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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
Research Designs and Standards Organisation
LUCKNOW-226011

Planning for Through Tamping on the basis of TGI

(ABRIDGED VERSION)

REPORT NO. TM – 1.15

TRACK MACHINES & MONITORING DIRECTORATE

OCTOBER 2007

This report is based on study made by the Track Machines and Monitoring directorate of RDSO. Although, every care has been taken in analysing it objectively, the views expressed in this report are subject to modifications from time to time in the light of fresh data. Further, they do not necessarily represent the views of the Ministry of Railways (Railway Board), Government of India.

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1. INTRODUCTION

Tamping is essential for correcting track geometry and providing resilient & firm support to track. Unwarranted tamping is however not desirable due to:

i) Pulverization of ballast, which results in choking of drainage,

ii) Disturbance of consolidation of track,

iii) Deterioration of track geometry,

iv) Loss of resilience in long term,

v) Deployment of costly resources for unproductive use.

In past manual tamping was done from one to other end of track beat on periodicity basis. With heavy track structure, mechanization became need of the hour and on track tampers were employed for this. Initially tamping was done at the periodicity of once a year. With gaining of experience, it has been revised and laid down in IR Track Machine Manual. The para 5.7.4 of Track Machine Manual reads as under:

(i) On PSC sleepers, the frequency of tamping will be once in two years or passage of 100 GMT of traffic which ever is earlier.

(ii) On other than PSC sleepers, frequency of tamping will be once in a year. In case of premature deterioration of track, the divisions shall go into the reasons and come out with adequate justification for approval of Chief Track Engineer for such additional tamping.

This provision is empirical in nature and is based on experience only. It gives flexibility to prepone the tamping but it cannot be deferred even if track condition is good. No rational instructions have been laid down for preponing the tamping & each case is to be decided subjectively. Preponing the tamping is not linked rationally with track geometry conditions.

Board vide it's letter no. 94/Track-III/TK/23 dated 30.12.1996 had issued guideline regarding grading of the track according to TGI, which is as under-

Band width of TGI	**Maintenance requirement of the track**
TGI value 80 and above	No maintenance required
50 to 80	Need based maintenance
36 to 50	Planned maintenance
Below 36	Urgent maintenance

It was also suggested that, "Within each band, the individual parameters should be examined and studied. From repeated recordings, trends in deterioration should be studied to pre-plan the action before entering the band width between 50 and 36 & 36 and below. This study would lead to "predictive need based track maintenance" ".

In practice, these guidelines were found to have some limitation, as these were suitable for spot attention and did not give a picture of the complete section. Also emphasis was not given on improvement of TGI value beyond 80, which is easily achievable in field with modern machines.

The item (Machine Maintenance of Track), relating to tamping standards i.e. TGI, standard deviation of unevenness, twist, gauge and alignment achieved after tamping was discussed in the 76th meeting of the track standards committee, on which the Railway Board passed the following orders; "Railways should prepare database regarding TGI, standard deviation of unevenness, twist, gauge and alignment achieved after tamping, for monitoring of quality of work done by track machine and send the same to RDSO for further analysis".

As of now, no such laid down standards are available on IR. It may be possible to extend the tamping cycle if we can achieve some uniform standards for the track parameters after tamping. This will not only lead to lower

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maintenance cost in terms of machine hours, but will also help in saving of time for traffic blocks, deterioration of ballast and so on.

2. COLLECTION OF DATA

A proforma was circulated to all zonal railways vide this office letter number TM/GL/70 dated 22.9.06 asking for the information about track parameters before tamping and after tamping. The various track parameters asked were SD for UN1, UN2, TW1, TW2, Gauge, AL1, AL2 and TGI values. This information was required both before and after tamping. Also the track structure, total ballast cushion and the clean cushion were asked for. Reminders to get the information were sent on 31.1.07, 16.03.07 & 30.4.07. This item could not be finalised during the 77th TSC, as sufficient information was not available till that time.

The item was again discussed during the 77th TSC, on which the Board passed the following orders, "Database should be prepared by railways as per proforma circulated by RDSO in this regard. This should be sent to RDSO for consolidation and putting up to Board for further orders".

As of now, the information has been received from the following Railways:

S.No.	Rly	Letter No.	File page ref. no.	Section	MSS	Route	Total Km
1	E.Co.	W-7/637/TM/Genl./1732 dated 21.05.07	36	PSA-VSKP UP LINE	105	B	203
2	E.Co.	W-7/637/TM/Genl./1732 dated 21.05.07	36	PSA-VSKP DN LINE	105	B	203
3	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	JSG-BSP UP LINE	110	A	53
4	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	BSP-JSG DN LINE	110	A	27
5	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	BSP-APR SL LINE	80	D	5
6	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	BSP-DUG UP LINE	105	A	46
7	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	BSP-DUG DN LINE	105	A	43
8	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	MID	105	A	7

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S.No.	Rly	Letter No.	File page ref. no.	Section	MSS	Route	Total Km
9	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	PMS-RJN	105	A	5
10	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	RJN-BAKL	105	A	8
11	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	BAKL-MUA	105	A	8
12	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	MUA-Yd	105	A	1
13	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	MUA-JTR	105	A	5
14	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	JTR-DGG	105	A	6
15	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	DGG-PJB	105	A	7
16	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	PJB-BTL	105	A	2
17	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	SKS-AGN	105	A	3
18	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	AGN-GDM	105	A	4
19	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	K-BRD	105	A	4
20	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	BRD-KT	105	A	2
21	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	KT-Yd	105	A	1
22	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	CHCR-SAL	105	A	1
23	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	KNHN-KP	105	A	3
24	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	KP-KAV	105	A	5
25	SEC	ENGG/TC-2/TSC/2684 dated 26.04.07	35	KAV-NGP	105	A	3
26	SER	TC/TM/QLY/3435 dated 13.03.07	32	SANKRAIL-CHENGAIL	110	A	12
27	SER	TC/TM/QLY/3435 dated 13.03.07	32	GIDHNI-DHALBHUMGARH	105	A	32
28	SER	TC/TM/QLY/3435 dated 13.03.07	32	DHALBHUMGARH-ASANBANI	105	A	34
29	SER	TC/TM/QLY/3435 dated 13.03.07	32	ASANBANI-DHALBHUMGARH	105	A	31
30	SER	TC/TM/QLY/3435 dated 13.03.07	32	KULGACHIA-HAUR	105	A	33

