FINAL REPORT

Improved design and cost-benefit analysis

CONTRACT N° : G1RD-CT-2002-00777

PROJECT N° :

ACRONYM : SUPERTRACK

TITLE : Sustained Performance of Railway Tracks

PROJECT CO-ORDINATOR : Norwegian Geotechnical Institute (NGI)

PARTNERS :

- Société Nationale des Chemins de Fer (SNCF)
- Administrador de Infraestructuras Ferroviarias (ADIF)
- Géodynamique et Structure (GDS)
- Centro de Estudios y Experimentacion de Obras Publicas (CEDEX)
- Ecole Centrale de Paris (ECP)
- Linköping University (LU)
- Swedish National Rail Administration - Banverket (BV)

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Date of issue of this report : September 20, 2005

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Final Report

1 Table of Content:

2 Introduction

The future of railways is strongly dependent on its ability to compete with other modes of transport in order to increase its participation in a liberalised transport market. To do so, it is very important to assure its maintenance ability at the lowest cost so the access charges can be minimised increasing the potential capacity of competition of railway operators.

Considering that track maintenance is responsible for more than 50% of all infrastructure maintenance costs, it makes it easy to realize the importance of the reduction of track maintenance costs to make railway transport system more competitive and efficient in the future.

The reduction in track maintenance cost contributes strongly to minimise the number of interventions, that is, to lengthen the intervals between them. This is especially underlined by the fact that the most efficient way to maintain track assets is to maintain “on condition” basis. This means that only an intervention is necessary when the track geometry has been deteriorated to a certain level (reaches the intervention threshold) before setting speed restrictions that will reduce the line’s availability and ride quality. Another advantage of minimising the number of interventions is the increase of the above mentioned line’s availability to commercial traffic.

The track is subjected to different types of loads that can be divided in quasi-static and dynamic. The first one is due to the gross tare, centrifugal force, cross winds and the centering one in curves, and the second one is due to rolling stock-infrastructure interaction and it is caused by track irregularities, non homogenous track stiffness, irregular rail running surface and vehicle running gear defects.

The reduction of the dynamic loads is an essential task to reduce maintenance cost.

Many researchers have come to the conclusion that the dynamic loads are strongly related to the lack of homogeneity of the track.

Among the infrastructure components are those that are standardised and easy to control (type of rail, sleeper, rail pad, ballast and its depth) and others that are related to the construction quality and the characteristics of the line layout. One of the main factors contributing to a bad quality of the line is the heterogeneity along the line, for example, moving from an embankment to a cutting or bridge or tunnel. From experience it is known that the contact zones of different infrastructure parts (along the line) are those that need more attention and consequently more maintenance operations.

From the preceding discussion it is clear that the most important parameter to evaluate is the formation’s vertical stiffness and its variation. It is well accepted that a smooth transition (limited rate of variation) of the vertical stiffness is a basic concept to minimise the need of track maintenance and its related costs.

A new line can and should be built considering the above mentioned concept and so guaranteeing the right maintainability (low track possession and extended period between interventions). Another matter is how to get a smooth vertical stiffness transition along tracks in operation without the need of long track possession for the upgrading works that normally require closing the line to commercial operation.

3 Retrofitting work

The WP 5 (Task 2) of SUPERTRACK deals precisely with this topic, namely the possibility of retrofitting a line site with a technique new to the railway industry. The site should be one with a history of problems and many interventions (mostly tamping).

The site selected was the transition zone between a bridge over the river Ebro and the embankment. It was situated in the line Valencia-Barcelona in the Mediterranean Corridor between the km 179+950 and 180+008. The line is a double track with mixed traffic one and a maximum speed of 200kph.

It was considered that the cause of the problems was the variations of the vertical stiffness in the transition zone, and the aim of the retrofitting work was to make a vertical stiffness transition.

CEDEX performed this task. Considering that details of the retrofitting work is presented in a dedicated report, the present report will concentrate on commenting how the site was maintained before the upgrading and the effectiveness of the work done till now.

The following data is included in this report: Data from dynamic monitoring, tamping figures and ballast used, control of track level. The following describes these data in detail.

3.1 Data from dynamic monitoring

This data has been recorded since the opening of the line with the speed of 200 km/h, on August 1997 till the date of this report (July 2005).

The tables enclosed in Appendix A include, for both tracks, the vertical acceleration of the recording coach, tamping dates, maximum track uplifting, and ballast depth under the sleepers.

3.2 Tamping figures and ballast used

Tamping figures are included in Appendix B. This appendix depicts linearly the length, the operations with their dates realised. It is easy to see the important increase of work that has been done comparing with other parts of the line.

3.3 Control of track level before and after the retrofitting

Data for the control of track levels are included in Appendix C. The tables in this part include evolution of the track level before the grouting (1st phase) and after grouting (2nd phase). One can observe that the site is stabilised without noticeable deformations until the control done on July 2005. In fact a tamping was due to be done on the track in the bridge because of the normal evolution of its condition but not in the transition zone treated.

4 Conclusion on retrofitting work

The collected data so far makes one optimistic about the final result of the treatment done (it is necessary to monitor the line for a longer time, for example three years, to have a final evaluation of the test). The problems of the site have been totally solved, and it will not need more maintenance interventions than for the rest of the line. This will mean that the treatment has been a successful one

Assuming the above result will also hold in the future, we can make the following conclusions/recommendations for design of new lines and improved maintenance of existing ones.

