- Low ground pressure
- Stability in uneven terrain
- Comfort to the operator
- Pavement protection



EXPAND

The expandable counterweight provides:

- Increased stability
- Increased lifting capacity
- Possible compact operation
- Increased comfort



SITE TO SITE

Excavators with good off-road capability are unable to drive on road without being transported on a lorry.

The 4-track solution is able to drive on-road independently, thereby eliminating the need of a lorry.

This is especially beneficial when driving small distances which is often the case with urban excavation jobs.



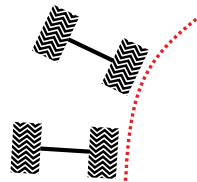
E7



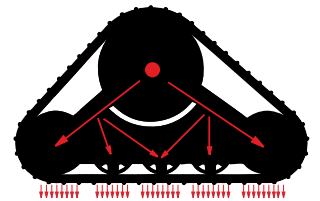
Speed 30 km/h



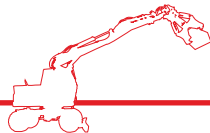
Below weight limit for driving on public roads



Axle-steering



Low ground pressure



ENTRANCE

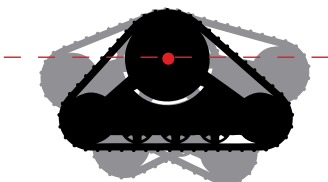
When preparing a job, metal sheets are used out to protect pavement and other fragile objects from the tracks of excavators.

The 4-track solution is flexible in terms of being able to drive both on and off-road thereby reducing the time

spent for protecting the surroundings whether it is the pavement or a curb.



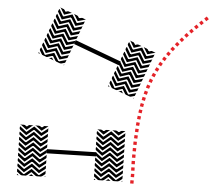
E17



Adaptable to ground



Distribution of load



Axle-steering



STABILITY

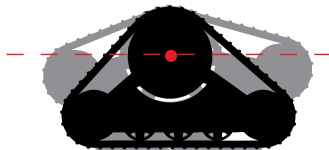
The stability of an excavator is an important factor in terms of excavator.

The tracks are able to adjust to uneven ground, providing a stable machine on uneven ground.

The counterweight provides an increased potential lifting capacity, minimizing the risk of tilting as well as improved comfort through a more stable machine.



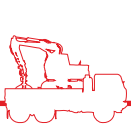
Adjustable counterweight



Adaptable to ground



Low ground pressure



PERFORMANCE

When working in situations that challenge the capacity of excavators, such as far reach or use of heavy tools (f.ex. hydraulic hammers), the

excavator is prone to vibrating or in a worst case scenario, tilting. The expandable counterweight minimizes

these problems by providing increased lifting capacity and stability while maintaining a possible smaller machine.