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S.No.	Rly	Letter No.	File page ref. no.	Section	MSS	Route	Total Km
31	SER	TC/TM/QLY/3435 dated 13.03.07	32	CHENGAIL-MOURIGRAM	105	A	17
32	SER	TC/TM/QLY/3435 dated 13.03.07	32	KGP-DATAN	105	B	51
33	SER	TC/TM/QLY/3435 dated 13.03.07	32	NILGIRIROAD-BHC	105	B	50
34	SER	TC/TM/QLY/3435 dated 13.03.07	32	BHC-BALASORE	105	B	60
35	SER	TC/TM/QLY/3435 dated 13.03.07	32	LAKHANNATHTUR-HIJLE	105	B	58
36	NER	W/TRC/Sdvalues/1-W-4A dated 20.03.07	31	LJN-GKP	110	D	5
37	NER	W/TRC/Sdvalues/1-W-4A dated 20.03.07	31	BUW-SCC	100	D	14
38	NER	W/TRC/Sdvalues/1-W-4A dated 20.03.07	31	GKP-CPR	110	D	46
39	NER	W/TRC/Sdvalues/1-W-4A dated 20.03.07	31	PNYA-GKC	100	D	63
40	NER	W/TRC/Sdvalues/1-W-4A	38	BTT-ALY	100	D	45
41	NER	W/TRC/Sdvalues/1-W-4A	38	CPR-ARJ	100	D	42
42	WR	W377/4/77(W-1) dated 12.01.07	25	BCT-NAD BCT(004)-LNK(509) LNK(509)-RTM(655) RTM(655)-NAD(696)	 120 100 130		108
43	WR	W377/4/77(W-1) dated 12.01.07	25	BCT-NAD BCT(004)-LNK(509) LNK(509)-RTM(655) RTM(655)-NAD(696)	 120 100 130		76
44	WR	W377/4/77(W-1) dated 12.01.07	25	BRC-ADI	100		23
45	WR	W377/4/77(W-1) dated 12.01.07	25	ADI-BRC	100		5
46	WR	W377/4/77(W-1) dated 12.01.07	25	PNU-ADI	100		39
47	SCR	W-507/2/1/RDSO/TRC/VOL-IV dated 5.10.06	17	BPQ-KZJ DN	120	A	93
48	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	RU-WD	100	B	24
49	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	WD-RU	100	B	98
50	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	BZA-GDR	110	A	51
51	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	GDR-BZA	110	A	78

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S.No.	Rly	Letter No.	File page ref. no.	Section	MSS	Route	Total Km
52	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	BPQ-BZA	120	A	30
53	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	BZA-BPQ	120	A	55
54	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	WD-KZJ	100	B	14
55	SCR	507/2/1/RDSO/TRC/VOL-IV dated 07.06.07	37	KZJ-WD	100	B	14
56	SR	507/11/BG/TRC dated 9.07.07	46	SRR-MAS	110	B	180
56	NR	Obtained on phone	-	TDL-GZB	110	A	41
57	NR	Obtained on phone	-	GZB-TDL	110	A	39
58	NR	Obtained on phone	-	TDL-ALD	110	A	57
59	NR	Obtained on phone	-	ALD-TDL	110	A	58
60	NR	Obtained on phone	-	UMB-KLK	110	B	57
61	CR	Obtained on phone	-	MTJ-AGC	110	A	30
62	CR	Obtained on phone	-	AGC-MTJ	110	A	29
63	NR	Obtained on phone	-	TDL-CNB	110	A	5
64	NR	Obtained on phone	-	CNB-TDL	110	A	4
65	NR	Obtained on phone	-	ALD-MGS	110	A	4
66	NR	Obtained on phone	-	MGS-ALD	110	A	4
67	CR	Obtained on phone	-	JHS-AGC	110	A	20
68	CR	Obtained on phone	-	AGC-JHS	110	A	20

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3. ANALYSIS OF DATA

Data of each Railway was segregated according to the maximum sectional speed. Two bands were made, one containing the track having MSS greater than or equal to 110 kmph and the other having MSS less than 110 kmph. The

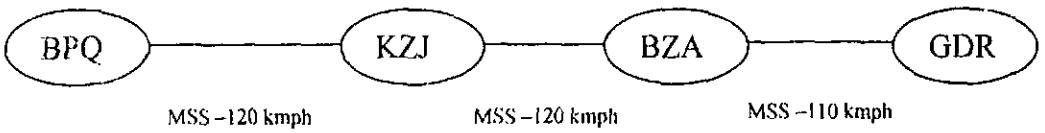
Cummulative frequency of TGI before and after tamping was worked out and the CFD was plotted.

From the cumulative frequency diagrams plotted, it is noted that that there is a definite trend in the plots, with the graph showing linearity between 10% and 70% CFD, both before and after tamping. The graphs also indicated that 60% CFD value of TGI was a good indicator of the geometric quality of track.

10% CFD values after tamping were also analysed, as the graph for post tamping needs to be shifted to a certain value after tamping. This value is also critical because this is the point from which the graph becomes linear.

4. OBSERVATIONS:

1. The data received from South Central Railway was for BPQ-KZJ-BZA, BZA-GDR, RU-WD and KZJ-WD sections. The section BPQ-BZA is on "A" route with MSS of 120 kmph. Most of this track on this section is having formation trouble. The section from BZA to GDR is also "A" route with speed of 110 kmph. This section is also having formation problems.



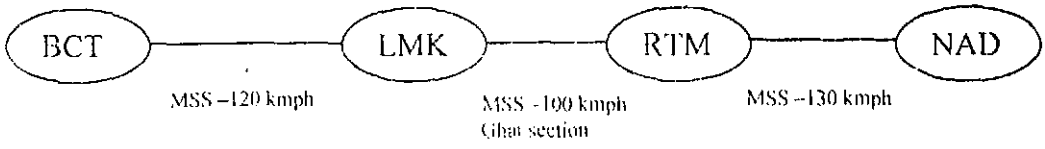
A separate analysis has been done for the "A" route from BPQ-GDR i.e. "A" route with MSS ranging from 110-120 kmph.

The 60% CFD value before tamping is 85 and after tamping is 95. The 10% CFD after tamping is 70. If the section from BPQ-BZA only is taken for analysis, the 60% CFD value before tamping is 80 and after tamping is 95. The 10% CFD value after tamping is 70.

On the "B" route i.e. WD-SC-KZJ and RU-WD sections having MSS of 100 kmph, the 60% CFD value before tamping is 90 and after tamping is also 90. The 10% CFD after tamping is 65. ***There is practically no improvement in***

TGI values after tamping, which is evident from the entwined curves of CFD.