4.1 Improved designs

The design of new tracks should be done considering the LCC (Life Circle Costing). The optimisation of this concept is related to minimisation of the maintenance costs. It is clear that to achieve this it is important to have the greatest possible homogeneity of the vertical stiffness along the track; this concept should be fully applied to the construction. (Note that it is not the objective of this project to advise on the best theoretical global track stiffness). Special care should be taken in the transition zones between cutting/embankment, embankment/bridge or cutting/tunnel.

To ensure this, it is recommended to guarantee a smooth transition of the vertical stiffness prior to installation of the track armament (ballast, or sleepers) on the sub-grade.

The work done by the University of Linköping in this project on how to optimise the transition of vertical stiffness is very essential. That study revealed that the shape could be different if the track changes from high to lower or from low to higher stiffness (going from soft to stiff is worse than going from stiff to soft). In the first case the stiffness change in the transition zone should be smooth in the beginning and at the end, and more rapid change in the middle of the zone, the other travelling direction the optimum transition zone shape should be more or less linear.

In case of in-service tracks, the methodology tested assures (with the experience achieved till now) that it is possible to repair the site without the need to affect the commercial use of the track (no need of line closure). This is very important (maybe essential), in fully operating lines (high speed, freight or with mixed traffic) where the line closure could cause important traffic difficulties (no lines alternatives).

4.2 Improved Maintenance procedures

When a track is subjected to problems of levelling, track engineers should analyse the main cause of the defects, and not just to use the tamping of the site, as a standard universal remedy. Such remedies will temporarily correct the effect/defect but do not remove the cause.

Engineers should analyse the deep cause that in some cases can be a drastic vertical stiffness variation; if it is so, the perennial solution will be to eliminate that variation by treating or retrofitting the track formation.

Another central research done in this project by the University of Linköping was the analysis of the effect of hanging sleepers. The study showed that the static load of the sleeper next to the unsupported one is increased by 70%. This increase is much higher if the wheel or rail has a certain amount of defects. This irregular load distribution creates more hanging sleepers. This dramatic increase of the total load due to the dynamic component causes a continuous and fast deterioration of the line geometry (through ballast attrition) that will end up with potential lack of safety or with a speed restriction.

The study underlines the need for track engineers to avoid hanging sleepers by early action before this type of "cancer" spreads along the track.

4.3 Cost-benefit analysis

As stated Sec. 4.1, in some lines the need of a temporary (minimum 48 hours) closure of a line for repair works can be unacceptable. In other cases, it makes sense to consider a cost-benefit analysis to decide on the type of treatment with the following two alternatives: to shut down the line to traffic or to repair it without affecting the traffic (not even imposing speed restrictions).

The cost-benefit analysis that follows can be applied only when the decision can be taken on just economical terms, that is the line can be closed for, at least, 48 hours, if it is necessary:

The retrofitting work done in the transition zone embankment/bridge in the river Ebro had a total cost, for both tracks, of: 302.090,31€.

The additional maintenance costs (due to the bad condition of the site) spent since the opening of the upgraded line (increased speed up to 200km/h) to traffic in the year 1997 until September 2004 (when the retrofit started) were: 90.503,32€, that means an average yearly extra cost of 12.929€.

Considering only economical consequences, this means that the costs of the retrofitting will be paid in 23 years. This is such a long time that the conclusion would be that it is better to spend the extra cost on more maintenance operations instead of retrofitting the track. However, it is necessary to take into account the track degradation as a variable. For short or medium term, there may be the need to take urgent action when the site condition may reach a critical intervention threshold. If this limit is reached the maintenance engineer, responsible of that section, may take the decision to set a speed restriction to guarantee train safety. The intervals between maintenance operations are shortening continuously.

A calculation of the cost of correcting the bad condition of the track has been performed in the theoretical scenario of closing the line to repair the site. The cost of the works would have been 167.590€., that is, 55% of the cost of the retrofitting.

The conclusions from this analysis are the following:

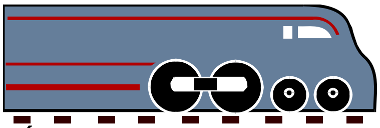
1) The procedure of the retrofitting performed in this project (see dedicated report by CEDEX) has been proved to be a good solution to solve situations that need to be repaired and when the closure of the line is not acceptable.
2) The experience of the retrofitting works tested in the project is not the best solution, in economic terms, if the importance of the line allows its closure for, at least, 48 hours. It is cheaper to do the job taking out completely the old soil and installing new and appropriate material instead of improving its characteristics with grouting.
3) It is not always the additional maintenance cost, in short or medium-term perspectives, that is the main reason to upgrade a problematic site; rather, it may be the need to maintain the line's functionality (i.e. punctuality, ride comfort and safety).