E17



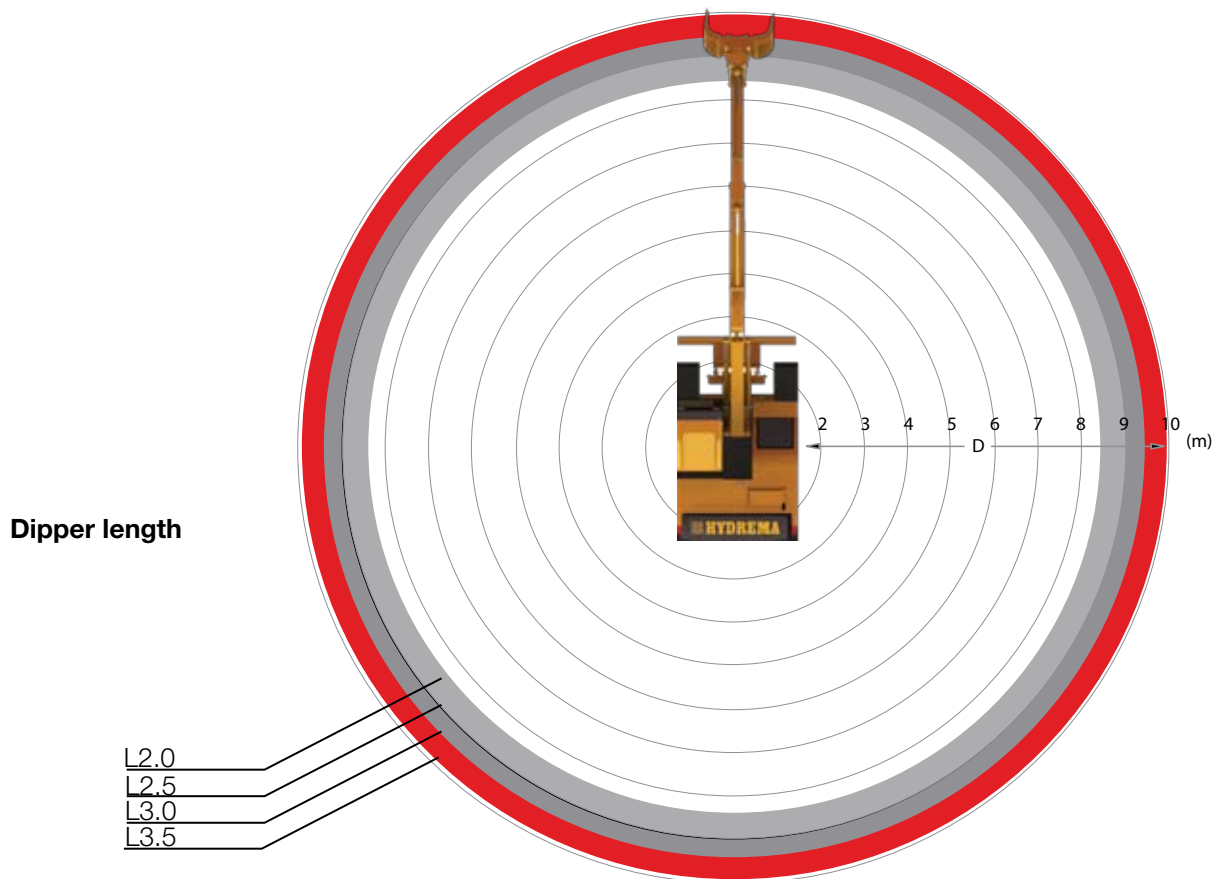
Adjustable counterweight



115-132%
Increase of lifting capability

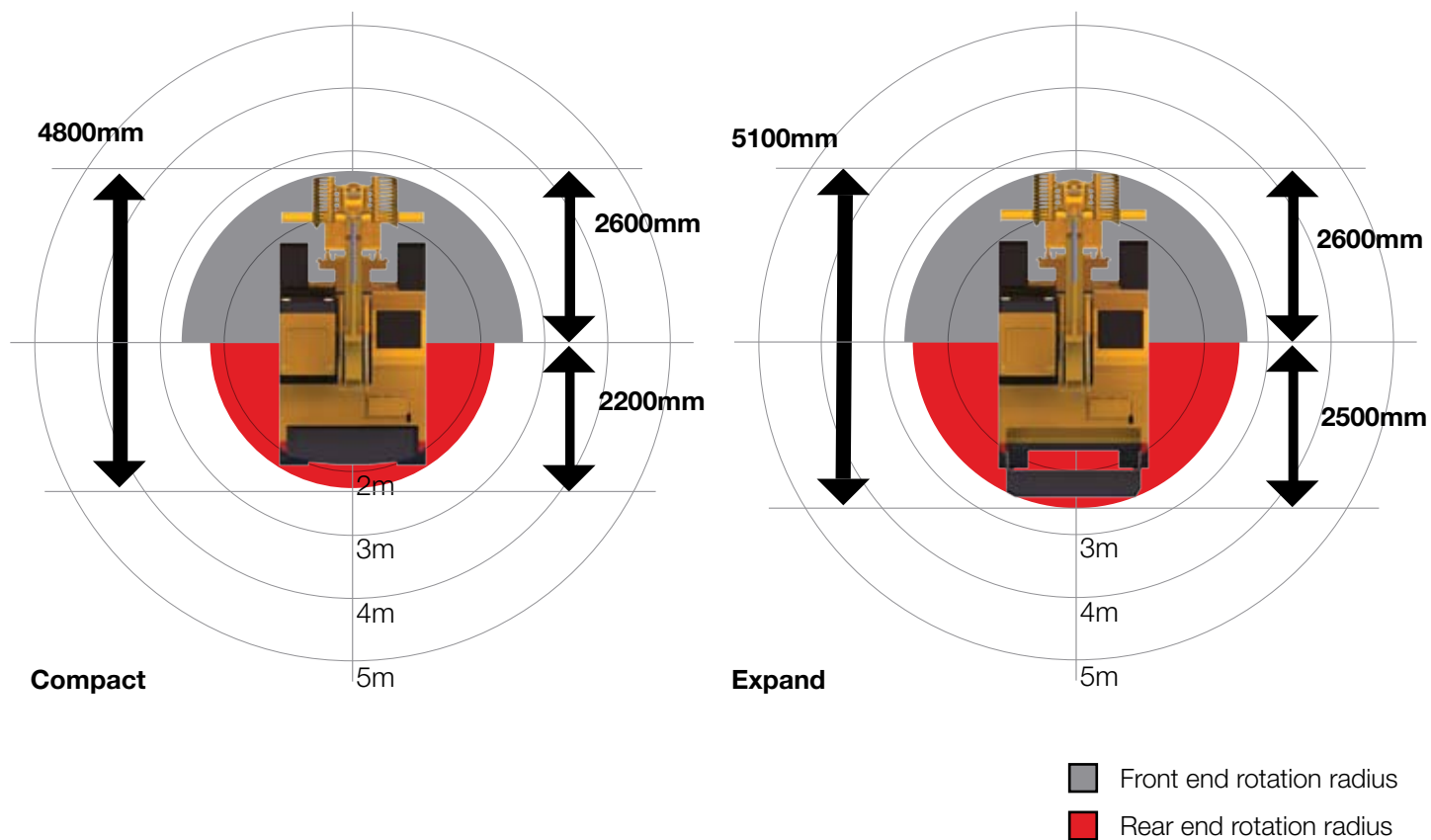
Working radius

15



Digging reach

When rotating 360 degrees, the E17 covers a work area of approximately 200 square metres.