2. Western Railway has submitted data for BCT-NAD, BRC-ADI and PNU-ADI sections. The subsections BCT-LMK and RTM-NAD on "A" route have MSS of



120 kmph and 130 kmph respectively. The 60% CFD value before tamping is 75 and after tamping is 100. The 10% CFD after tamping is 75.

The subsection LMK-RTM on "A" route and sections BRC-ADI & ADI-PNU on "B" route have MSS of 100 kmph. LMK-RTM is a ghat section with black cotton soil. The analysis of their results indicates that 60% CFD value before tamping is 82 and after tamping is 113. The 10% CFD after tamping is 80.

It is observed that the average increase in TGI on Western Railway after tamping is 30. All the sections analysed had a clear ballast cushion of 150-200 mm.

3. The data received from NER pertained to both CST-9 and PRC sleeper track. The data submitted is for LJN-GKP, BUW-SCC, GKP-CPR, PNYA-GKC, BTT-ALY and CPR-ARJ sections. All the sections are on "D" route.

The sections BTT-ALY and CPR-ARJ, which have CST-9 track also, are having MSS of 100 kmph. Analysing the data for CST-9 sleepers indicates that 60% CFD value before tamping is 44 and after tamping is 48. The 10% CFD after tamping is 32. *Thus no benefit was accrued by tamping on CST-9 sleepers in this section.*

LJN-GKP and GKP-CPR sections are having MSS of 110 kmph. BUW-SCC, GKC-PNYA, BTT-ALY and CPR-ARJ have MSS of 100 kmph. Analysing the data for PSC sleeper track indicates that 60% CFD value before tamping is 77 and after tamping is 90. The 10% value after tamping is 50. Same results are

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achieved even if the sections LJN-GKP and GKP-CPR having MSS of 110 kmph are segregated.

4. On South Eastern Railway, data has been received for HWH-JSG ("A" route) and KGP-BHC ("B" route) sections. The data for the former section is for 167 km track length and 219 km for the later. Sankrail-Chengail section on HWH-JSG is having MSS of 110 kmph and rest all the sections are having MSS of 105 kmph. As the data for 110 kmph and above track is only for 12 km, separate analysis was not feasible. The data has been analysed separately for "A" and "B" routes.

On "A" route 60% CFD value before tamping is 84 and after tamping is 102. The 10% value after tamping is 76.

On "B" route 60% CFD value before tamping is 84 and after tamping is 90. The 10% value after tamping is 65. The improvement on "B" route after tamping is on a lower side. The track recording was done within a month of tamping. KGP-BHC is a CC+8+2 section.

5. South East Central Railway has given data for Geetanjali route ("A" route).

JSG-BSP section is having MSS of 110 kmph. The kilometres analysed are having CC+8+2 loading. 60% CFD value before tamping is 84 and after tamping is 90. The 10% value after tamping is 62.

BSP-NGP section is having MSS of 105 kmph. 60% CFD value before tamping is 78 and after tamping is 93. The 10% value after tamping is 70.

6. East Coast Railway has given a data of 406 km on PSA-VSKP section ("B" route). MSS of this section is 105 kmph. Whole data could not be used, as it was incomplete. Analysis of the relevant data indicates that the 60% CFD value before tamping is 102 and after tamping is 117. The 10% value after tamping is 76.

7. Southern Railway has submitted a data of approximately 180 km of MAS-SRR section ("B" route). The MSS is 110 kmph. Analysis of the data indicates that the 60% CFD value before tamping is 106 and after tamping is 107. The

10% value after tamping is 72. There is practically no difference in the TGI after tamping. This is quite evident from the entwined CFD curves.

8. Data of approximately 313 km of "A" route of NCR was collected telephonically. The data pertains to GZB-MGS & MTJ-JHC sections. The MSS is 110 kmph. Analysis of the data indicates that the 60% CFD value before tamping is 103 and after tamping is 111. The 10% value after tamping is 70.

9. Data of approximately 57 km of "B" & "D" routes of NR was collected through phone. The data pertains to UMB-KLK section. Analysis of the data indicates that the 60% CFD value before tamping is 81 and after tamping is 88. The 10% value after tamping is 54.

5. PROPOSED VALUES:

The summarized position of the 60% CFD values before tamping, after tamping and the 10% CFD values after tamping for different routes and speeds is as under:

S.No.	Railway	Route	MSS	TGI values		
				60% CFD before tamping	60% CFD after tamping	10% CFD after tamping
1.	SCR	A	110,120	85	95	70
2.	SCR	B	100	90	90	65
3.	WR	A	120,130	75	100	75
4.	WR	A & B	100	82	113	80
5.	NER	D	110	77	90	50
6.	NER	D	100	77	90	50
7.	SER	A	105	84	102	76
8.	SER	B	105	84	90	65

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S.No.	Railway	Route	MSS	TGI values		
				60% CFD before tamping	60% CFD after tamping	10% CFD after tamping
9.	SEC	A	110	84	90	62
10.	SEC	A	105	78	93	70
11.	ECR	B	105	102	117	76
12.	SR	B	110	106	107	72
13.	NCR	A	110	103	111	70
14.	NR	B & D	50,110	81	88	54

The following values of TGI for 60%CFD before tamping, 60% CFD after tamping and 10% CFD after tamping are proposed:

Speeds greater than or equal to 110 kmph

S.No.	INDICES	TGI value
1.	60% CFD before tamping	≤ 90
2.	60% CFD after tamping (i.e. minimum 40% of track length after tamping should have TGI)	≥ 115
3.	10% CFD after tamping (i.e. minimum 90% of track after tamping should have TGI)	≥ 75

Speeds less than 110 kmph

S.No.	INDICES	TGI value
1.	60% CFD before tamping	≤ 80
2.	60% CFD after tamping (i.e. minimum 40% of track length after tamping should have TGI)	≥ 115
3.	10% CFD after tamping (i.e. minimum 90% of track after tamping should have TGI)	≥ 75

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6. CORROBORATION OF PROPOSED VALUES:

The various indices proposed above are based on the data of two recordings, one before and one after the tamping. The data pertains to track all over IR. Variation of TGI values over a certain period of time on a particular route would give a good indication as to whether the proposed 60% CFD values are achievable. Similarly the correctness of the 10% CFD value after tamping can be ascertained.

For this purpose, Kilometer wise data was obtained from NCR and NWR regarding inputs given over a period of about 5 years in the form of tamping. This data was analysed PWI wise to get graphs of the variation in TGI over a period of about 5 years. The inputs in the form of tamping were also marked on the graph. The trend of the graphs indicates that the proposed values for 60% CFD before and after tamping are achievable.