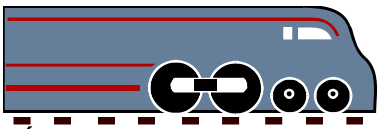
Appendix A

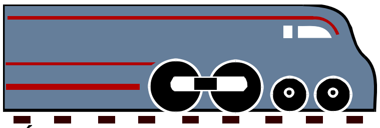
Mantenimiento de Infraestructura Renfe
Gerencia Eje Levante

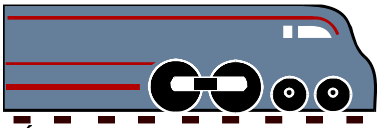
CORREDOR MEDITERRÁNEO

CUADRO GLOBAL DE DATOS DINAMICOS OBTENIDOS. AÑOS 1997-2005 VIA I

 VÍA I Tarragona -->Valencia		LINEA : VALENCIA - TARRAGONA **TRANSICIÓN TERRAPLÉN VTO. EBRO LADO SUR (P.K.: 179+950-180+008)**			
Fecha de auscultación	Ac. Vert. Caja vehíc. (m/s^2)	Velocidad (Km/h)	Fechas de Bateos	Levantes máximos (mm)	Balasto Bajo Traviesa (cm)

 VÍA I Tarragona -->Valencia		LINEA : VALENCIA - TARRAGONA **TRANSICIÓN TERRAPLÉN VTO. EBRO LADO SUR (P.K.: 179+950-180+008)**			
Fecha de auscultación	Ac. Vert. Caja vehíc. (m/s^2)	Velocidad (Km/h)	Fechas de Bateos	Levantes máximos (mm)	Balasto Bajo Traviesa (cm)
20-Agosto-97	0,95	200	25/09/97	25	33
08-Octubre-97	1,10	195	14/11/97	69	40*
19-Noviem-97	0,50	199	25/11/97	20	42
21-Enero-98	0,60	198	-	-	42
25-Febrero-98	0,40	181	-	-	42
15-Abril-98	0,55	202	-	-	42

 VÍA I Tarragona -->Valencia		LINEA : VALENCIA - TARRAGONA **TRANSICIÓN TERRAPLÉN** **VTO. EBRO LADO SUR** **(P.K.: 179+950-180+008)**			
Fecha de auscultación	Ac. Vert. Caja vehíc. (m/s^2)	Velocidad (Km/h)	Fechas de Bateos	Levantes máximos (mm)	Balasto Bajo Traviesa (cm)
03-Junio-98	0,75	197	30/06/98	20	44
22-Julio-98	0,50	199	-	-	44
02-Septiem-98	0,65	197	-	-	44
07-Octubre-98	0,55	197	-	-	44
18-Noviem-98	0,65	200	09/01/99	38	48
21-Enero-99	0,50	201	23/03/99	39	52
24-Marzo-99	0,35	195	-	-	52
25-Mayo-99	0,65	198	-	-	52
08-Septiem-99	0,80	203	-	-	52
14-Diciem-99	0,65	197	-	-	52
29-Febrero-00	0,85	202	-	-	52
25-Abril-00	0,90	202	20/06/00	43	56
24-Junio-00	0,40	193	-	-	56
09-Septiem-00	0,40	198	-	-	56
30-Noviem-00	0,50	202	-	-	56
09-Febrero-01	0,50	199	-	-	56
03-Mayo-01	0,60	200	-	-	56
14-Julio-01	0,65	204	-	-	56
15-Septiem-01	0,80	205	-	-	56
01-Noviem-01	0,80	198	-	-	56
15-Febrero-02	0,95	199	15/04/02	46	61
19-Abril-02	0,50	201	-	-	61
28-Junio-02	0,50	126	-	-	61
20-Septiem-02	0,55	133	-	-	61
29-Noviem-02	0,60	121	-	-	61

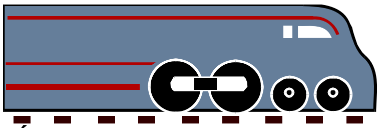


VÍA I Tarragona -->Valencia

LINEA : VALENCIA - TARRAGONA
TRANSICIÓN TERRAPLÉN
VTO. EBRO LADO SUR
(P.K.: 179+950-180+008)

Fecha de auscultación	Ac. Vert. Caja vehíc. (m/s^2)	Velocidad (Km/h)	Fechas de Bateos	Levantes máximos (mm)	Balasto Bajo Traviesa (cm)
01-Febrero-03	0,9	195	-	-	61
26-Abril-03	0,95	200	-	-	61
04-Julio-03	1,05	203	15/09/03	45	65
19-Septiem-03	0,25	200	-	-	65
29-Noviem-03	0,45	199	-	-	65
10-Marzo-04	0,65	199	03/06/04	29	68
10-Junio-04	0,4	205	06/09/04	28	71
16-Septiem-04	0,4	201	-	-	71
15-Diciem-04	0,45	189	-	-	71
07-Abril-05	0,5	198	-	-	71
07-Julio-05	0,5	196	-	-	71

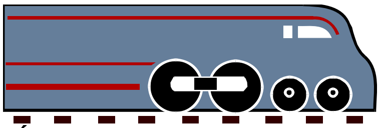
NOTA:
El balasto bajo traviesa acumula el de los anteriores tratamientos con maquinaria pesada desde la puesta en servicio en Noviembre de 1996 sobre un balasto inicial de obra de 30 cm. En Noviembre de 1997 se realizó una cata confirmando la altura del balasto bajo traviesa (*).