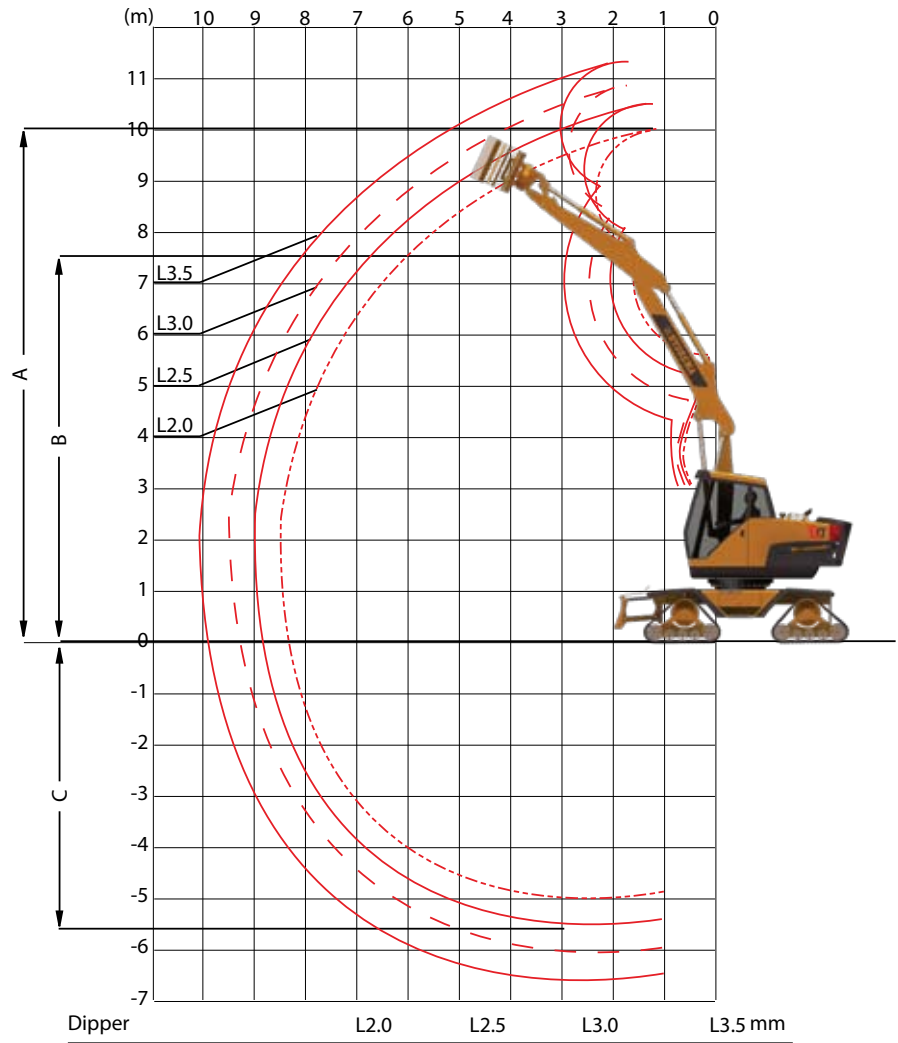


Rotation ratio

When rotating 360 degrees the E17 has a working radius of 4800mm in compact mode and 5100mm in expanded mode.

Digging performance

17



Compact mode

In compact mode the E17 cutting, lifting and digging height is similar to the M1700C as illustrated in the scheme.



