Integrated Project (IP)
Project No. TIP5-CT-2006-031415

Thematic Priority 6:
Sustainable Development,
Global Change and Ecosystems

Selection of a Railway Track System by Best Value Analysis

SLABTRACK SELECTION USING BEST VALUE FOR MONEY ANALYSIS

Benefit Assessment

REF	ASSESSMENT / BENEFITS CRITERIA (Add omit or adjust to suit particular situation)	Design Criteria and Performance (Specification) - 32%																				
		Life of components	Rail head fixity. (Gauge corner cracking, RCF, head checking ? etc.)	Contamination ingress (Sand, water, ice etc)	Track Reliability	Low corrosion susceptibility	Track Availability	Maximises space available (height, width and fixity)	Low system weight	Simplicity & number of components	Compatability with S&C, IBJ's, Expansion joints etc.	Flexibility of alignment (e.g. gauge widening)	Flexibility of later alignment change minor / major	Suitability for Tunnel	Suitability for Structures	Seismic	Extent of Transition design	Extent of formation and foundation works	Wide Stiffness range	Accel/ Braking forces (longitudinal rail restraint)	Low change in vert &horizontal head displacement with time	Low minimum radii / geometrical restraint
		A	B	C	D	E	F	G	H	I	J	K	M	N	O	P	Q	R	S	T	U	U
	%	3.6	3.2	1.2	3.6	2.0	#####	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	IMPORTANCE WEIGHTING	9	8	3	9	5	Weightings to be determined by clients, designers and other stakeholders															
A	TRACKFORM OPTION A	3	2	4	3	5		5	5	3	9	2		4	5						2	5
		27	16	12	27	25																
B	TRACKFORM OPTION B	9	9	6	8		Consensus assessment to be made by clients, designers and other stakeholders															
		81	72	18	72																	
C	TRACKFORM OPTION C	6	5	5	6																	
		54	40	15	54																	
D	TRACKFORM OPTION D																					
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	(Ballast ?)																					
	CP -01-01-10	Each option is graded out of 10 the indicative levels are: 10 Excellent, 7 Good, 4 Fair, 1 Poor																				

REF	ASSESSMENT / BENEFITS CRITERIA	Safety - %						Environment -%				Co		
		Operational safety	Low frequency of inspections	Ease of Evacuation and access /egress for maintenance	Other system safety (broken rails, loss of pads) etc	Derailment Protection	Appearance	Noise	Vibration	Carbon Footprint	Water / drainage management	Short Installation time	Low Installation complexity	Low Installation resources
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	%	4.0	3.2	2.8	4.0	0.8	4.0	1.0	3.2	2.0	2.4	3.6	2.8	2.8
	IMPORTANCE WEIGHTING	10	8	7	10	2	10	7	8	5	6	9	7	7
A	TRACKFORM OPTION A	4	4	4	8	3	3	8	8	8	2	8	5	6
		40	32	28	80	6	30	56	64	40	12	72	35	42
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	(Ballast ?)													

INNOTRACK GUIDELINE

Deliverable D2.3.6

Table of Contents

1. Overview

Selection of the best track type for a Railway Infrastructure Provider is difficult and complex in view of the many factors to be considered. This situation is compounded by the wide variety of slab track systems now available. These are often sophisticated and complex. The process in this guide aims to ensure that early track selection decisions are justified, avoid personal whim, and provide an audit trail and deliver best value to the stakeholders. The intent is that they are followed up by a detailed Life Cycle Cost study when all the detailed information is available.

This document sets out the decision making process to enable a Railway Infrastructure Provider, his representative or a tenderer/bidder to determine the track option which is most likely to give demonstrably best value in the particular circumstances prevailing.

There are many factors which determine the best choice of the type of track to adopt. Some, such as the method of construction, access, and time available, relate to installation. Others are Railway Infrastructure Provider and performance specific such as, location, service, type of traffic and the environment.

A third issue is affordability. Every Railway Infrastructure Provider seeks the best value solution – the maximum benefit, including all the functional needs, for the minimum cost within the available budget. This is different for each Railway Infrastructure Provider depending on his needs, his preferences/wants, the available funding and the situation.

All these factors are specific to, and need to be evaluated for, the particular circumstances.

