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INNOTRACK

Integrated Project (IP)

Thematic Priority 6: Sustainable Development, Global Change and Ecosystems

D5.5.1 First report on the logistics of rails

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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1. Executive Summary

The work carried out within the WP5 of the Innotrack project has shown that logistic aspects have to be considered during the development of innovative solutions especially when LCC represent a fundamental decision criterion.

Long rails with lengths up to 120 meters represent an innovation developed about 20 years ago and show a very high potential regarding logistics as they allow the introduction of just-in-time transportation from the rail rolling mill to the construction site. This dramatically reduces the efforts concerning unnecessary transportations, unnecessary additional unloading and loading actions as well as stock keeping.

Beside these benefits long rails reduce the number of weldings in track significantly and therefore lead to reduced costs during the installation of the rails as well as they lead to reduced costs during the service life of the rails.

These advantages of long rails lead to a continuously increasing proportion of this innovation since many years which is also supported by the fact that the transportation of these rails nowadays represents a standard type of transportation and that this transportation can take place using standard freight cars.

The work carried out within this deliverable leads to the general recommendation that the use and installation of long rails should become a European standard as their benefits regarding LCC contribute to the main future need of railways which is also the main objective of the Innotrack project: the reduction of the total LCC of the railway track.

2. Introduction

In order to optimise the delivery of rails an exact understanding of the logistics path of a rail from rolling mill to the installation site is strongly required. As there several delivery alternatives exist, these different possibilities have to be considered for a detailed evaluation regarding economic impacts. The “standard case” among the different logistic chains is as follows: delivery of rails to the site, storage and assembly and then installation into the track.

A presentation of the logistics paths allows the identification of disruptions in the supply chain. As an example, loading and unloading operations are time and resource consuming and thus should be minimised. This requires handling operations (loading / unloading) which are optimised to just-in-time requirements based on the assessment of different unloading-devices and associated packaging. As the just-in-time supply represents a standard supply path since more than 20 years, also the benefit of just-in-time supply of rails to track construction sites will be addressed too.

The current work package also includes an analysis of installation methods of rails, including welding and laying processes. A comparison of long rails welded on site versus long welded rails assembled in welding plants will be carried out as well as the general comparison of long rails with short rails.

Additionally maintenance aspects of this innovative solution are addressed in coordination with the SP4 team.

3. Main section

3.1 Input from WP5.1 and Benchmark

Different approaches have been followed to encompass the existing methods (regarding logistics) that have been developed throughout Europe: on one hand face-to-face interviews were carried out and on the other hand an online questionnaire was filled in.

Two purposes were aimed at with these approaches: firstly to collect quantitative data with the help of questionnaires and interviews, and secondly to collect qualitative information by face-to-face interviews.

Quantitative information collection was about procedures relating to: rail, sleepers, ballast, switches and crossings, machinery, and maintenance and renewal planning.

The major aspects that were discussed within interviews were as follows:

- What is the main product/services spectrum of your company?
- In which countries and with which type of contracts are you typically working?
- What are the typical volumes or durations and the risks of your contracts?
- In real life, what are the key discriminations between profitable and loss-making projects from your perspective?
- What are the main issues in the entire cooperation process with infrastructure managers
  - that make it unnecessarily difficult to deliver good value-for-money ("could be improved")
  - that are very helpful in optimising the process ("lesson to learn from", "good-practice").

At the conclusion of this work two deliverables were produced:

- D5.1.5 "*Final Report on Existing States-of-the-Art for Construction, Maintenance and Renewal Activities and Assessment of Logistic Constraints*"
- D5.1.6 "*Final Report on conduct of interfaces between contractors and infrastructure managers*"

The background for the development of logistics & support will be guided by these two reference documents.

D5.1.6 has classified the key findings of WP5.1 pertaining to the conduct of interface between Infrastructure Managers and contractors into seven clusters detailed below:

A – Market strategy
B – Long-term funding, planning and contracting
C – Work programming
D – Project management and logistics

E – Contracting strategies

F – Rules and Regulations

G – Plant

At first sight these subjects can be considered as dealing merely with management. However among these, some apply indeed to a management level but also to a technical level and especially logistics and logistics costs.

To make this point clearer it is helpful to define the numerous interfaces in the logistic process out of the mentioned seven "critical to success" areas and determine which ones could have a direct application at the worksite level.

The table below identifies the "critical to success" areas that are applicable to the current study of Logistics and Support:

	WP5.5 Logistics & Rail
Market strategy	
Long term funding and strategic planning	
Work programming	X
Project management and logistics	X
Contracting strategies	X
Rules and regulation	X
Plant	X

The content of the selected "critical to success" areas is: Work programming, Project management and logistics, Contracting strategies, Rules and regulation, and Plant (is detailed hereafter).