Regular reach
Total lifting capacity

2.4 ton



Side reach
Total lifting capacity

1.6 ton



Regular reach - dozer
Total lifting capacity

4.8 ton

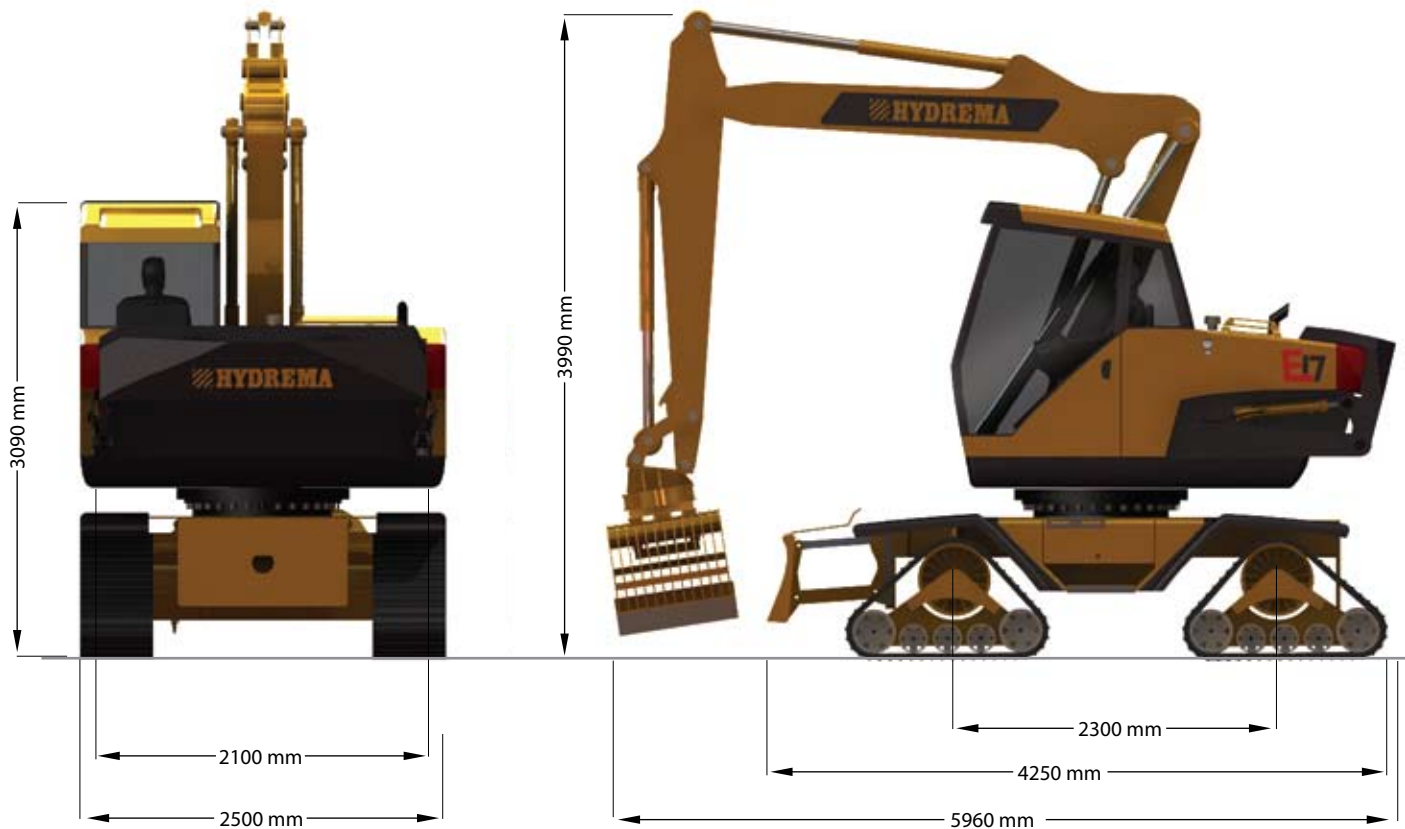


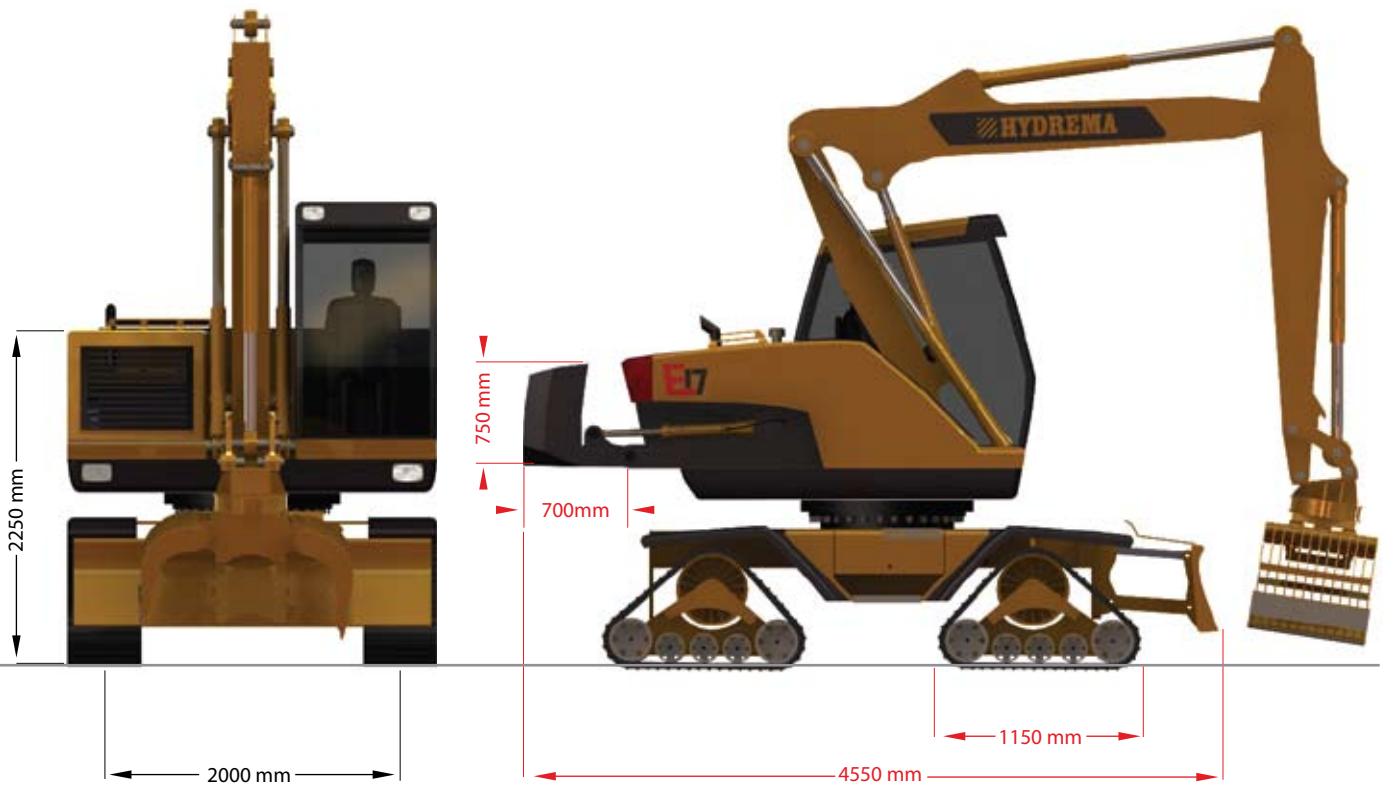
Expand mode

The digging performance and load capacity of E17 is increased in several working positions when the counter weight is expanded.

Dimensions

- 19 The E17 excavator has the outer dimensions that make the excavator capable to drive on the roads. The illustrations show E17 according to width, transport height and length in compact mode and furthermore the length in expanded mode.







E17

TRACK SYSTEM

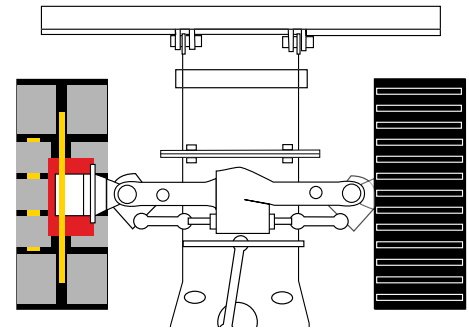
The track system of E17 is based on a simple architecture of wheels, belt and a frame.

The tracks are mounted on hydraulic driven axles which allow the excavator to be manoeuvred as a regular axle steered excavator.

