Summary (English)

A fast growth of cargo flows in ports and (bulk)terminals has resulted in a more frequent use of handling equipment which leads to deferred maintenance. Mechanical problems occur especially to the (driven) bogies and corrective maintenance and reparation operations to the travelling mechanisms lead to a more than average downtime of the handling equipment. A solution to limit this downtime is the use of a spare travelling mechanism which replaces the existing one temporarily. The question is how a spare travelling mechanism can be designed. It must be used for a range of different handling equipment types which makes a modular built up design reasonable.

Main aims are to define the functions, requirements and objectives of the spare travelling mechanism and to define the range of handling equipment for which it must be applicable. From here the boundaries for the design are obtained. The design restrictions are considered and taken into the final concept solution. A short introduction of the different components is given to get some insight into travelling mechanisms.

A spare travelling mechanism is usable for different handling equipment types if:

- It can be used on different rail types.
- The number of required wheels (based on the cornerload) can be assembled.
- The base length can be varied.
- The height to the connection point of the sill beam is adjustable.

Following structural requirements are important:

- Transverse forces (perpendicular to the rail) applied by the connection point with the sill beam must be absorbed and conducted to the rail.
- Adaptation to vertical rail unevenness.
- Cornerload must be divided rather equally over the number of wheels under all circumstances.

Later investigation is done if brake provisions in storm conditions and buffers are needed. Finally a check is made if drives are needed during crane travelling.

Solutions for these functions and requirements are obtained and they are united into 6 conceptual variants. Basic calculations of the working principle are made to check if they can be used in practice and a final conceptual variant is chosen based on the following technical and economical criteria:

- Costs: material and production costs low.
- Reliability: the change of a failure must be small.
- Operation: the cornerload must be divided rather equal over the wheels under all circumstances.
- Maintenance: must be kept to a minimum.
- Flexibility: possibility to change something at the last moment.

The final concept contains the following solutions:

- The main construction structure is based on the existing principle of using balances to divide the variable cornerload rather equally over the number of wheels. In stead of using shafts between the balances, rubber pads are used as supports. They provide small rotations in the vertical plane between the modules. The balances are coupled with pins.
- Wheels with a diameter of 630 mm are chosen. They can absorb around 30 % more load than wheels with a diameter of 500 mm. Using wheels with a diameter of 500 mm requires travelling mechanisms of more than 12 wheels due to the high cornerloads which requires an extended construction and thus more modules. Using less wheels is also cost saving. The wheels have no flanges to use them on different rail widths.
- Rail slides, mounted at the front and at the end of the wheel modules are created for each rail type. By using these rail slides, travelling on different rail types is possible. Forces parallel to the rail are also absorbed by the rail slides.
- Two wheel modules are coupled with a secondary balance. Two secondary balances are coupled with a main balance. The secondary balances consist of two welded I-profiles and are

strengthened with welded side plates. The main balance consist of three welded plates in a reverse u-shape. The main balance is positioned over the complete construction.

- The modules can be coupled at different distances to each other to vary the base length.
- The transverse forces acting at the connection point of the spare travelling mechanism with the sill beam are conducted via the side plates of the balances to the rail slides and to the rail.
- The part which connects the spare travelling mechanism with the handling equipment will be fabricated for each equipment separately. This eliminates a complex module for adjusting the connection width and shaft diameter.
- Transport is possible with conventional equipment like standard containers and the parts of the spare travelling mechanism can be handled with lift trucks.
- Because different storm anchor methods are used in practice, wheel blocks are used as anchor provisions.
- No buffers are installed. The chance of an accidental collision is negligable small. Care must be taken when positioning two cranes close to each other or when the crane is travelling to the end block of the storage position.

Usually all travelling mechanisms have 50% to 75% driven wheels. The question is if drives on the spare travelling mechanism are needed (remaining three driven corners) during crane travelling. The akews behavior and available drive power are taken into account:

- Askew behavior: This behavior is occuring during crane travelling when the equipment tends to move oblique in respect to the longitudinal direction of the rail. The acting askew force perpendicular to the rail of a corner must not exceed the value of 15% of the maximum vertical cornerload of that corner. Removing drives on one corner will change the askew force. The askew forces are not exceeding the value of 15% of the maximum vertical cornerload. Travelling with only three driven corners is possible when taking the askew behavior into account.
- The required moter power is built up of three main components: needed power for acceleration, friction and wind load. The component for windload is between 70-80% of the total required drive power. The needed power for wind load is quadratically dependent on the windforce and is reducing around 25% with one Beaufort lower. When the restriction is made that crane travelling is possible with a maximum windforce of 7 in stead of 8 on the scale of Beaufort the remaining drives have enough power left. Usually the drive power for cranes is calculated for crane travelling in storm with wind force 8. The crane must be stored before a heavy storm is on crane location.
- As a safety factor the acceleration time can be doubled. This reduces the needed acceleration torque with 50%.

The final concept design which is worked out in this report is the best solution based on defined technical and economical criteria. It is not said that this solution is the one and only solution for the given problem.

The design of the spare travelling mechanism can offer some new ideas for the construction structure of the present travelling mechanism structure. Movements between the balances are negligible small which makes the need of shaft questionable. The use of a simple support between balances could be profitable.

Nowadays each travelling mechanism is different. If travelling mechanisms from different manufacturers and from different types are constructed with the same modular built up construction structure it is a lot easier to replace parts of it when a module is damaged or has to be maintained.