The proposed value for 60% CFD before tamping should be adopted for the purpose of planning through tamping. Similarly, the values of 60% and 10% CFD after tamping should be adopted for benchmarking the results after tamping.

The above guidelines are for through tamping of the section and take care of the quality and other allied maintenance works such as pre tamping works, post tamping works, long level correction etc. in an indirect way, as without proper accomplishment of these works, the recommended levels of TGI post tamping cannot be achieved. Also, it takes care of level of traffic as the recommended TGI for initiation of planned maintenance (TGI 80/90) will depend upon the rate of deterioration i.e. intensity of traffic.

Concept of tamping cycle is in built, and will depend upon the quality achieved after tamping & the rate of deterioration.

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7. RECOMMENDATIONS:

1. Board should discontinue the system of awarding points to the individual Railways for overall improvement in TGI values over their networks. Due to this system, frequent tamping is being carried out to maintain the TGI, which is serving no purpose. Instead weightage should be given to the average improvement in TGI after tamping. This will ensure quality work and prolonging the tamping cycle.

2. The following values are recommended for planning through tamping i.e. tamping form one end of PWI's jurisdiction to the other end. The 60% and 10% CFD values after tamping should be adopted as benchmark for the results obtained after tamping.

Speeds greater than or equal to 110 kmph

S.No.	INDICES	TGI value
1.	60% CFD before tamping	≤ 90
2.	60% CFD after tamping (i.e. minimum 40% of track length after tamping should have TGI)	≥ 115
3.	10% CFD after tamping (i.e. minimum 90% of track after tamping should have TGI)	≥ 75

Speeds less than 110 kmph

S.No.	INDICES	TGI value
1.	60% CFD before tamping	≤ 80
2.	60% CFD after tamping (i.e. minimum 40% of track length after tamping should have TGI)	≥ 115
3.	10% CFD after tamping (i.e. minimum 90% of track after tamping should have TGI)	≥ 75

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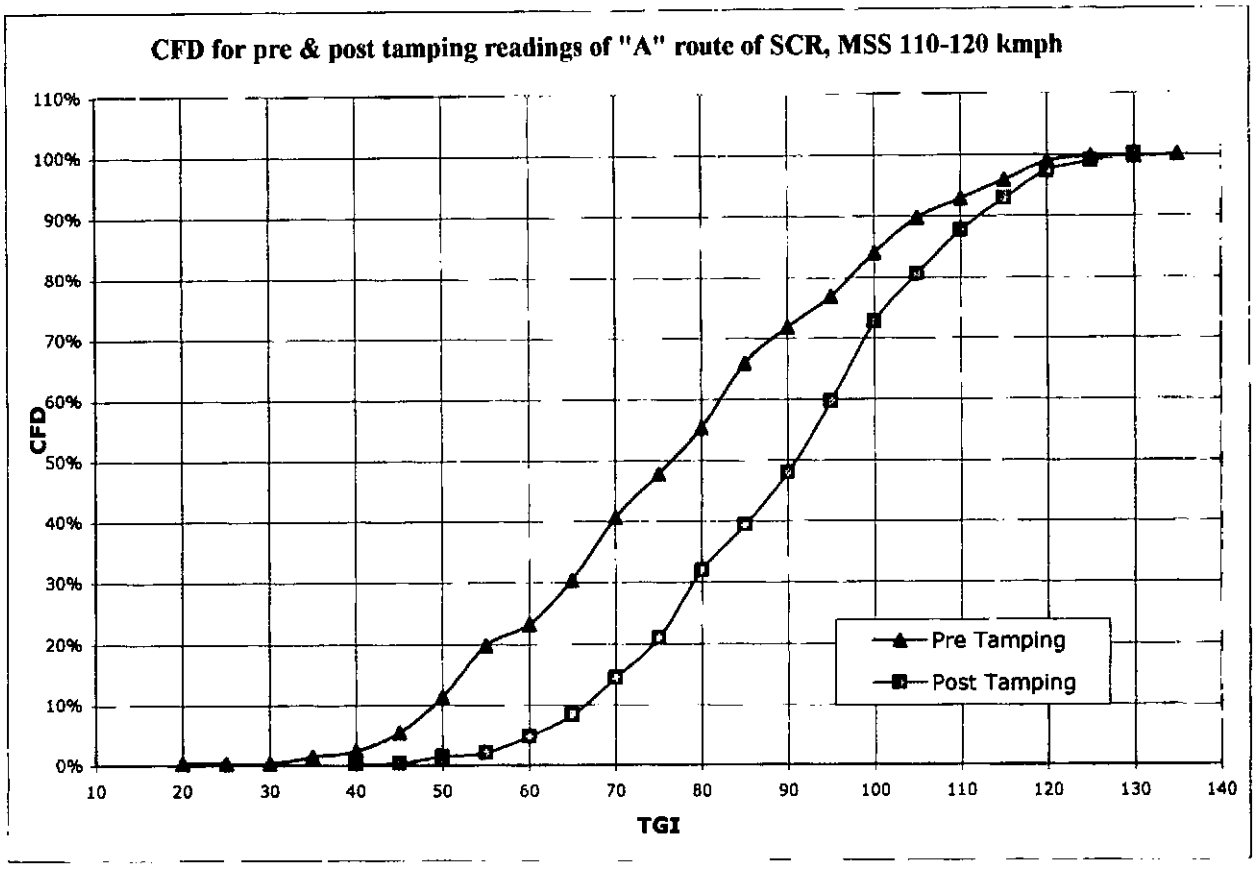
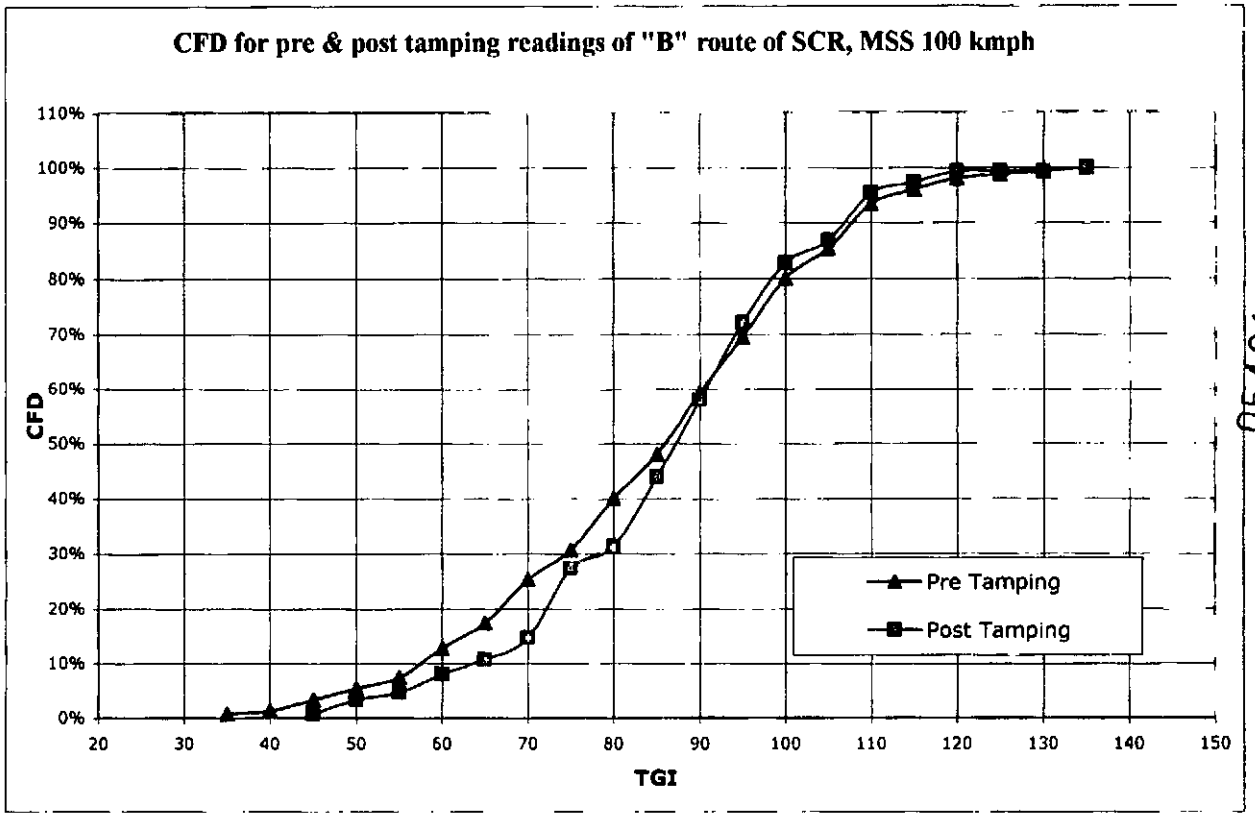