VÍA II Tarragona -->Valencia

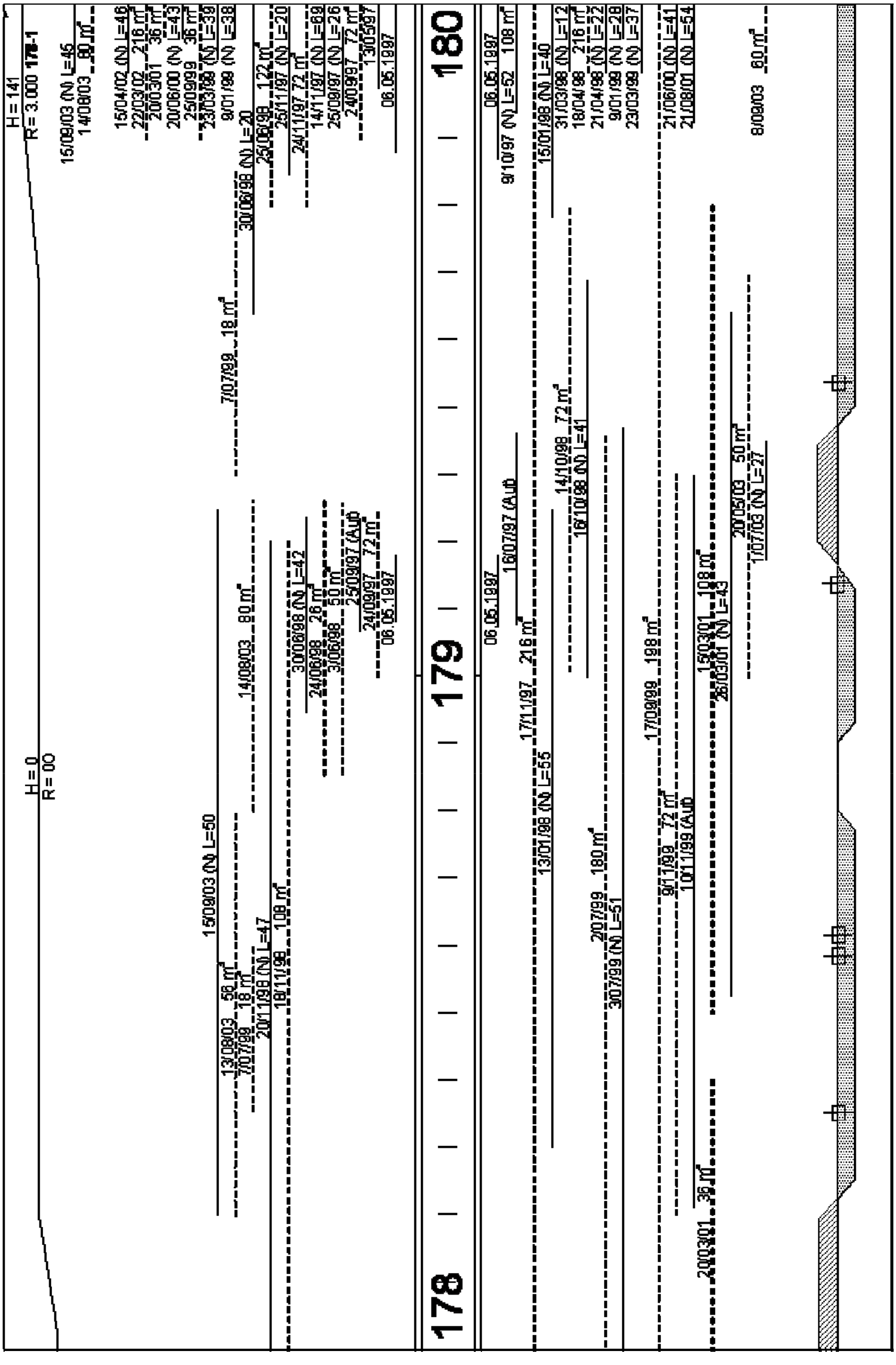
LINEA : VALENCIA - TARRAGONA
TRANSICIÓN TERRAPLÉN
VTO. EBRO LADO SUR
(P.K.: 179+950-180+008)

Fecha de auscultación	Ac. Vert. Caja vehíc. (m/s^2)	Velocidad (Km/h)	Fechas de Bateos	Levantes máximos (mm)	Balasto Bajo Traviesa (cm)
21-Agosto-97	1,30	200	-	-	34
09-Octubre-97	0,75	198	-	-	35
20-Noviem-97	0,90	198	15/01/98	40	38*
22-Enero-98	0,55	196	-	-	38
26-Febrero-98	0,65	198	31/03/98	12	39
16-Abril-98	0,50	200	21/04/98	22	41
04-Junio-98	0,50	199	-	-	41
23-Julio-98	0,65	197	-	-	41
03-Septiem-98	0,80	199	-	-	41
08-Octubre-98	0,80	201	-	-	41
19-Noviem-98	0,85	199	09/01/99	28	44
22-Enero-99	0,75	199	23/03/99	37	48
25-Marzo-99	0,30	199	-	-	48
26-Mayo-99	0,55	197	-	-	48
08-Septiem-99	0,75	199	-	-	48
15-Diciem-99	0,95	197	-	-	48
01-Marzo-00	1,00	200	-	-	48
26-Abril-00	1,00	190	21/06/00	40	52
25-Junio-00	0,83	202	-	-	52
10-Septiem-00	0,90	197	-	-	52
01-Diciem-00	0,87	203	-	-	52
09-Febrero-01	1,15	199	-	-	52
04-Mayo-01	1,13	200	-	-	52
13-Julio-01	1,25	203	21/08/01	54	57
14-Septiem-01	0,25	155	-	-	57