The example evaluation provided is intentionally incomplete and indicative only. It is based on comparison of 3 Slab Tracks but could also include a ballasted track for reference. Clearly some of the issues are significant only to slab track or only to ballasted track. Where not relevant they should be omitted i.e. have a zero or appropriate low weighting. The weightings of the value/importance criteria are not prescribed. They will need to be reviewed and revised to suit the particular site, traffic and stakeholders concerned.

In this Guide the merits and result of using Life Cycle Costing can be compared with consideration of lowest first cost. It is often the case that selection of lowest first/installed cost will ensure continued heavy maintenance and its associated on-going high cost. Thus depleting the budget of funds for investment in any solution, which could eliminate the avoidable cost. The high cost of continued heavy maintenance or, alternatively, deterioration of the network, is thereafter inevitable. This guide is complimentary to, and can contain the output of, the Life Cycle Costs determined in Innotrack SP 6

This guideline is intended to assist the objectivity of the decision makers and thus provide a mechanism that helps the common objective of Innotrack, the Commission and Railway Infrastructure Managers to deliver a safer and more affordable railway. However, not all railways find that this deliverable should be an INNOTRACK Guideline.

2. Decision Process Steps

2.1. Step I – Track Classification

It is first necessary to understand clearly the current environment and potential future use of the track. This will include items such as:

A. Type of Traffic

- Passenger
- Freight
- Construction and maintenance plant

If passenger

- Main line
- Metro
- Light rail

If main line

- High speed (200 kph to 300+ kph)
- Normal speed

If freight

- Axle load
- High speed or normal speed
- Container size
- Piggyback and High back

B. Structures

- Structure Gauge
- Tunnels
- Bridges
- Viaducts
- Embankments

C. Formation

- Water table
- Embankment and cuttings
- Ground support strength
- Concrete

D. Environment

2.2. Step II – Stakeholders

The different stakeholders must be identified and will include, but not be limited to:

- Passengers
- Tax payers
- Local residents
- Constructors
- Infrastructure managers
- Train operators
- Funders
- Safety, Standards, and Approval Authorities

Primary Stakeholders are those with a direct and significant financial interest in the outcome. Secondary Stakeholders are the remainder who can affect, or be affected by, the outcome.

They each have different perceptions of value and their perspective must be represented in the evaluations in Steps III to V that follow.

2.3. Step III – Determination of Importance Criteria

It is necessary to determine all the issues, which relate to the decision i.e. all those items, which can affect, or be affected by, the decision. This must not be the work of one person or one vested interest group. It will consider the points of view of all the stakeholders in Step II above and will include items such as:

- Safety
- Reliability
- Capacity
- Environmental impact
- Ease of construction
- Etc.

N.B. These items will be project and site specific

Once determined, these items are included in the analysis chart – Refer to Appendix "A".

The importance criteria shown in the example are indicative only and should be omitted or changed as appropriate. However all factors affecting the decision should be included.

The importance criteria will not contain cost statements such as "low cost". The costs are dealt with separately and have an equal weighting to the total benefits.

2.4. Step IV – Benefit Evaluation

The above items are then weighted on the basis of their degree of importance/significance to the decision on the final track choice **in the particular circumstances under consideration.**

The importance weightings are included in the analysis chart – Refer to Appendix “A”.

Clearly some of the issues are significant only to slab track or only to ballasted track. Where not relevant they should be omitted i.e. have a zero or appropriate low weighting.

The results of the evaluation are only as good as the experience of the team doing the evaluation. The best available team is needed for the best results.

2.5. Step V – Options Evaluation

The available track options are identified and all available attributes and technical information determined for each option.

Each option is evaluated and weighted in turn against each of the predetermined importance criteria from Step III.

The results of this exercise are included in the analysis chart – Refer to Appendix A”.

The results of the analysis are only as good as the experience of the team doing the evaluation. The best available team is needed for the best results.

The above weightings will vary and must relate to the particular circumstances under consideration.

2.6. Step VI – Options Analysis

The total benefit of each option (the attribute rating) is then determined by adding the product of the option evaluation and the importance criteria weighting for each combination.