CFD for pre & post tamping readings of "A" route of SCR, MSS 110-120 kmph
CFD
TGI
Pre Tamping
Post Tamping


CFD for pre & post tamping readings of "B" route of SCR, MSS 100 kmph
CFD
TGI
Pre Tamping
Post Tamping

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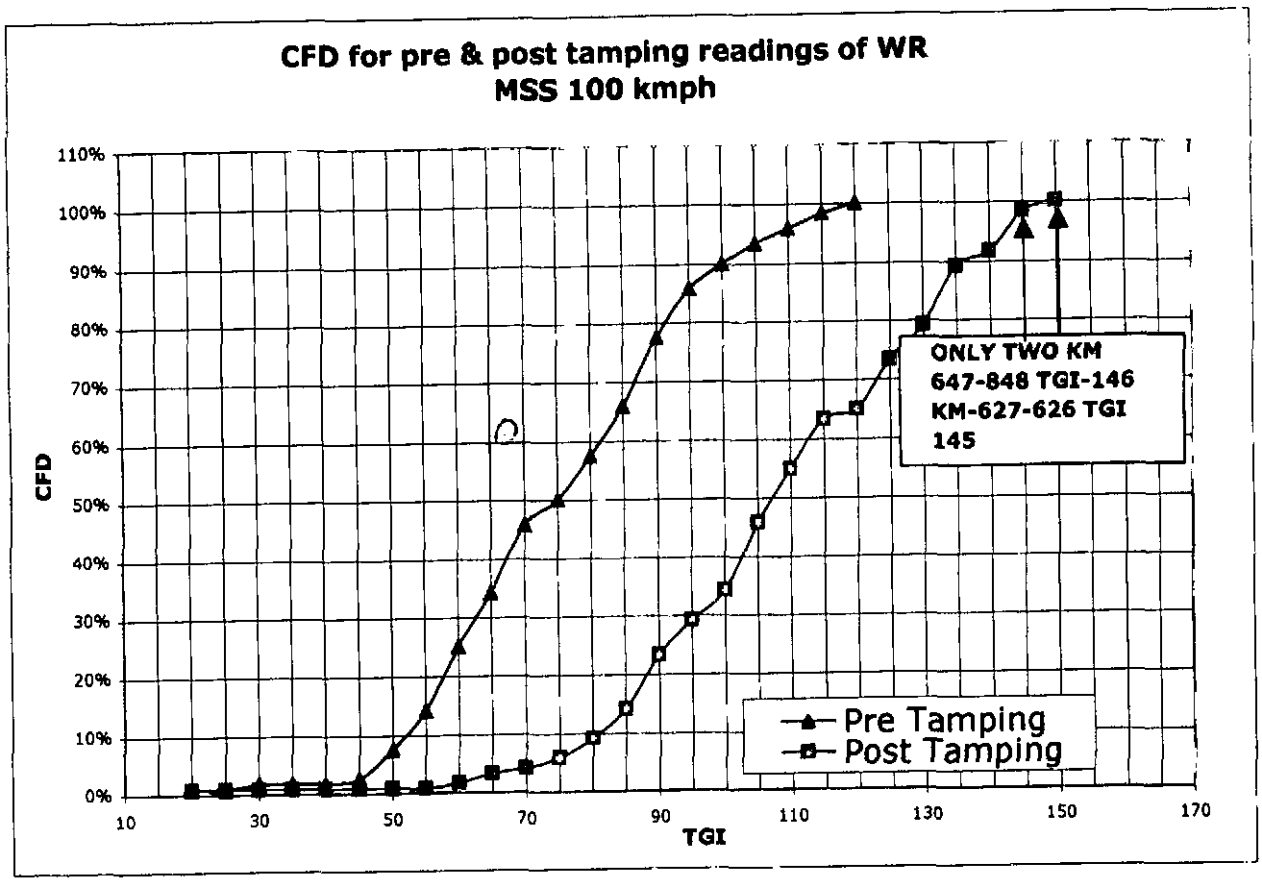
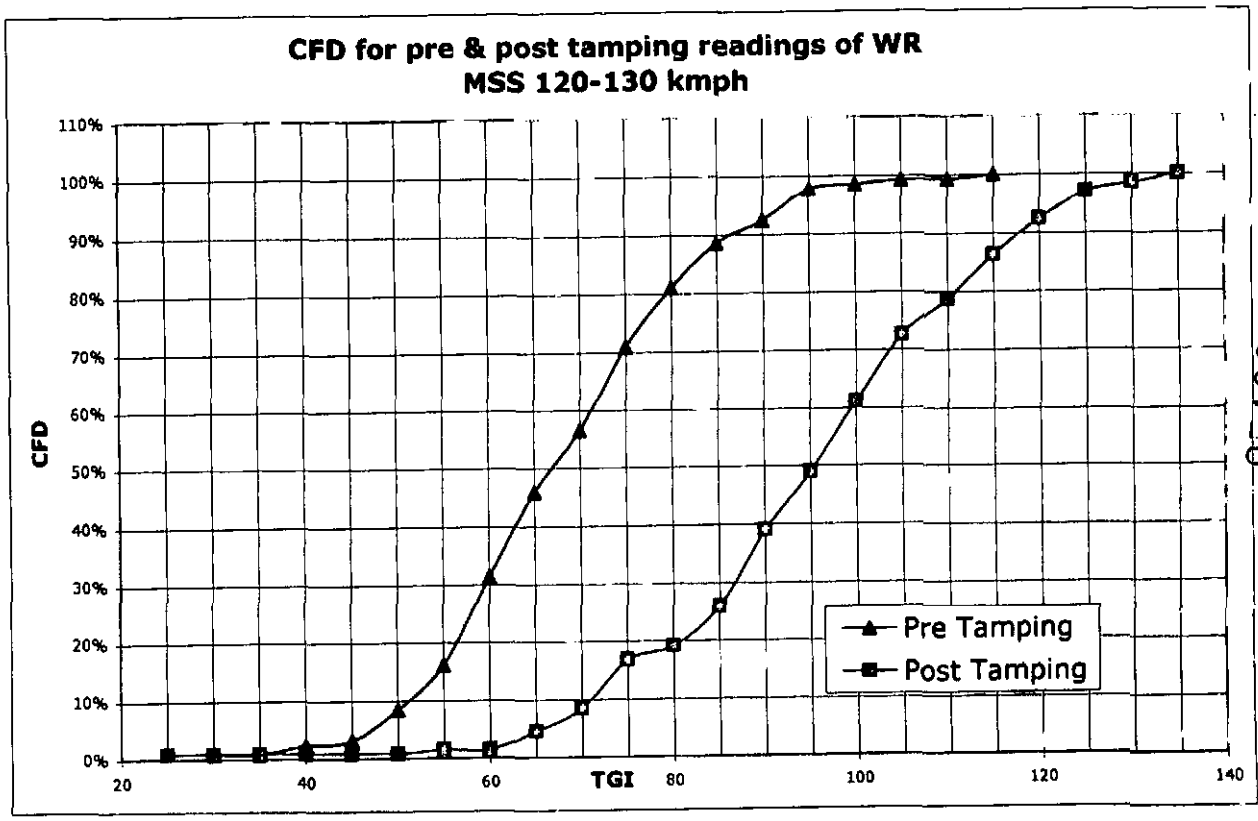
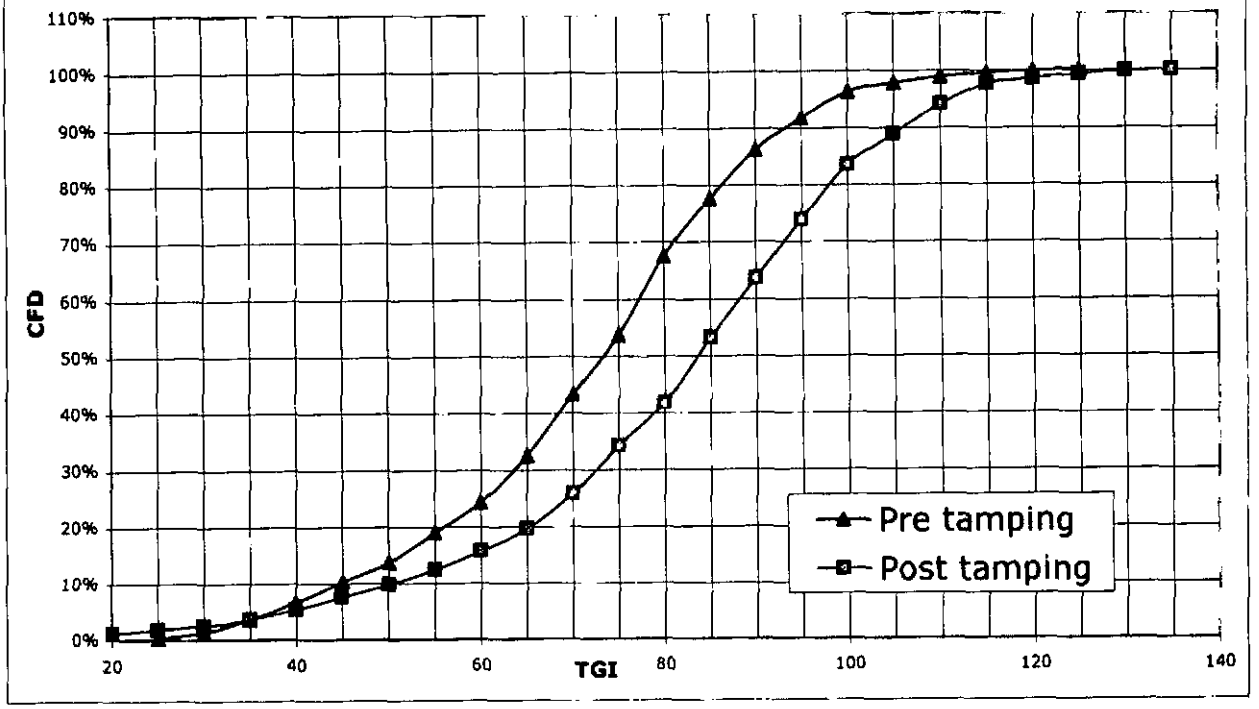

CFD for pre & post tamping readings of WR
MSS 100 kmph
CFD
TGI
ONLY TWO KM
647-848 TGI-146
KM-627-626 TGI
145
Pre Tamping
Post Tamping