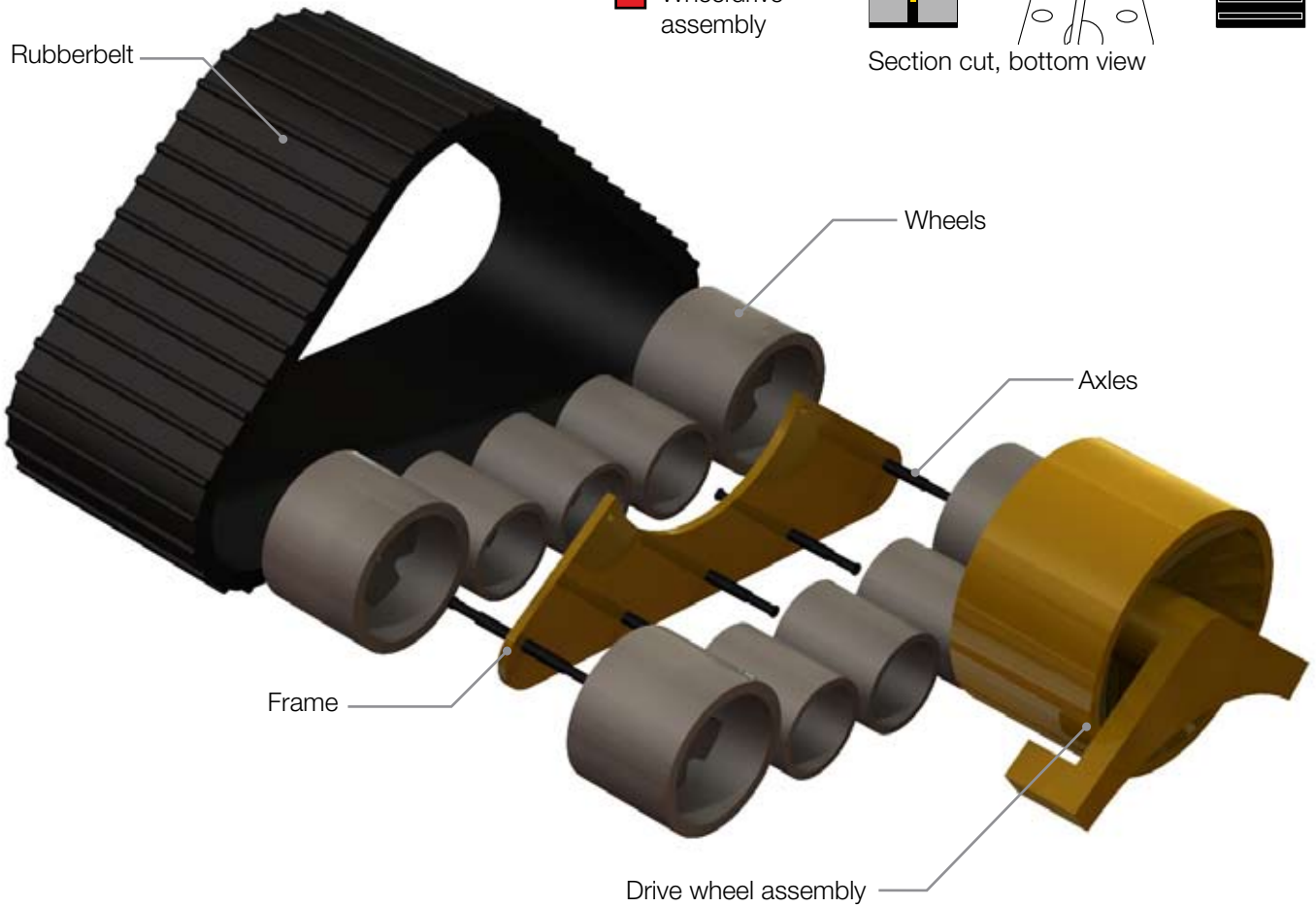
Axle steering

The tracks are mounted on regular hydraulic driven axle.

- Frame
- Wheels
- Wheeldrive assembly

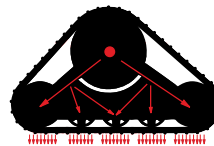


Section cut, bottom view



Flexibility

The tracks rotate around the axles.



Load

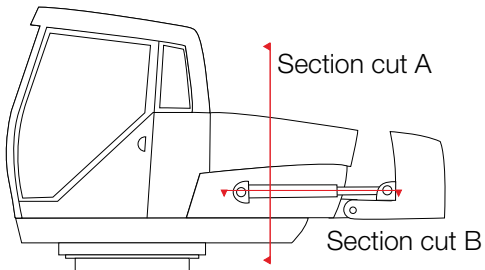
The load is distributed to four tracks with each five wheels.



COUNTERWEIGHT

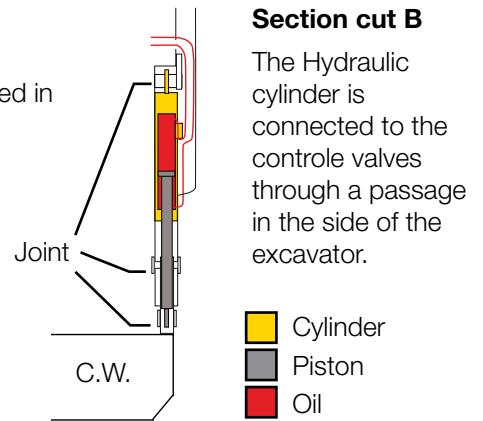
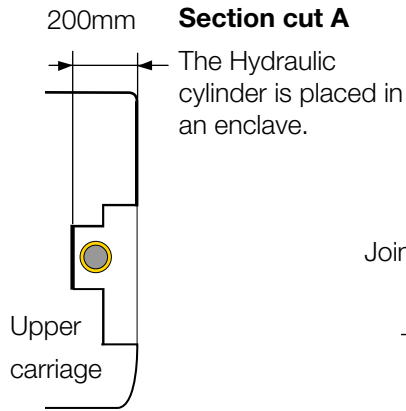
E17 has two modes; compact and expanded mode. The system consists of a 4.1 ton counterweight, a hydraulic system and assemblies that connect the system to the excavator. The mechanism is hydraulic driven and is

activated manually from the cabin. By activating the counterweight the lifting capacity is increased with 115-132% depending on the work position of the excavator.