 VÍA II Tarragona -->Valencia	LINEA : VALENCIA - TARRAGONA **TRANSICIÓN TERRAPLÉN** **VTO. EBRO LADO SUR** **(P.K.: 179+950-180+008)**				
Fecha de auscultación	Ac. Vert. Caja vehíc. (m/s^2)	Velocidad (Km/h)	Fechas de Bateos	Levantes máximos (mm)	Balasto Bajo Traviesa (cm)
30-Noviem-01	0,40	200	-	-	57
15-Febrero-02	0,55	201	-	-	57
19-Abril-02	0,50	192	-	-	57
28-Junio-02	0,45	141	-	-	57
20-Septiem-02	0,55	152	-	-	57
29-Noviem-02	0,60	146	-	-	57
31-Enero-03	0,75	204	-	-	57
25-Abril-03	0,95	201	-	-	57
04-Julio-03	0,95	200	-	-	57
19-Septiem-03	0,85	155	-	-	57
28-Noviem-03	1,0	199	09/02/04	45	62
11-Marzo-04	0,85	198	-	-	62
10-Junio-04	0,95	206	06/09/04	34	65
16-Septiem-04	0,65	205	-	-	65
16-Diciem-04	0,75	206	-	-	65
07-Abril-05	0,8	164	-	-	65
07-Julio-05	1,1	198	-	-	65

NOTA:
El balasto bajo traviesa acumula el de los anteriores tratamientos con maquinaria pesada desde la puesta en servicio en Agosto de 1996 sobre un balasto inicial de obra de 30 cm. En Enero de 1998 se realizó una cata confirmando la altura del balasto bajo traviesa (*).

Appendix B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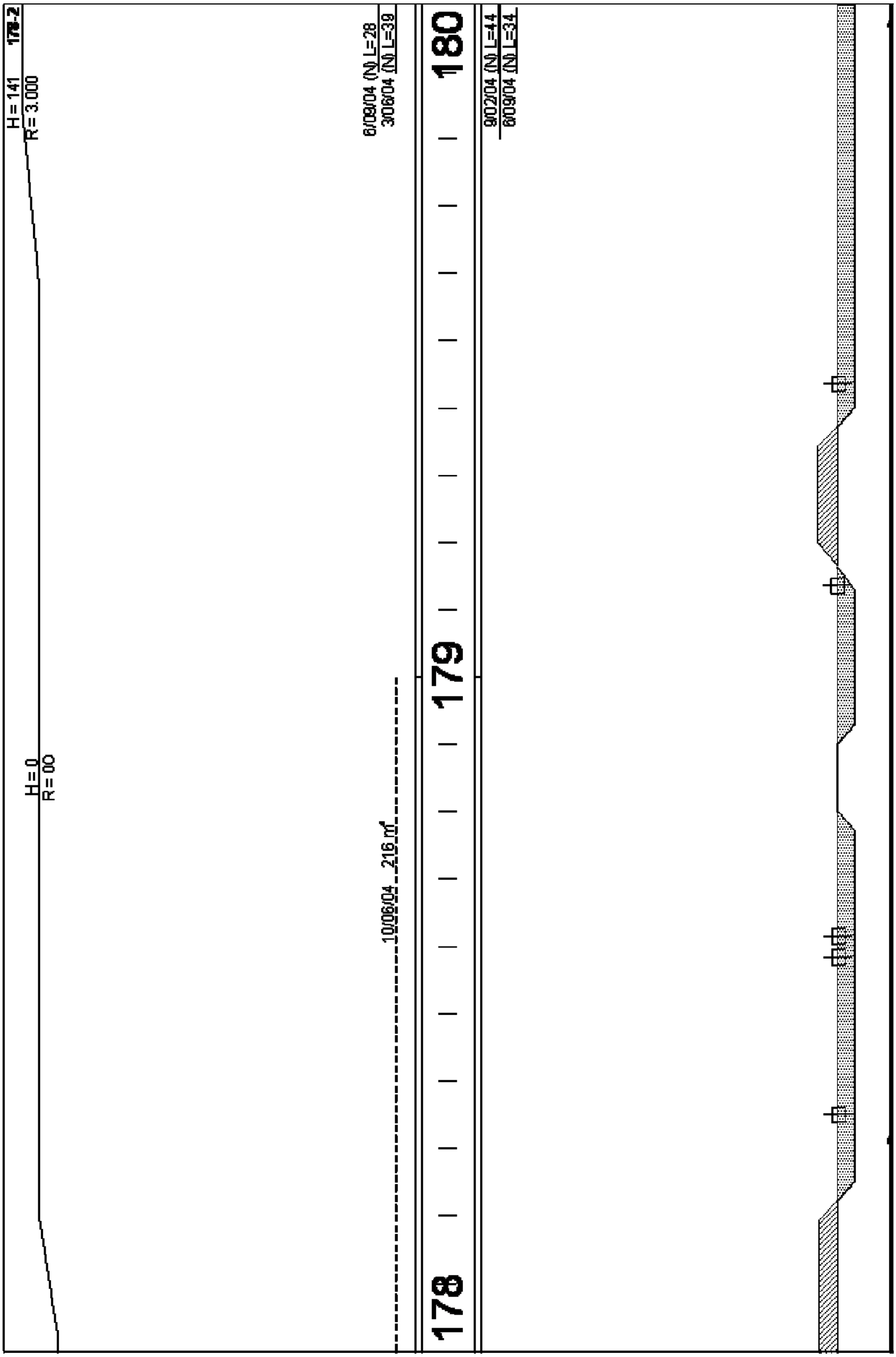
R = 00
178
179
180