Work programming

Work Programming, i.e. proper planning and programming, is at the heart of all efficiency of contractors works.

- consistent sequencing of all works over time and geographically
- coordination of activities, bundling
- "a clockwork" approach to worksite logistics and work execution (mutual programme management)

- a well programmed pipeline of major projects leading to a “clockwork” approach to worksite logistics and work execution
- avoiding large programme changes resulting in increase of costs both for supply-side and the execution of work
- careful attention to all details in planning process and work programming
- Infrastructure managers’ approach in this regard is a key to create a cost efficient framework, for the execution of works by contractors primarily by
    - mid-term planning and work programming
    - consistent sequencing of work
    - logistics and execution dependability
    - an even workload distribution over the year

Project management and logistics

Multiple interfaces on site between IM, IM’s suppliers and contractors introduce cost and undermine responsibility to deliver efficiency. Maintenance and renewal work is often carried out by various parties (e.g. staff of the infrastructure manager for worksite protection, contractor's staff for work execution). This increases the number of the interfaces and the effort required for coordinating work (elimination of synergies, process perturbations, etc.). Great variability in working time per possession-output can be improved by step change both in processes and technology.

Due to the fragmentation of work without clearly defined responsibilities for project management, the contractors cannot sufficiently influence the overall efficiency of the project. Moreover, they often have to take the risk for delay in the execution of the work and thus cost due to the disturbances in the logistics which are beyond of their potential intervention.

It is therefore vital that project management is clearly defined and assured by a body/person authorised by client and agreed with contractor. Logistic has to be also carefully designed in overall programming of the work jointly with contractors at a very early stage. All changes in project management and logistics have to be agreed with contractors and risk properly allocated.

Benchmark of logistics constraints

Infrastructure Managers identified the following constraints affecting logistics:

- Fluctuating levels of funding from governments, adversely affecting the ability to plan long-term
- The loss of skilled staff through retirement and a shortage of suitable new people willing to come into the industry/railways

The input and benchmark that can be drawn from WP5.1 constitutes a helpful reading grid that will be the basis for the analysis of the logistic aspects and for the taking account of suggested ways of improvement.

Rails (existing system as reported by IM's)

- 60% of IMs place orders for rail more than three months in advance.
- 60% of the IMs use framework contracts for rail supply: contract duration is between one and two years.
- 60% of the rail supply call-off contracts do not have volume guarantees.
- IMs use an average of three rail suppliers each.
- Bulk distribution of rail is generally carried out by the IMs (depending on agreed delivery conditions), perhaps because the rail distribution market is seen as not very competitive. Delivery of rail to site is 100% by train.
- The stock of rail held by IMs at any one time is no more than 10% of the annual tonnage used.
- The market for rail welding seems under-developed, with approximately 80% being carried out by the IMs (varies strongly per country).
- Recovery of rail from renewal sites is greater than 50% of available tonnage (i.e. recycled "second hand rails", which are however not utilisable for mainline application).

3.2 Input from SP4 (Rail)

Beside all Innotrack Subprojects also the SP4 will be able to provide useful information for questions concerning logistics with its final deliverables. As possible interfaces the following workpackages have been identified so far:

- WP4.1 Study of degradation of actual and new rail steels and joints
- WP4.2 Validation of tolerances and limits for rails and joints
- WP4.4 Innovative inspection techniques
- WP4.5 Validation of new maintenance processes
- WP4.6 Innovative welding processes

The WP 4.3 (Innovative laboratory tests of rail steels and joints) will not provide a direct contribution to SP5, because WP4.3 does not comprise logistic-related items. As a preview on the final deliverable on logistics of rails several matters of particular interest have been recognised so far and will be listed (and commented on) below. They are based on findings and results of the work done within SP4 and therefore may represent direct results of SP4 deliverables as well as consequences out of SP4 results.

+ **Recommendation for using a defined rail grade selection strategy**

  As a matter of course a defined rail grade selection strategy will have a remarkable input on the logistics of rails. As the final guidelines will be based on findings of all work packages within SP4 this item must not be seen as a result of WP4.1 only.

  A defined rail grade selection allows optimizing all activities concerning acquisition, stockkeeping, transportation and inspection of rails within one network.

+ **Recommendation for a just-in-time delivery of rails**

  Basically a just-in-time delivery of rails minimizes loading actions. As is generally known every loading activity implies a certain amount of risk concerning creating cold formed marks on the rail surfaces. These very small damages - especially if occurring on the rail foot - have been identified as a contributing factor to degradation of rails of major importance.

  Therefore - with respect to technical issues - a just-in-time delivery is deemed as an aspired integral part of a new logistic process.

+ **Recommendation for careful unloading activities at the worksite**

  With respect to the item above (and the respective comments) serious endeavours have to be made in order to avoid any cold formed scratches on the rail surfaces as a consequence of a rude unloading activity at the worksite.