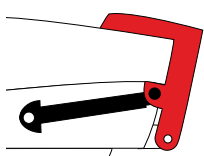
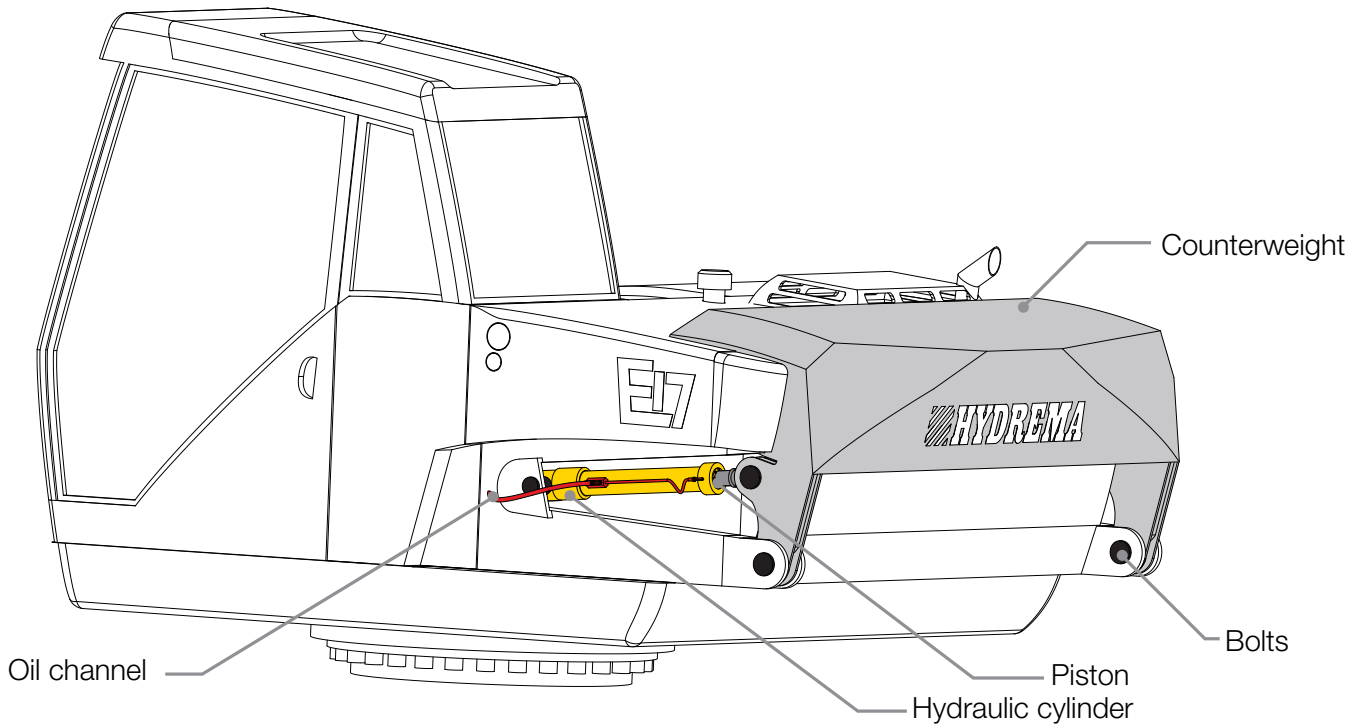


Mounting

The counterweight is hydraulic driven. The cylinders are placed in an enclave and mounted with three joints on each side.

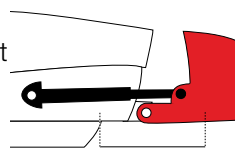


- Cylinder
- Piston
- Oil



Compact mode

In compact mode the counterweight is placed inside the uppercarriage.



Expand mode

The offset of the mass middle point of the counterweight increases the lifting capacity.

650mm

Counterweight parts

- 25 The elements used to produce the counterweight are lasercut from 10mm Domex 700 MC steel sheets. Afterwards the different parts are processed and welded together.

Parts: Assembling



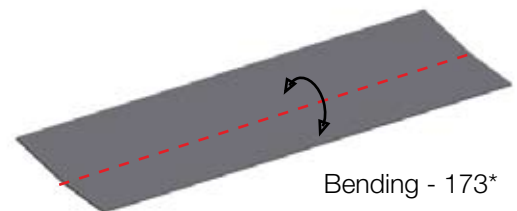
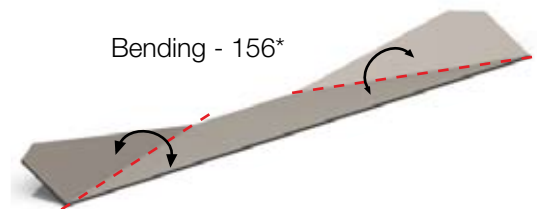
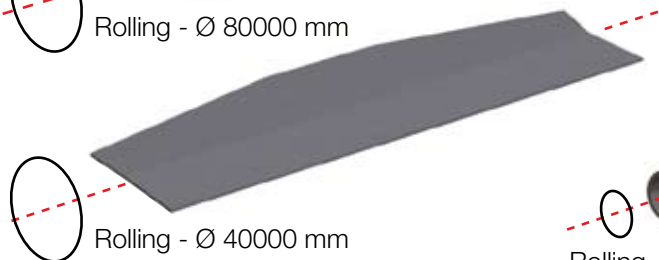
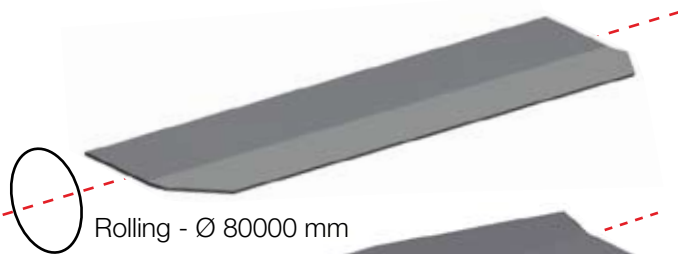
Parts: Bending