H = 141
R = 3.000
6/09/04 (N) L=28
3/06/04 (N) L=39
180
9/02/04 (N) L=44
6/09/04 (N) L=34
179
H = 0
10/06/04 216 m²
178

Appendix C

Mantenimiento de Infraestructura Renfe
Gerencia Eje Levante

CORREDOR MEDITERRÁNEO

SEGUIMIENTO DE LA EVOLUCIÓN DEL TRATAMIENTO MEDIANTE INYECCIONES EN LA CUÑA SUR DEL VTO. EBRO A TRAVÉS DE LA VÍA 1ª FASE ANTES DEL BATEO (06/09/04)

TRAMO :	CASTELLÓN - VANDELLÓS	FECHA :	08.09.04
TRAYECTO :	ULLDECONA - L'ALDEA	VÍA :	I

PUNTO	COTAS EN CARRIL			
NIVELADO	02.08.2004	03.09.2004	06.09.2004	BAT.06/09/04
179+910	42,316	42,317	42,316	"
179+915	42,259	42,259	42,259	"
179+920	42,204	42,204	42,204	"
179+925	42,148	42,147	42,147	"
179+930	42,092	42,091	42,090	"
179+935	42,034	42,031	42,032	"
179+940	41,978	41,973	41,975	"
179+945	41,920	41,915	41,917	"
179+950	41,864	41,859	41,862	"
179+955	41,807	41,801	41,802	"
179+960	41,750	41,744	41,746	"
179+965	41,695	41,688	41,688	"
179+970	41,638	41,631	41,632	"
179+975	41,582	41,575	41,575	"
179+980	41,525	41,531	41,531	"
179+985	41,464	41,473	41,474	"
179+990	41,407	41,409	41,409	"
179+995	41,348	41,354	41,354	"
180+000	41,289	41,293	41,292	"
180+005	41,238	41,233	41,232	"
180+010	41,186	41,175	41,176	"
180+015	41,129	41,129	41,128	"
180+020	41,068	41,059	41,060	"
180+025	41,011	41,014	41,013	"
180+030	40,953	40,956	40,955	"
180+035	40,895	40,898	40,897	"
180+040	40,838	40,841	40,840	"

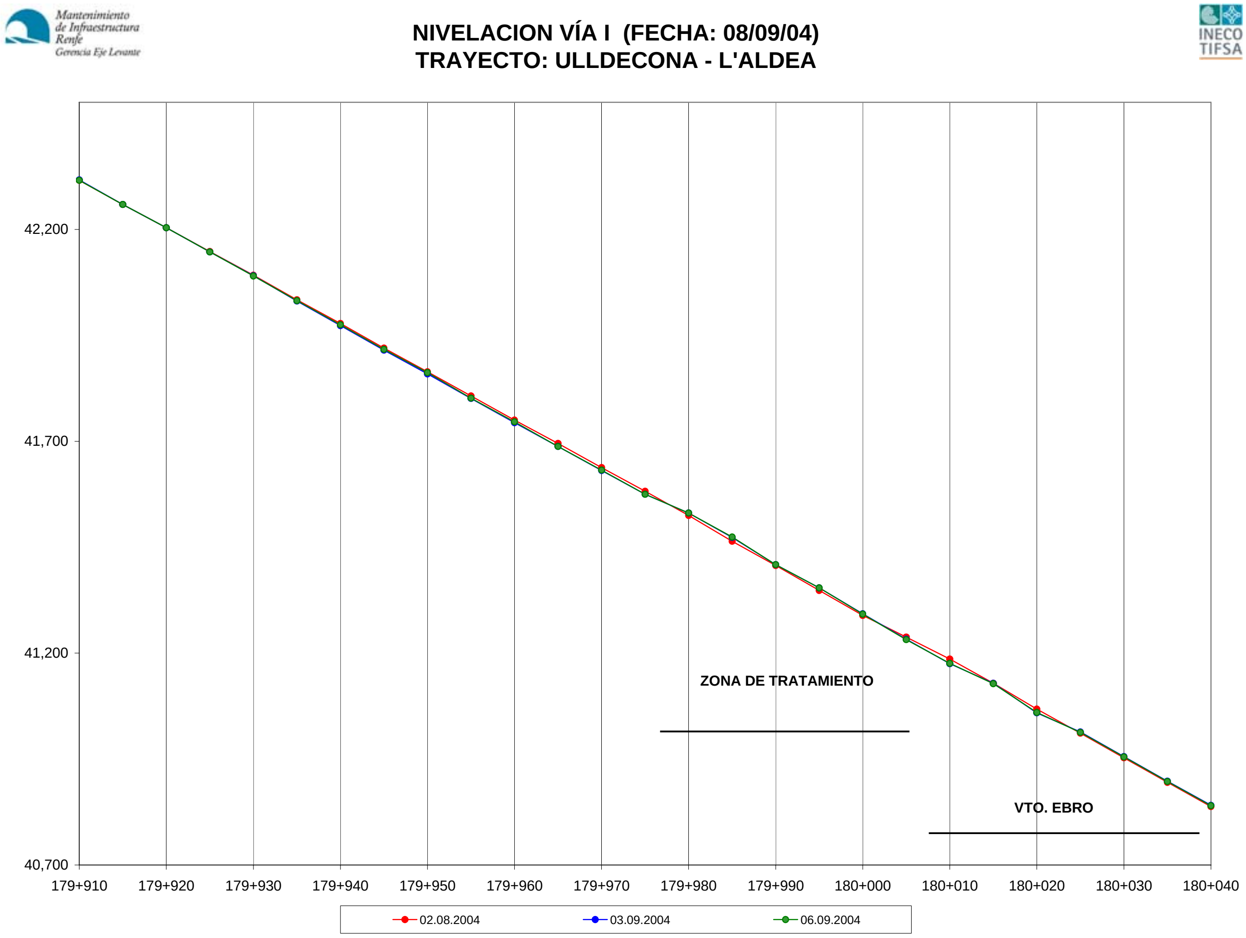
Mantenimiento de Infraestructura Renfe
Gerencia Eje Levante