The option with the most benefit to the stakeholders is established. (Refer to column headed “ATTRIBUTE RATING” in APPENDIX “A”)

The importance criteria can usefully be grouped to obtain a sensibility check on the group importance. **These groupings are not absolute as some criteria could fall into several of the groups.** Each criteria is only included once. The % shown is indicative only. It is simply an addition of the individual importance weightings in the group expressed as a %.

The values in the example should not be taken as prescriptive. For example the design criteria in many cases also affect the safety.

Common group headings might be:

a) Safety
b) Environment
c) Installation
d) Performance
e) Maintenance
f) Range of Application

These are included in the analysis chart – Refer Appendix “A”.

2.7. Step VII – The Cost

The cost of each option is then incorporated into the analysis (Refer Appendix “A”). This should be based if possible on competitive free market quotations or known actual cost and include all Railway Infrastructure Provider and contract management Life Cycle Costs (LCC).

The cost can/should include, separately identified:

- The installed cost;
- the maintenance cost;
- the track related operational cost (delays, loss of track access etc) and,
- where appropriate, the decommissioning cost.

The combination of these will sum to give the total Life Cycle Cost.

Such costs can come from an LCC analysis, see the INNOTRACK subproject SP6

2.8. Step VIII- Value Analysis

The best value option is then calculated by dividing the total attribute / benefit score for each option by the appropriate cost. This could be;

- the installation only cost or
- the installation and maintenance cost or
- any or all of the install, maintain, operate, de-commission costs.

The highest “value rating” identifies the best value option for the cost being considered. The analysis is self apparent from the example shown in Appendix “A”.

2.9. Step IX - Monetry Equivalent of Value Savings

A further step is to place a monetary value on non-monetary (non-cashable) savings.

In this step the cost of each option is reduced until it delivers a value ratio equal to that of the best value option.

The reduction in cost in each case represents the additional value that is provided by the best value option over the other options. This can be represented as cents in the Euro or pence in the pound of value for each option. It is a relative measure which however identifies the extent to which the money is well spent.

3. Conclusion

Which track type to adopt is most effectively determined using a Best Value Analysis. It is Demonstrable, Auditable and as Accurate as the available information.

It is a live and flexible document which can be adjusted to suit each situation and as new information becomes available or as the circumstances change. The sensitivity to any particular criteria or weighting can be checked but is often not critical to the final selection. An omitted criteria or an erroneous weighting rarely affects the outcome.

The output will only be as good as the competence and experience of the participants. It is thus necessary to have a team of well experienced personnel, representing all the stakeholders' needs and wants, who are very familiar with both the available solutions, the technology and the circumstances surrounding the particular installation under consideration.

The evaluations should be supported by technical or other evidence whenever possible.

This process is intended as a first step in identifying the requirements of the track system, assessing the options available and determining the solution which delivers the best value for money in the particular circumstances.

The best value option from the study should be adopted as the base case solution.

Appendix “A” – Slabtrack Options Analysis – Best Value for Money

Appendix “B” – Value Analysis – Definitions

N.B. THESE DEFINITIONS ARE NOT PRESCRIPTIVE AND SHOULD BE REPLACED, ADJUSTED OR OMITTED TO THE CONCENSUS OF THE STUDY PARTICIPANTS.

They are provided to enhance the example and to support the brief headings used on the Analysis sheet.

1.0 Design Criteria and Performance (Specification)

The assessment of the benefits will be specific to the particular locations and circumstances of the installation. It will be based on, and account for, but not be limited to, any or all of:

A Life of components
The reasonably expected / design life, taking account fitness for purpose, safety and normal maintenance. Life may vary depending on the extent to which the system is loaded or not loaded and the environment and duties of the particular installation anticipated, i.e. It will be site specific.

B Rail head fixity (gauge corner cracking, rolling contact fatigue, head checking etc)
The ability of the rail head to maintain its optimum designed head position. The rail head stability under traffic load.

C Contamination ingress (sand, water, ice etc)
The likelihood and impact of contamination into areas where such contamination would be detrimental to performance, inspection, or appearance. Such contamination will include oil, sand, water, coal dust etc depending on materials carried and the weather environment. Contamination of the ballast through ballast attrition, weeds etc.

D Track reliability
The need for the track to perform, as designed, at any time it is required, whether frequently or infrequently with the stated maintenance levels applied.