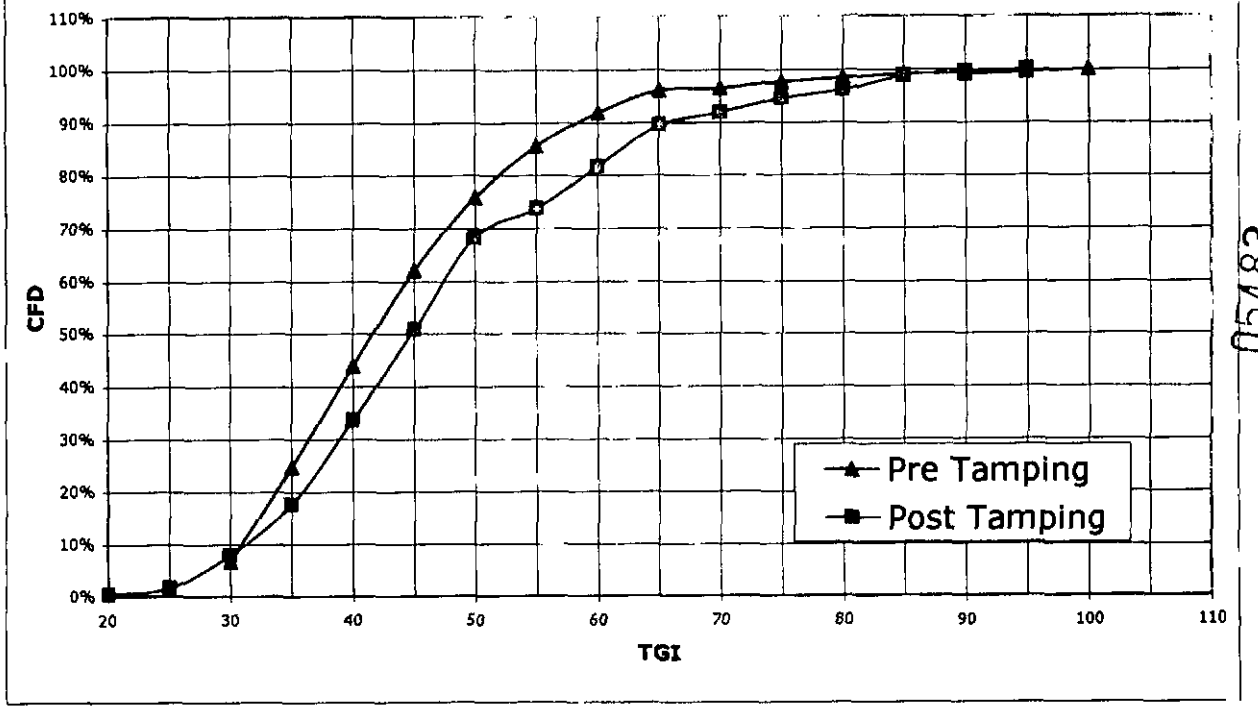

CFD for pre & post tamping readings of WR
MSS 120-130 kmph
CFD
TGI
Pre Tamping
Post Tamping

28450

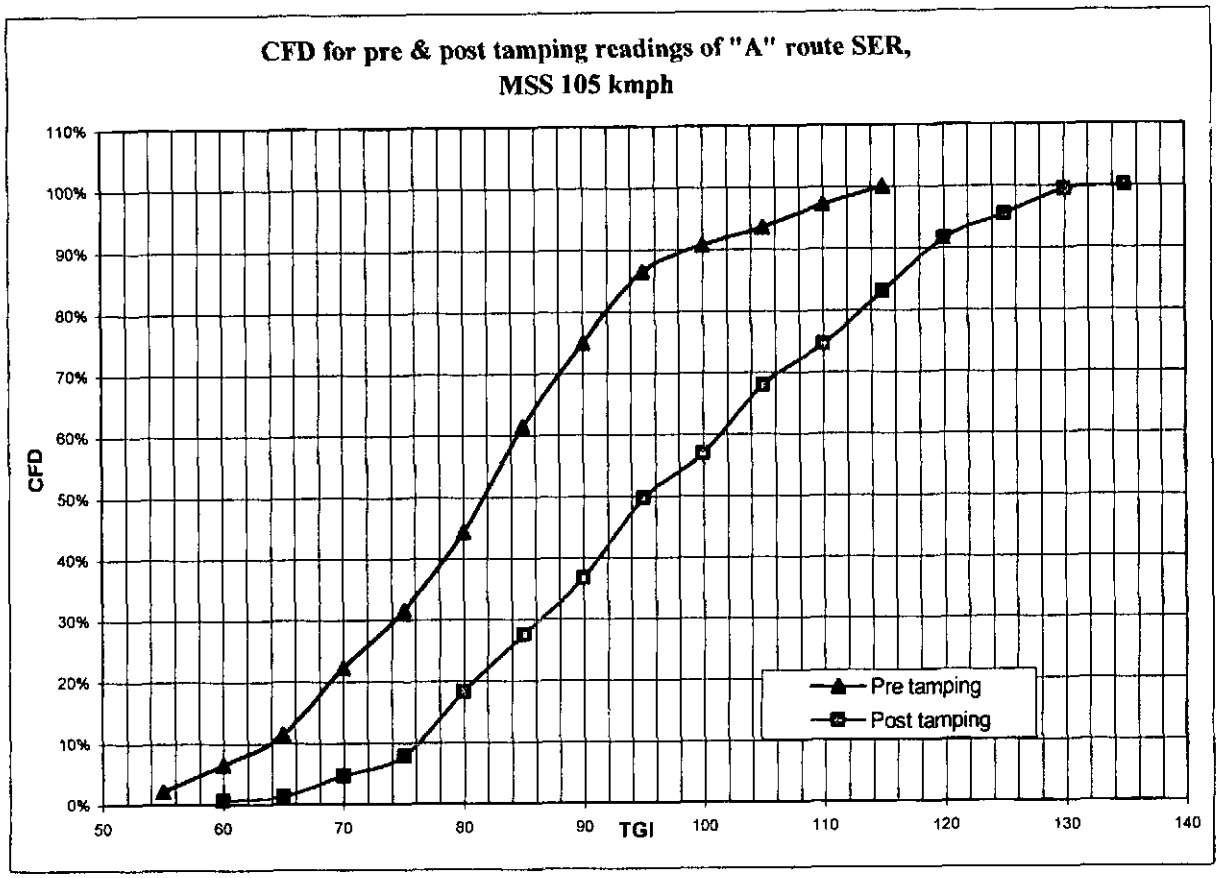
CFD for pre & post tamping readings on NER
(for PSC sleepers)MSS 100 kmph