CORREDOR MEDITERRÁNEO

SEGUIMIENTO DE LA EVOLUCIÓN DEL TRATAMIENTO MEDIANTE INYECCIONES EN LA CUÑA SUR DEL VTO. EBRO A TRAVÉS DE LA VÍA 1ª FASE ANTES DEL BATEO (06/09/04)

TRAMO :	CASTELLÓN - VANDELLÓS	FECHA :	08.09.04
TRAYECTO :	ULLDECONA - L'ALDEA	VÍA :	I

PUNTO	DIFERENCIAS DE COTAS		
NIVELADO	2ª-1ª	3ª-2ª	3ª-1ª
179+910	0,001	-0,001	0,000
179+915	0,000	0,000	0,000
179+920	0,000	0,000	0,000
179+925	-0,001	0,000	-0,001
179+930	-0,001	-0,001	-0,002
179+935	-0,003	0,001	-0,002
179+940	-0,005	0,002	-0,003
179+945	-0,005	0,002	-0,003
179+950	-0,005	0,003	-0,002
179+955	-0,006	0,001	-0,005
179+960	-0,006	0,002	-0,004
179+965	-0,007	0,000	-0,007
179+970	-0,007	0,001	-0,006
179+975	-0,007	0,000	-0,007
179+980	0,006	0,000	0,006
179+985	0,009	0,001	0,010
179+990	0,002	0,000	0,002
179+995	0,006	0,000	0,006
180+000	0,004	-0,001	0,003
180+005	-0,005	-0,001	-0,006
180+010	-0,011	0,001	-0,010
180+015	0,000	-0,001	-0,001
180+020	-0,009	0,001	-0,008
180+025	0,003	-0,001	0,002
180+030	0,003	-0,001	0,002
180+035	0,003	-0,001	0,002
180+040	0,003	-0,001	0,002


Mantenimiento de Infraestructura Renfe Gerencia Eje Levante
NIVELACION VÍA I (FECHA: 08/09/04)
TRAYECTO: ULLDECONA - L'ALDEA
INECO TIFSA
42,200
41,700
41,200
40,700
179+910
179+920
179+930
179+940
179+950
179+960
179+970
179+980
179+990
180+000
180+010
180+020
180+030
180+040
ZONA DE TRATAMIENTO
VTO. EBRO
02.08.2004
03.09.2004
06.09.2004

Mantenimiento de Infraestructura Renfe
Gerencia Eje Levante

INECO TIFSA

CORREDOR MEDITERRÁNEO

SEGUIMIENTO DE LA EVOLUCIÓN DEL TRATAMIENTO MEDIANTE INYECCIONES EN LA CUÑA SUR DEL VTO. EBRO A TRAVÉS DE LA VÍA 1ª FASE ANTES DEL BATEO (06/09/04)

TRAMO :	CASTELLÓN - VANDELLÓS	FECHA :	08.09.04
TRAYECTO :	ULLDECONA - L'ALDEA	VÍA :	II

PUNTO	COTAS EN CARRIL			
NIVELADO	02.08.2004	03.09.2004	06.09.2004	BAT.06/09/04
179+920	42,227	42,228	42,228	"
179+925	42,168	42,169	42,169	"
179+930	42,108	42,107	42,106	"
179+935	42,046	42,045	42,045	"
179+940	41,984	41,980	41,982	"
179+945	41,922	41,917	41,918	"
179+950	41,860	41,855	41,857	"
179+955	41,798	41,793	41,794	"
179+960	41,740	41,734	41,736	"
179+965	41,681	41,676	41,676	"
179+970	41,620	41,612	41,614	"
179+975	41,558	41,551	41,553	"
179+980	41,501	41,509	41,509	"
179+985	41,442	41,459	41,459	"
179+990	41,386	41,393	41,394	"
179+995	41,332	41,336	41,336	"
180+000	41,270	41,272	41,271	"
180+005	41,225	41,229	41,227	"
180+010	41,179	41,180	41,179	"
180+015	41,120	41,123	41,121	"
180+020	41,058	41,061	41,059	"
180+025	40,994	40,998	40,996	"
180+030	40,933	40,937	40,937	"
180+035	40,870	40,875	40,876	"
180+040	40,813	40,817	40,816	"