E Low corrosion susceptibility
Levels of corrosion taking into account the particular loads (salt, acids, etc) and environment (rain, acid rain, low temperatures, stray currents etc).

F Track availability
The proportion of the 24 hour day that the track system is available for traffic at line speed whether traffic is scheduled or not. Dependent upon normal maintenance, renewals plus unplanned maintenance, track related incidents etc. It is not available while maintenance or renewal plant is on the section or moving to other sections.

G Maximises space available (height, width and fixity)
The extent to which the track system occupies a large cross section, ie. can permanently enhance the available space, through and past structures, for larger vehicles. Or can reduce the structure size.

H Low system weight
Weight per metre of a standard system. The weight of the least heavy version of each system that is fit for purpose. Important on bridges, viaducts and poor foundations.

I Simplicity & number of components
Maximum simplicity whilst meeting the expected performance specs and required fitness for purpose.

J Compatibility with switches & crossings, Insulated Block Joints, expansion joints etc
Compatibility with adjacent components. This will depend on the length of the system and how many turnouts, crossovers etc, occur in the section under study. This will include the provision of IBJ, broken rail clamps, expansion joints.

K Flexibility of design alignment (e.g. gauge widening, head)
This should consider the flexibility of the critical alignment, (see also L for realignment) and the ability to vary the gauge, individual rail inclination, individual rail height, track stiffness etc.

L Ease of later realignment, settlement etc
The ability to realign the track for a later design realignment or settlement.

M Suitability for tunnel use
Minimum in tunnel access required for inspection and maintenance. Ease of maintenance. Likelihood of derailment with system in place

N Suitability (non weight) for structures
Low influence of track system on structure performance. Consider expansion joints, longitudinal restraint of track on rail and rail on track.

O Seismic
Ability to sustain seismic movements. This importance weighting serves a good example of the need for all the issues to be client, location and traffic specific

P Extent of transition design
Extent and complexity of transition design, both of the rail and of the track stiffness. It should be questioned/discussed whether or to what extent the complexity is due to the ballast or to the slab track or to one slab system to another slab system that is responsible for different transition needs.

Q Extent of formation and foundation works
This should consider the extent of the ground works required below the ballast or slab track form. In either case this might include a frost layer (depending on location). This includes the extent to which the track system can accommodate areas of weak ground. Also the need/extent of a frost layer.

R Wide stiffness range
The range of design stiffness availability as seen by the rail head/vehicles. This will include the influence of rail, pad and supporting slab/sleepers/ballast.

S Acceleration/braking forces (longitudinal rail restraint)
The ability to vary the longitudinal restraint on the rail depending on design need.

T Track quality retention (low change in horizontal and vertical head displacement with time)
The ability to retain the designed performance with time. This includes pad performance, rail head position, slab/sleeper position.

U Low minimum radii/geometrical restraint
The ability to handle low radius curves with minimum lubrication demand.

2.0 Safety

V Operational safety
Risk level to which the railway installation maintenance and renewal workforce are exposed. This can be taken from the approved safety model. Degree of automation of inspection that is possible.

W Low frequency of inspections
The extent to which inspection of the track system requires to be inspected/monitored in order to meet the duty of care of the infrastructure provider and maintainer. The inspection level should be track type specific for the purpose of this assessment.

X Ease of evacuation and access/egress for maintenance
This should consider the safety and ease of access and egress to an incident or workplace. This should include emergency equipment/services.

Y Other system safety (broken rails, loss of pads etc)
Susceptibility to broken rails fixings etc. Consequences of broken rails, fixings etc.

Z Derailment protection
The ease of provision and the effectiveness of derailment protection. Damage done to clips, track slab, sleepers etc and consequences in the event of a derailment.

3.0 Environment

AA Appearance
The appearance of the track system taking into account its ease of cleaning, ability to trap debris, drain ability, susceptibility to vegetation growth.

AB Noise
The level of noise nuisance generated by the system under both normal and exceptional duties on a comparative basis. This will depend on peak noise levels, noise frequencies, and total noise power. It will be affected by the choice of rail, fittings, pads, slab/sleepers, anti-noise measures (i.e. grinding regime)

etc. It will be particularly site specific. The impact will depend on the affect upon the local regulations, the local population, their sensitivities and activities. Residual noise protection measures may be onerous.