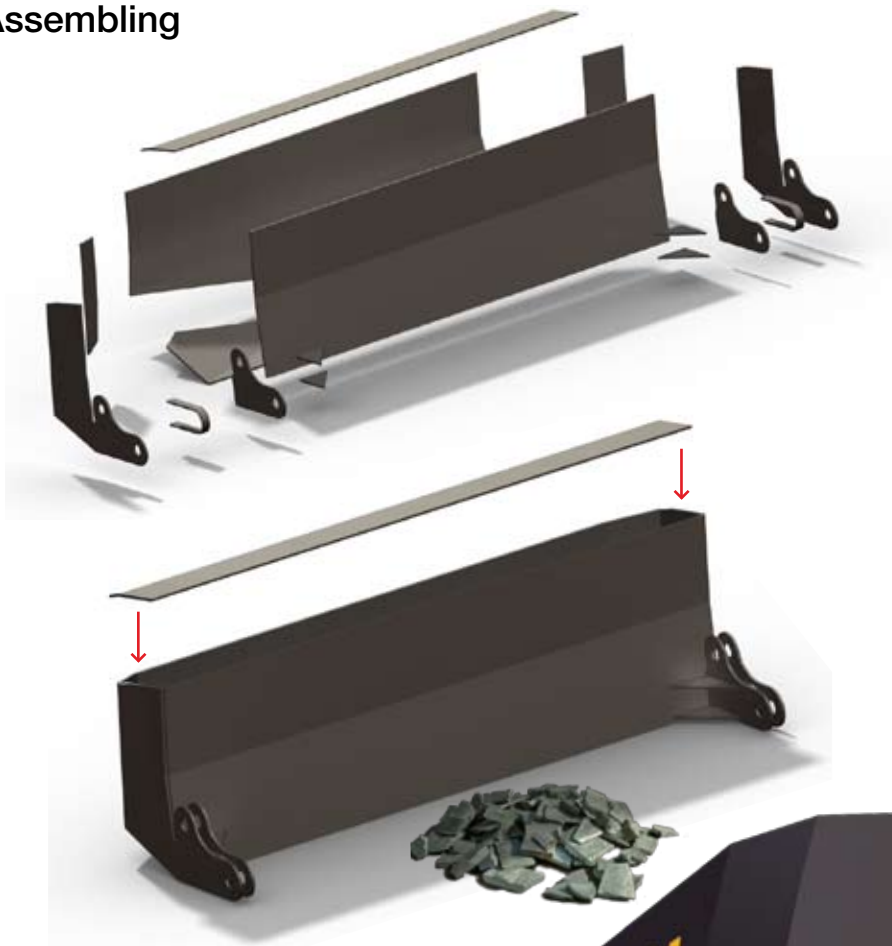
Parts: Rolling



Procedure specifications



Assembling



1. Besides the top plate, all the elements are welded together. 26
2. Scrap iron is filled into the steel case.
3. The top plate is welded on to the steel case.
4. The case is painted and ready to mount.

Mounting

The hinges of the counterweight and the upper carriage are bolted together and the counterweight is connected to the hydraulics. Once this is done, the counterweight is operational and ready for testing.



Market

27 **Designed for city use**

Besides demolition, E17 is capable of handling several city-related jobs.

The small dimensions combined with a 4-tracked undercarriage, allows the operators to drive directly to the sites, even through narrow gates, without having to wait for the truck or the protective iron plates to be put on the pavement.

E17 can also easily be relocated at night, if the working place is exposed to vandalism.

Sewers

With a low turning radius, the E17 has features suited for sewers and pipe work, where space is often limited to a single lane. The tracks do not damage the road and the counterweight provides the driver with more stability in situations where the boom is fully extended.

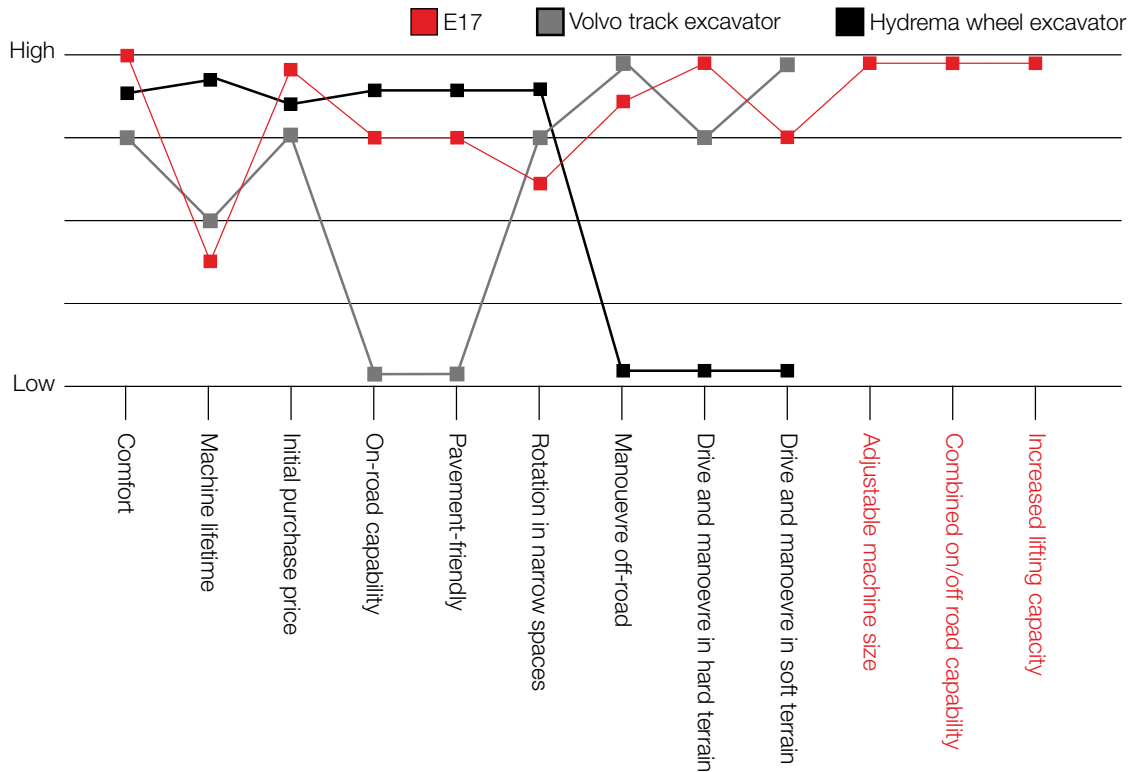
Renovation

For jobs in areas where tiles or pavement must not be damaged, the E17 is a suitable excavator. The 4-track system distributes the ground pressure on a bigger area, while having a lower friction than regular tracked excavators.

New builds

The E17 is also capable of handling and moving heavy loads. This could be jobs for construction sites, where the trucks are either not able to unload the equipment/material nearby or if heavy material needs to be loaded onto a truck.





Market position

The strategy canvas show the position of E17 according to track and wheel excavators in similar performance class.