+ **Recommendation for using long rails**

  As every welding represents an entrapment in track - which can be clearly seen in analyses of track measurement actions - a reduction of weldings is deemed a desirable aim of a new logistic process. Therefore the use of long rails is considered very reasonable and will contribute to saving costs at the end of the day, which is the main aim of a new logistic process.

+ **Recommendation for manufacturing weldings with care**

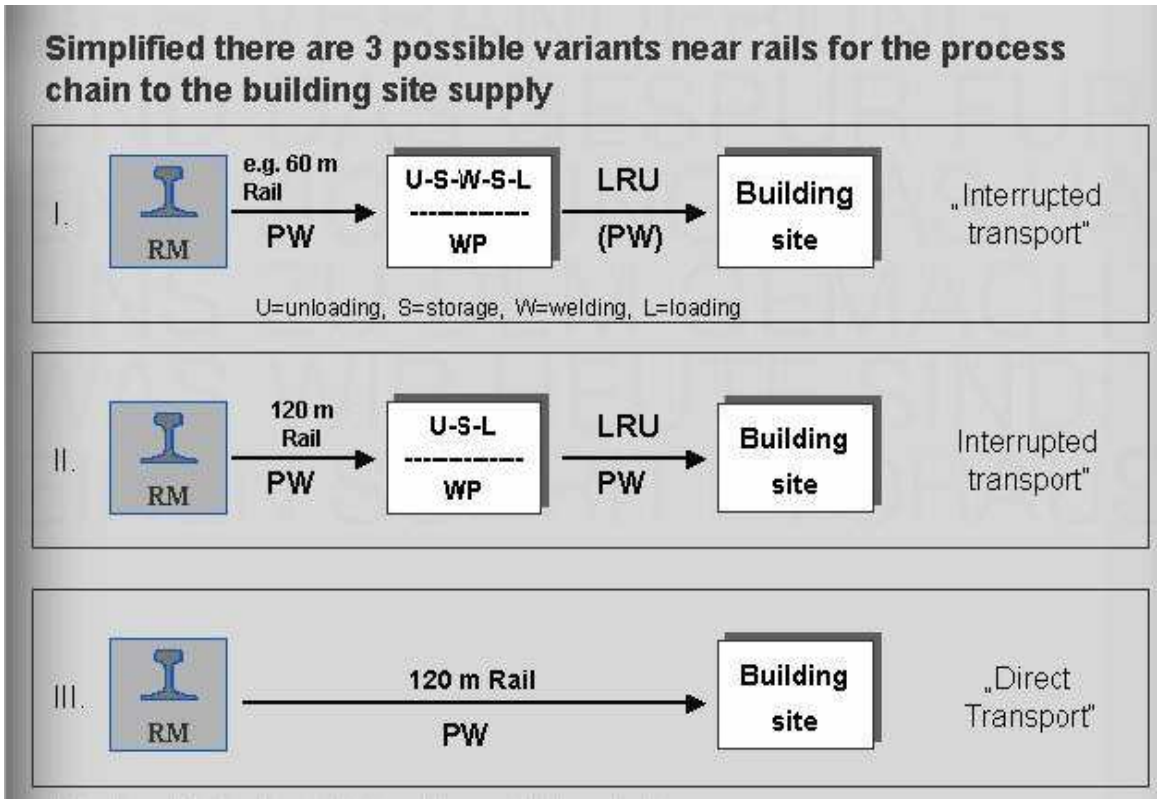
  There are two reasons why those weldings which are indispensable remaining should be manufactured with special care: On the one hand every welding represents a material notch as well as a geometric notch (in most cases), and on the other hand it is especially in this “weak” point in the track that high dynamic forces occur. Therefore every possible action should be taken in order to break this “vicious circle”.

Additionally it can be asserted that the certain welding method does not influence logistics in a significant way if an equal logistic process provides the basis for the comparisons. As a matter of course welding represents a very important issue concerning track engineering and the quality of the welds has a high

influence on the degradation behavior of the weld. Logistic related items however are not affected, because welding equipment is needed on the site in any case, as there are always weldings required.

In the cases of comparing short rails with long rails welding issues may become important, because short rails usually are welded in welding plants and then transported to the site, while long rails usually are delivered directly to the site which leads to significant lower logistic efforts.

3.3 Using long rail vs. short rails



PW = public wagon, LRU = long rail unit

Difference short rails to long rails (advantage / disadvantage)

Short rails

Generally short rails require more weldings. This leads to a various number of disadvantages which are associated with short rails. Below some examples are given:

- more weldings produce excessive and unnecessary high costs
- more control and check-up costs (unnecessary follow-up costs)
- every welding joint is a weak spot (i.e. a potential failure - and if neglected, even safety/breakage – risk which should be avoided by all means)

- more maintenance (which increases cost as well and reduces the operational availability of the track)
- thereby more track closing time (financial loss by lost user fees)

In the end of the day these disadvantages lead to the assessment that short rails generally are less economic compared with long rails.