AC Vibration
The extent to which a) vibration is not generated at the wheel/rail interface and b) it is not transferred to the surrounding ground or structure. The impact will depend on the affect upon the local regulations, the local population, their sensitivities and activities. In extreme cases floating track may be required. The extent to which the track system minimizes the risk of problems or cost.

AD Carbon footprint
The carbon footprint generated by the system in first installation, maintenance, renewal and disposal. This is significantly a component life issue. The impact on rolling stock energy used by poor alignment or poor track stability.

AE Water/drainage management
The ability of the system to withstand the effects of rain, acid rain, groundwater and storm water. Also spillages and discharges from rolling stock. This should take into account the ability of the system to shed water away from the formation. Also the potential for water 'pumping'. The ability to capture potential environmental contaminants for later removal.

4.0 Construction / Installation

AF Short installation time
This will depend on whether the installation is new on a Greenfield site or a replacement track. In the first case it should include any formation and other preparation work. In the latter case of a live railway the time of unavailability of the track should be used. The speed of the concreting, the alignment and the railing operations should be considered.

AG Low installation complexity
A simpler installation method, using simpler equipment, has less chance in principle of failure and needs less sophisticated resources and supervision.

AH Low installation resources
Fewer resources lead to less interfaces, less disruption and less supervision. The degree of automation should be considered.

AI Ease of achieving alignment
Achieving accurate alignment tolerance is essential. The ease of adjustment, method of surveying, degree of automation are important considerations in achieving accuracy speedily.

AJ Alignment options available (top down, bottom up etc)
To check the alignment before locking it in is deemed prudent. Top down construction does this. Other methods are also capable of delivering accurate alignments. Optimally, no further adjustment is required after the rails are first set. Alignment of only one component is preferred. One survey set up to serve both concreting and railing is an advantage.

AK Concreting options available (in-situ, slip form, pre-cast)
A track system which gives the designer and contractor a choice of concrete

method, design, construction method, installation time, alignment, degree of automation, labor /plant balance, 27/7 working etc.

AL Low interdependency of construction activities
Where construction activities are not interdependent disruption and programmed risk are reduced. This can include ground preparation, drainage, concreting, railing aligning, plant dependency etc.

AM Alignment adjustments during and post installation
The number of alignment readjustments/surveys necessary after first setting of the alignment.

AN Can be installed with limited access e.g. single line working
The degree to which a system needs access for installation maintenance and renewal. Some systems can be delivered from single line working. Some need dedicated access for concreting plant. The importance weighting will be site specific depending on the access and traffic conditions.

AO Low formation bearing capacity
Systems that can accommodate low bearing capacity have the advantage of less preparation work to the formations and better response to later development of soft ground.

AP Materials availability
Fewer materials, readily available, are an advantage. Also reduces stores required for maintenance.

5.0 Maintenance

AQ Frequency of grinding regime
It is a distinct advantage if adoption of a particular system leads to less grinding, whether little and often or occasional heavy grinding.

AR Frequency and level of inspection
Any system requiring less frequency of inspection is preferred. Systems that can be inspected by CCTV from service trains are preferred. This reduces the need for qualified track inspectors to walk the track.

AS Ease of minor alignment (line and level) adjustment
The ease to which minor (less than 20mm) line and level adjustment can be made during maintenance and operation.

AT Ease of major alignment (line and level) adjustment
The number of options and ease of major (20-150mm) line and level adjustment can be made. This information should be in the maintenance manual. The importance weighting should reflect the likelihood (or %) of track that might reasonably be expected to have differential settlement.

AU Long component life
Long component life (i.e. still fit for purpose) is an advantage to avoid interventions, inspections, spares, safety etc.

AV Ease of renewal of the components
This is affected by the number of components, the access to replace them, and further the degree of difficulty of their removal and replacement.

AW Loss of residual component life
Loss of residual life of one component if replaced, when another component is life expired.

AX Maintenance resources/plant required
The need for extensive maintenance equipment and other resources to maintain the system.

AY Track quality retention (ability to maintain design alignment)
This could equally be a design or performance or safety requirement. This relates to the effectiveness of the system to retain the designed alignment. It is fundamental to the delivery of a safe, functional and affordable railway.