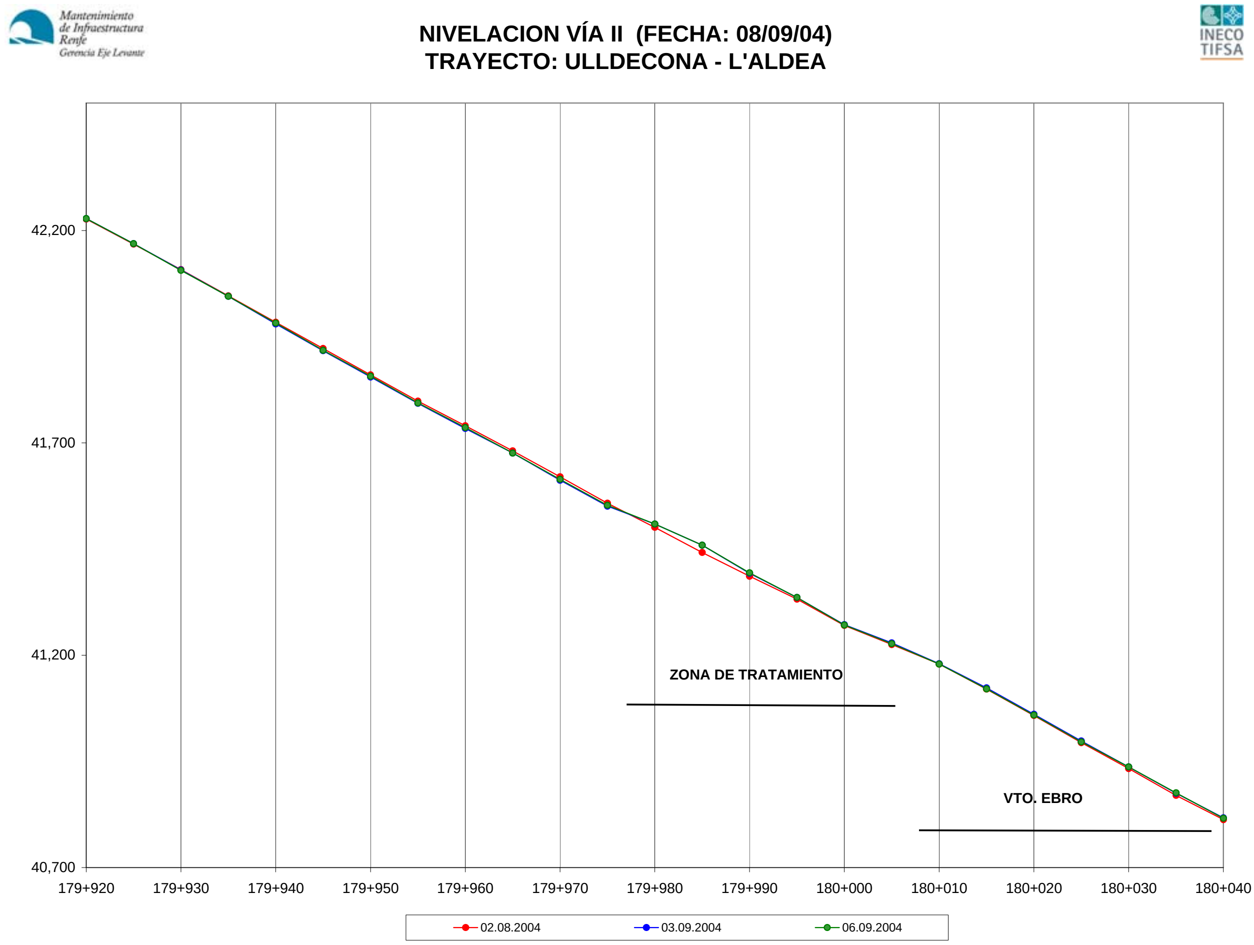
Mantenimiento de Infraestructura Renfe
Gerencia Eje Levante

CORREDOR MEDITERRÁNEO

SEGUIMIENTO DE LA EVOLUCIÓN DEL TRATAMIENTO MEDIANTE INYECCIONES EN LA CUÑA SUR DEL VTO. EBRO A TRAVÉS DE LA VÍA 1ª FASE ANTES DEL BATEO (06/09/04)

TRAMO :	CASTELLÓN - VANDELLÓS	FECHA :	08.09.04
TRAYECTO :	ULLDECONA - L'ALDEA	VÍA :	II

PUNTO	DIFERENCIAS DE COTAS		
NIVELADO	2ª-1ª	3ª-2ª	3ª-1ª
179+920	0,001	0,000	0,001
179+925	0,001	0,000	0,001
179+930	-0,001	-0,001	-0,002
179+935	-0,001	0,000	-0,001
179+940	-0,004	0,002	-0,002
179+945	-0,005	0,001	-0,004
179+950	-0,005	0,002	-0,003
179+955	-0,005	0,001	-0,004
179+960	-0,006	0,002	-0,004
179+965	-0,005	0,000	-0,005
179+970	-0,008	0,002	-0,006
179+975	-0,007	0,002	-0,005
179+980	0,008	0,000	0,008
179+985	0,017	0,000	0,017
179+990	0,007	0,001	0,008
179+995	0,004	0,000	0,004
180+000	0,002	-0,001	0,001
180+005	0,004	-0,002	0,002
180+010	0,001	-0,001	0,000
180+015	0,003	-0,002	0,001
180+020	0,003	-0,002	0,001
180+025	0,004	-0,002	0,002
180+030	0,004	0,000	0,004
180+035	0,005	0,001	0,006
180+040	0,004	-0,001	0,003


Mantenimiento de Infraestructura Renfe
Gerencia Eje Levante
NIVELACION VÍA II (FECHA: 08/09/04)
TRAYECTO: ULLDECONA - L'ALDEA
INECO TIFSA
42,200
41,700
41,200
40,700
179+920
179+930
179+940
179+950
179+960
179+970
179+980
179+990
180+000
180+010
180+020
180+030
180+040
ZONA DE TRATAMIENTO
VTO. EBRO
02.08.2004
03.09.2004
06.09.2004