E17 introduces three values to the market

- combined on and off road capability
- adjustable machine size
- adjustable lifting capacity

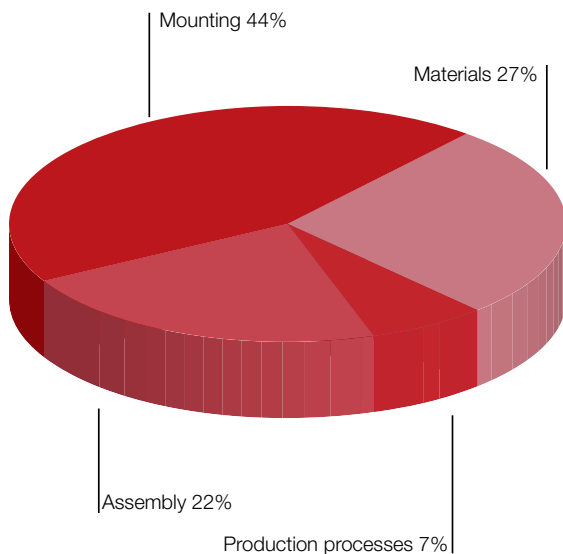
These are the parametres that makes E17 stand out on the market.

Cost estimation and allocation

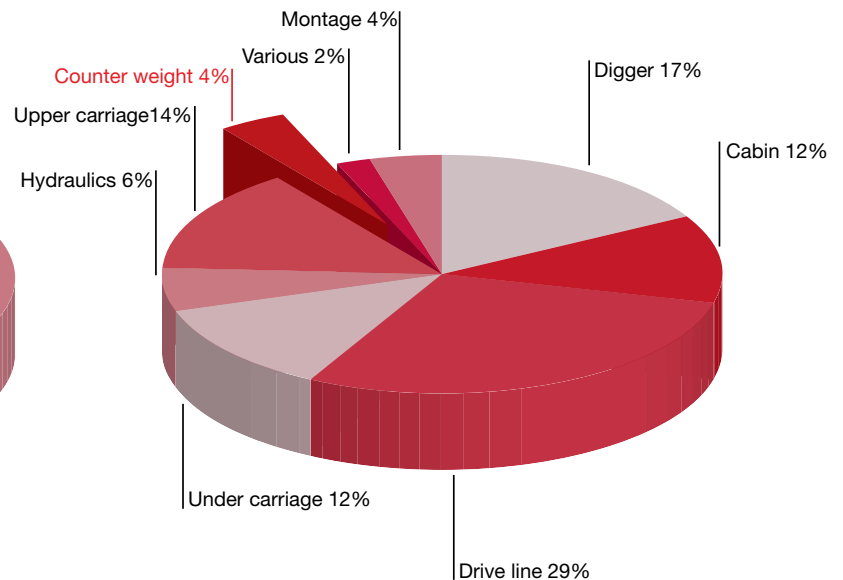
29 The cost estimation for the E17 machine is defined from the existing numbers for the M1700C excavator of Hydrema. The cost allocation model is added the price for the 4-track system which is estimated between 80.000 – 150.000 D.kr. for 4 tracks.

In addition for the counterweight system, a specified pricelist is made with estimates regarding production, assembly and mounting of the counterweight system. It is estimated that the overall production cost for the counterweight is approximately 15.000 D.kr.

Cost allocation - counterweight system



Cost allocation E17 design



Cost estimation - counterweight system

Materials	Items / Process	Units	Unit price - D.Kr.	Total - D.Kr.
Steel	Domex 700 MC - 10 mm	3 m2 *	10 kr. / kilo	2340 D.kr
Sub-total				2340 D.kr
Parts				
Bolts	Ø 60 mm	4 pcs	50 D.Kr.	200 D.kr.
Hydraulic cylinders	Ø 100/85 mm	2 pcs	2000 D.Kr.	4000 D.Kr.
Sub-total				4200 D.Kr.
Production processes				
Laser cutting	CNC Processed	2 Hours	200 D.Kr.	400 D.Kr.
Bending	Machined	1 Hours	250 D.Kr.	250 D.Kr.
Rolling	Machined	1 Hours	250 D.Kr.	250 D.Kr.
Welding	CNC Processed	2 Hours	200 D.Kr	500 D.Kr
Sub-total				1300 D.Kr.
Assembly				
1 person	Man-hours	15 Hours	250 D.Kr	3750 D.Kr.
Sub-total				3750 D.Kr.
Mounting				
2 persons	Man-hours	5 Hours	250 D.Kr	2500 D.Kr.
Sub-total				2500 D.Kr.
Total				14090 D.Kr.

*Sanistål, 1000 kr./100kg

Reflection

31 Market

The concept is developed to target demolition but it does not exclude other markets such as sewers, construction and foundation where the features of the concept also are beneficial. This will expand the potential market for the concept.

Track system

E17 implements a 4-track system with rubber belts as a replacement of the wheels and ordinary tracks. The solution maintains the ability to drive on road as well as increasing off-road capabilities. A similar track system is implemented on a 25 ton dozer developed by John Deere and a Bell dump truck. Technical specifications from Tidue, which is the producer of the tracks state that the rubber belts will last for approximately 2000 working hours before they are worn down and have to be changed, but this number of operating hours is stated for equipment that moves a lot more than an excavator.

Introducing these tracks on an excavator aimed for demolition present some problems, because of the tougher ground like concrete, demolished bricks as well as iron from destroyed concrete.

Counterweight

The counterweight system is a simple solution to a need that exists in the market. The E17 counterweight system is potential for further development and has to be tested regarding aspects such as operator comfort, durability and cost/benefit.

Cost/benefit

The next step in the progress of further development is to estimate whether the costs of the 4-track system will pay off in accordance with the gain that the operator and contractor achieves. The calculation can be done by calculating the extra price the contractor have to pay for the machine compared to the amount of reduced working hours and thereby how much money the contractor can save during a typical lifetime of an excavator. The maintenance of the 4-track system needs to be taken into account as well. If the calculations turns out that the concept is not cost effective it needs to be estimated whether the solution can be developed into a beneficial solution. The main argument is that the concept needs to be beneficial according to expenses and time for the manufacturer, the contractor and the operator.

Further development

Further development of the concept will require an optimization of the shape of the excavator to obtain a lower rear-end rotation radius for the excavator to be optimal for city use. Also the tracks need to be tested in the working situations off-road to see if there are implications when applying them on an excavator. One area of improvement could be to implement a hydraulic system that manually locks the tracks when the excavator is maneuvered into the work position.