6.0 Operation

AZ Co-ordinate vehicle, wheel, rail, sub system and formation
It can be beneficial to have a holistic design in which the performance of the track and the rolling stock is optimized. This can relate to rail wheel profiles and to the overall stiffness of rolling stock suspension, rail pad, support structure and foundation.

BA Passenger comfort
Passenger comfort is affected by the quality of track. Corrugation, rail joints, poor alignment, etc will have an influence. The importance level of this item will depend on the passenger expectation of noise, vibration etc. on the route under consideration.

BB Electrical insulation (incl. stray current performance and EMC effects)
This factor will have a more significant weighting where the signaling system uses track circuits rather than axle counters.

BC Traffic capacity (Kinematic Envelope)
The purpose of the railway is to carry passengers and freight. The carrying capacity depends on the ability of the track to ensure a stable vehicle. The more stable, the larger the permitted load or vehicle. Also the track system should occupy the minimum space within the structure gauge to allow maximum carrying capacity.

BD; BE; BF; BG Traffic type – high speed (200-400+ km/h); heavy freight (35+ tonnes axle load); mixed traffic (passenger and freight); light rail
These four categories are generally mutually exclusive. They depend on the anticipated traffic on the route being studied. The ability/flexibility to accommodate other traffic types in the future is however also beneficial. One will have a high weighting and the others less so.

BH Electrical System compatibility
The compatibility with the electrical supply including 3rd rail if present and the contribution to a stable relationship with the overhead supply. Ease and reliability of electrical bond connections. Impact of bond connections on safety (broken rails through bond holes etc.)

SLABTRACK SELECTION USING BEST VALUE FOR MONEY ANALYSIS

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Safety - % / Environment -% / Co

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	%	4.0	3.2	2.8	4.0	0.8	4.0	1.0	3.2	2.0	2.4	3.6	2.8	2.8
	IMPORTANCE WEIGHTING	10	8	7	10	2	10	7	8	5	6	9	7	7
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E	TRACKFORM OPTION E													
	(Ballast ?)													
	CP -01-01-10													

Construction / Installation - % / Maintenance - 16% / Operation - 14%

Ease of achieving Alignment	Alignment options available (Top Down, Bottom up etc)	Concreting options available (In-situ, Slipform, Pre-cast)	Low Interdependency of construction activities	Alignment adjustments during and post installation	Can be installed with limited access e.g single line working	Low formation Bearing Capacity	Materials availability	Frequency of Grinding Regime	Frequency & Level of Inspection	Ease of minor alignment (line and level) adjustment	Ease of major alignment (line and level) adjustment	Long component life	Ease of component renewal	Loss of residual component life on renewal	Maintenance resources / plant required	Track Quality Retention (Ability to maintain design alignment)	Co-ordinated vehicle, wheel, rail, sub system and formation performance	Passenger Comfort	Electrical Insulation (incl stray current performance and EMC effects)	Traffic Capacity (Kinematic envelope)	Traffic Type - high speed (200-400+km/h)	Traffic Type - heavy freight (35+tonnes axle load)	Traffic Type - mixed traffic (passenger & freight)	Traffic Type (light rail)	Electrical system compatability
AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BB	BC	BD	BE	BF	BG	BH	BI
2.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.2	2.8	2.8	4.0	0.0	0.0	0.0	4.0	2.4	2.8	2.0	3.6	3.2	3.2	2.8	2.8	1.2
7	5							9	8	7	7	10				10	6	7	5	9	8	8	7	7	3
5	4							4	2	9												3	6	8	
35	20							36	16	63												24	42	56	
						Consensus assessment to be made by clients, designers and other stakeholders																			

Benefit / Cost / Value Analysis

ATTRIBUTE RATING	Attribute Ranking	% Attribute Increase on lowest	INITIAL COST	MAINTENANCE COST (60 years)	OPERATIONAL COST (lost availability) (60 years)	LIFE CYCLE COST -60 Years	TOTAL LIFECYCLE COST	Cost Ranking	% Cost Increase on lowest	Value Rating	Value Ranking	Adjusted Cost for Value Equal to Best Value	Lifecycle Value Saving	5 year saving	% Value for Money (Relative to BV option)
ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP
100		%	€m	€m	€m	€m	€m		%	Q/T		€m	€m	€m	%
253															
	3	0	8.70	8.30	1.60	18.6	27.3	3	33	35.93	3	13.2	14.1	1.2	48%
981															
	1	56	9.60	1.20	0.20	11.0	20.6	1	0	74.17	1	20.6	0.0	0.0	100%
1528															
	2	16	10.80	3.10	0.70	14.6	25.4	2	23	44.72	2	15.3	10.1	0.8	60%
1136															
												CP 01-01-10			