Long rails

The use of long rails can be characterized by having an optimized proportion between parent rail material and welding zones (weldings and HAZ) in track. Less weldings per track-km lead to:

- lower installation costs
- less control and check-up costs
- less weak spots in track (future costs)
- less maintenance
- less track closing time

Concluding these advantages lead to the fact that long rails provide an economic solution for railway administrations. Therefore the general trend can be noticed that the purchase of long rails is continuously increasing since more than 20 years. This trend is also supported by the fact that in the recent past the transportation of long rails became a standard type of rail transportation, which can be executed even using standard freight wagons.

Simple example

The following much unsophisticated example should demonstrate the effect of purchasing long rails compared to short rails concerning the track installation costs:

rail length (rail meters)	rail type	rail length	required weldings	cost per welding	welding cost*	additional cost
[m]	-	-	#	*[€]*	*[€]*	-
3600	Short rails	30	120	200 to 500	24.000	+400%
		60	60		12.000	+100%
	Long rails	80	45		9.000	+50%
		100	36		7.200	+20%
		120	30		6.000	*benchmark*

**based on 200€ welding costs per rail welding (in track) – no additional costs (overheads e.g.) considered*

As a matter of course, the given welding costs may be reduced if a certain amount of weldings is done in welding plants which exist all over Europe. On the other hand this leads to the fact that remarkable additional costs arise due to the required transportation and unloading and loading actions as well as the storage on the welding plant.

3.4 Direct transport - intermittent cargo

Rail Mills (red) and Fixed Flash Butt Welding Plants (blue) of Europe (Both = Green)

Not on the map: Kaipianinen Finland, Sannahed Sweden, Entrocamento Portugal and Schaerbeek Belgium

The base calculations of all cargos in the conventional cargo traffic are the rate kilometres between the departure and the end destination (usually with an additional fixed amount) on the direct way. Deliveries are therefore more cost–efficient if going directly to the construction site, i.e. just-in-time deliveries (JIT) from A to B.

Cost disadvantages occur in case of deliveries of short rails to a welding plant which necessarily are connected with unloading, storage, followed by welding and after then, possibly again storage, uploading a

new transport to the construction site. This proceeding with its additional needs for transportation also leads to the disadvantage that the basic cost (fixed amount) for transportation must be paid two times.

Another important cost component is the minimum load factor of the wagons. Minimum load factor is the freight to be paid irrespective of the actual load. For example, if minimum load factor is 35MT, these 35MT must be paid for, even if only 20MT are loaded per wagon. Unfortunately these regulations often differ from country to country.

3.5 Transport by vessel

Rail transportation can also be executed using sea vessels (of course depending on the final destination). This type of transportation can be more favourable for a larger tonnage with the same final destination and has its major importance for long-distance deliveries.

In case of vessel-transportation rails must be loaded under deck as rails which are exposed to saltwater corrode very fast - which in the end of the day causes damage to the rail surface. For this type of transportation vessels are available which can transport rails with lengths up to 80m under deck. Longer rails (for example 108m) can only be transported over deck which has the previously given disadvantages.

4. Conclusions

Long rail vs. short rail

The innovation of long rails with lengths up to 120 meters was mainly driven by cost-conscious railway administrations together with innovative railway industry. Due to its obvious advantages and the related cost savings, this type of rails became more and more popular in the last 20 years. With respect to the advantages of these rails (which are given below) this innovation on the railway sector should be exploited on a broad basis. It is recommended to apply ultra-long or at least long rails as a general standard throughout Europe.

The main advantage of having long rails in track is that there are less welding in track which leads to

- reduced welding costs and reduced installation costs *and*
- less control and check-up costs

during the installation of the rails. As a consequence having less weldings in track leads to

- less weak spots in track,
- less maintenance work which is required *which leads to*
- less track closing time

The advantages of long rails are also supported by the fact that the transportation of these rails became a standard type of transportation in the last 20 years and that this transportation can take place using standard freight wagons. The highest benefits can be reached if unnecessary transportations are avoided which means that long rails are transported just-in-time from the rail rolling mill to the construction sites.

5. Bibliography

INNOTRACK deliverable D5.1.5 – Final Report on Existing States-of-the-Art for Construction, Maintenance and Renewal Activities and Assessment of Logistic Constraints

INNOTRACK deliverable D5.1.6 – Final Report on conduct of interfaces between contractors and infrastructure managers

ANNEX: Sample cost calculation and savings potentials