Summary

This report consists of a design study on a concept of a rapid hybrid lightweight CPT crawler (RLC^2). This RLC^2 is a tracked vehicle (crawler) which can reach higher speeds compared to the conventional CPT crawlers (up to 7.5 km/h compared to 4 km/h), can be driven by hybrid technology, and is capable of conducting CPT's. Cone Penetration Testing (CPT) consists of an in-situ test in which a measuring cone on the end of a series of rods is pushed into the soil in order to gain information with regards to the soil type and structure.

During the report a look is taken at the conventional lightweight crawler and the improvements which can be made to the design, which leads to both technical as well as functional demands, such as a hybrid driven vehicle to reduce emissions, speeds up to 7.5 km/h to minimize travel time and maximize CPT time and a redesign of the whole machine to reduce overall weight and complexity.

Following the short analysis of the current crawler a look is taken at the drive system this machine; this is used during the design of a hybrid drive system. This conventional diesel-hydraulic system consists of a Hatz diesel engine which drives a hydraulic piston pump.

With the information emerging from the conventional design the desired hybrid configuration and components were selected, which resulted in two possible hybrid concepts:

- full electric configuration, which uses a generator and batteries to power a frequency converter which controls the all-electric functions
- diesel electro hydraulic configuration, which uses the conventional hydraulic setup and is powered by a generator and electric motor

To power both of these configurations the following powers could be calculated for the primary (diesel generator) and secondary power source (batteries):

Function	
Primary power source	12 kW
Secondary power source	8.1 kWh

Table 0.1 Desired power per power source

After comparisons of the two configurations using criteria from the technical and functional demands, the full electric concept emerged as the best concept, based on its high efficiency and practicability. This resulted in the following configuration:

Figure 0.1 Hybrid design (Full electric design)

In order to reach the desired speed of up to 7.5 km/h a look has been taken at the conventional undercarriage, which relies on a complete rigid structure which causes vibrations to be transferred to the superstructure which limits the speed. These vibrations are calculated to aid the design process, when one has to take the eigenfrequencies into account. This resulted in the recommendation that during the actual design process enough stiffness and damping needs to be incorporated to cope with the calculated frequencies.

The desired speed of 7.5 km/h can be reached by using a suspended undercarriage in the form of 'boogie' type bogies to reduce the impact due to vibrations and obstacles.

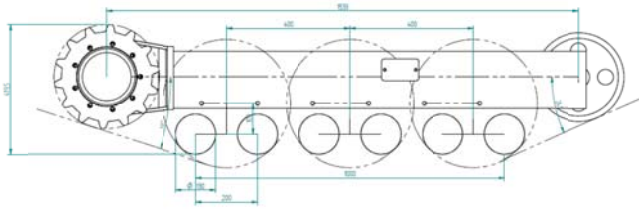

Figure 0.2 Boogie set conceptual drawing

The total crawler layout in the conventional setup incorporates a heavy chassis due to cope with reaction forces, and a central placed penetrometer which causes complex routing of other components. With the aid of a redesign the penetrometer was placed on a tilting mechanism on one of the end crawler, and incorporating the leveling jacks and anchoring beams into this construction. This reduced the overall height, the heavy chassis construction and complex routing of other components.

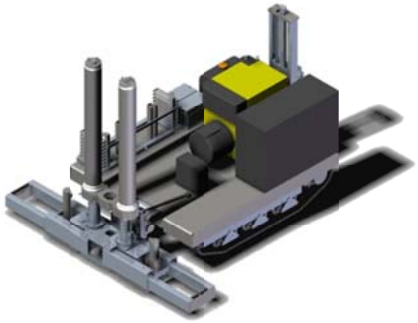

Figure 0.3 Hybrid CPT crawler in CPT mode*

This resulted in the final concept of the crawler, which thus includes the full electric hybrid drive system, the swiveling undercarriage and tilting penetrometer.

The most important conclusions and recommendations are:

Conclusions:

1. The proposed full electric hybrid concept equipped with a 12 kW generator set and a 600V 8.1 kWh battery pack is capable to work standalone for 1 day.
2. The maximum speed of 7.5 km/h is possible using a 'boogie' type undercarriage, which eliminates the vibrations and forces caused by small bumps and irregularities
3. Overall height, chassis weight and complexity can be improved with the use of a tilting penetrometer, which reduces the needed strength of the chassis and can be laid down to reduce height.

Recommendations:

1. A thorough research into the travel eigenfrequencies of the crawler, which can be carried out on the existing crawler as well
2. Research to other mechanisms which could replace the current linear motion penetrometer

The overall conclusion of this project is that it is feasible to construct a new type of hybrid LWC using the full-electric concept mentioned in this report, combined with the 'boogie' type undercarriage and tilting penetrometer.

*The figures shown of the new CPT crawler include the use of the conventional hydraulic penetrometer, since the 3D models of the linear actuators were not available at the time of designing this model. The linear actuators used will roughly be equally sized.