SLABTRACK SELECTION USING BEST VALUE FOR MONEY ANALYSIS

Benefit Assessment

REF		Design Criteria and Performance (Specification) - %																					Safety - %						Environment -%				C		
	ASSESSMENT / BENEFITS CRITERIA (Add omit or adjust to suit particular situation)	Life of components	Rail head fixity. (Gauge corner cracking, RCF, head checking ? etc.)	Contamination ingress (Sand, water, ice etc)	Track Reliability	Low corrosion susceptibility	Track Availability	Maximises space available (height, width and fixity)	Low system weight	Simplicity & number of components	Compatability with S&C, IBJ's, Expansion joints etc.	Flexibility of alignment (e.g. gauge widening)	Flexibility of later alignment change minor / major	Suitability for Tunnel	Suitability for Structures	Seismic	Extent of Transition design	Extent of formation and foundation works	Wide Stiffness range	Accel/ Braking forces (longitudinal rail restraint)	Low change in vert &horizontal head displacement with time	Low minimum radii / geometrical restraint	Operational safety	Low frequency of inspections	Ease of Evacuation and access /egress for maintenance	Other system safety (broken rails, loss of pads) etc	Derailment Protection	Appearance	Noise	Vibration	Carbon Footprint	Water / drainage management	Short Installation time	Low Installation complexity	Low Installation resources
		A	B	C	D	E	F	G	H	I	J	K	M	N	O	P	Q	R	S	T	U	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
	%																																		
	IMPORTANCE WEIGHTING																																		
A	TRACKFORM OPTION A																																		
B	TRACKFORM OPTION B																																		
C	TRACKFORM OPTION C																																		
D	TRACKFORM OPTION D																																		
E	TRACKFORM OPTION E																																		
	(Ballast ?)																																		
	CP -01-01-10	Each option is graded out of 10 the indicative levels are: 10 Excellent, 7 Good, 4 Fair, 1 Poor																																	

Construction / Installation - %									Maintenance - %									Operation - %									Benefit			Cost							Value Analysis					
Low Installation resources	Ease of achieving Alignment	Alignment options available (Top Down, Bottom up etc)	Concreting options available (In-situ, Slipform, Pre-cast)	Low Interdependency of construction activities	Alignment adjustments during and post installation	Can be installed with limited access e.g single line working	Low formation Bearing Capacity	Materials availability	Frequency of Grinding Regime	Frequency & Level of Inspection	Ease of minor alignment (line and level) adjustment	Ease of major alignment (line and level) adjustment	Long component life	Ease of component renewal	Loss of residual component life on renewal	Maintenance resources / plant required	Track Quality Retention (Ability to maintain design alignment)	Co-ordinated vehicle, wheel, rail, sub system and formation performance	Passenger Comfort	Electrical Insulation (incl stray current performance and EMC effects)	Traffic Capacity (Kinematic envelope)	Traffic Type - high speed (200-400+km/h)	Traffic Type - heavy freight (35+tonnes axle load)	Traffic Type - mixed traffic (passenger & freight)	Traffic Type (light rail)	Electrical system compatability	ATTRIBUTE RATING	Attribute Ranking	% Attribute Increase on lowest	INITIAL COST	MAINTENANCE COST (60 years)	OPERATIONAL COST (lost availability) (60 years)	LIFE CYCLE COST -60 Years	TOTAL LIFECYCLE COST	Cost Ranking	% Cost Increase on lowest	Value Rating	Value Ranking	Adjusted Cost for Value Equal to Best Value	Lifecycle Value Saving	5 year saving	% Value for Money. (Relative to BV option)
AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BB	BC	BD	BE	BF	BG	BH	BI	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP
																											100		%	€m	€m	€m	€m	€m		%	Q/T		€m	€m	€m	%
																																									CP 01-01-10			