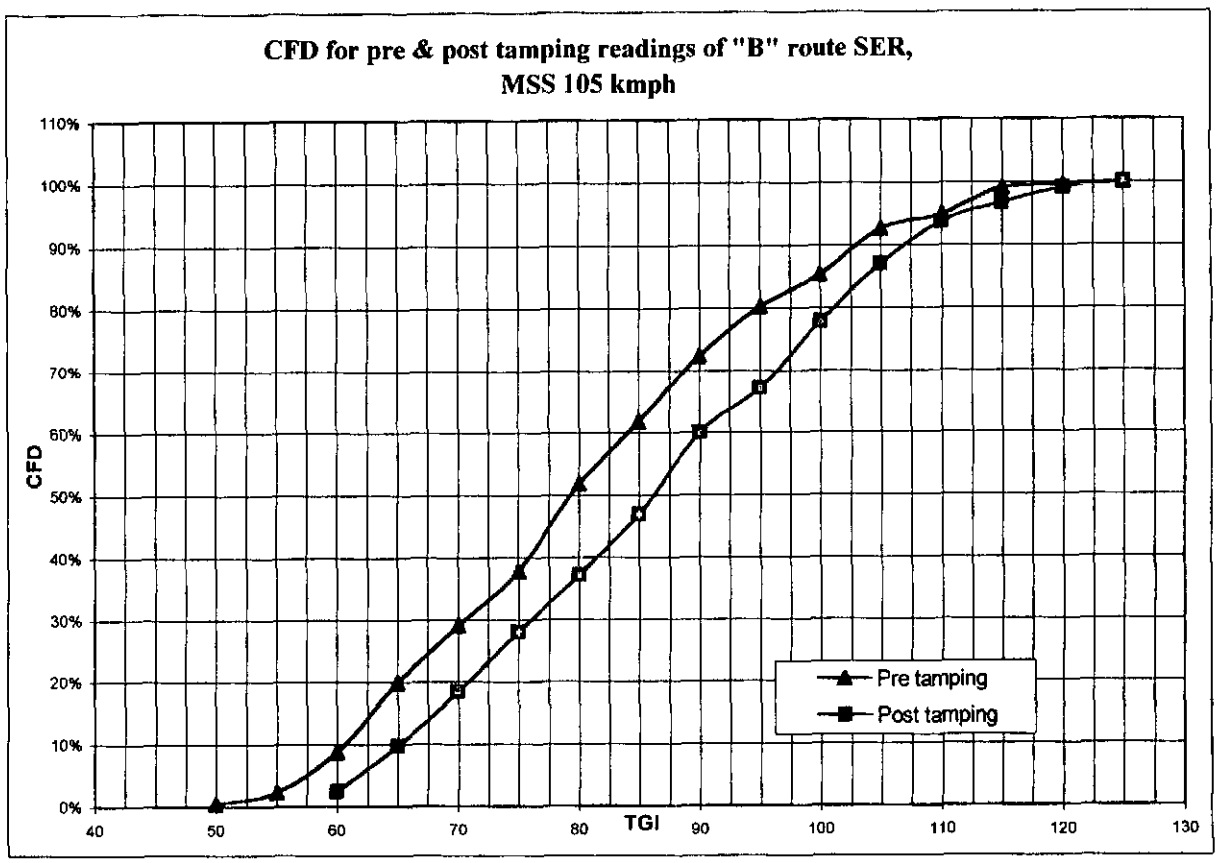


CFD for pre & post tamping readings on NER
(CST-9 sleepers) MSS 100 kmph



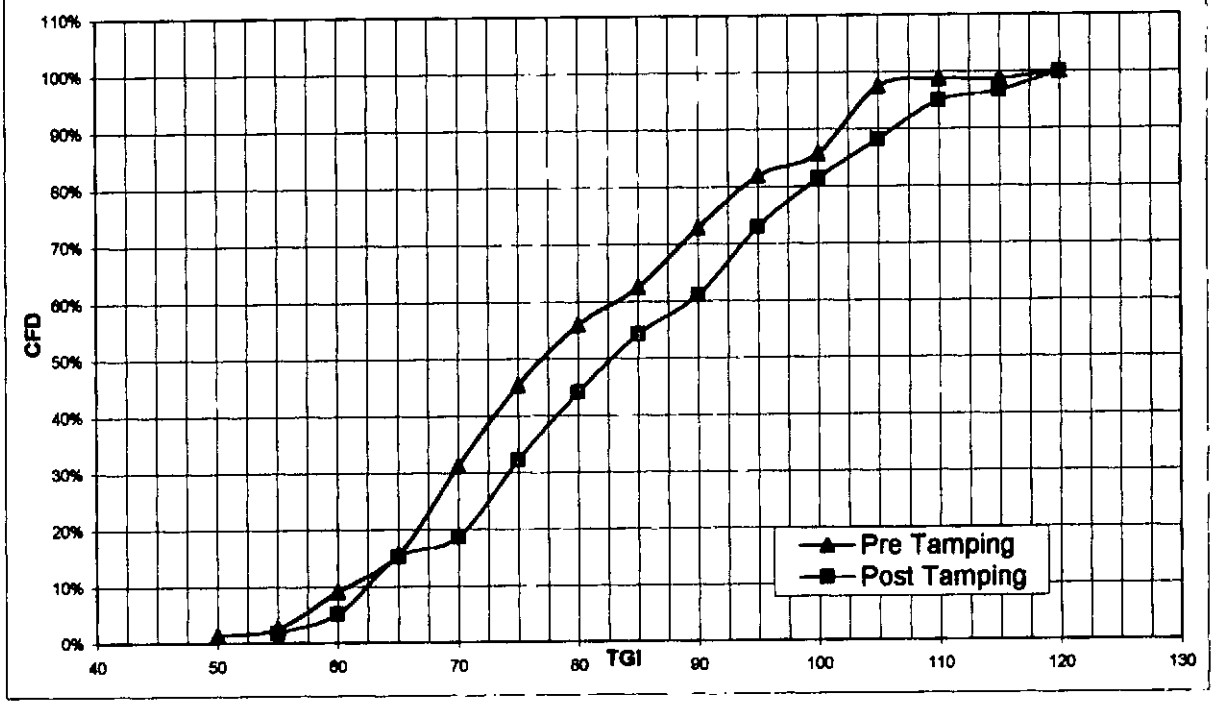
05483


CFD for pre & post tamping readings of "A" route SER,
MSS 105 kmph
CFD
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
50
60
70
80
90
TGI
100
110
120
130
140
Pre tamping
Post tamping

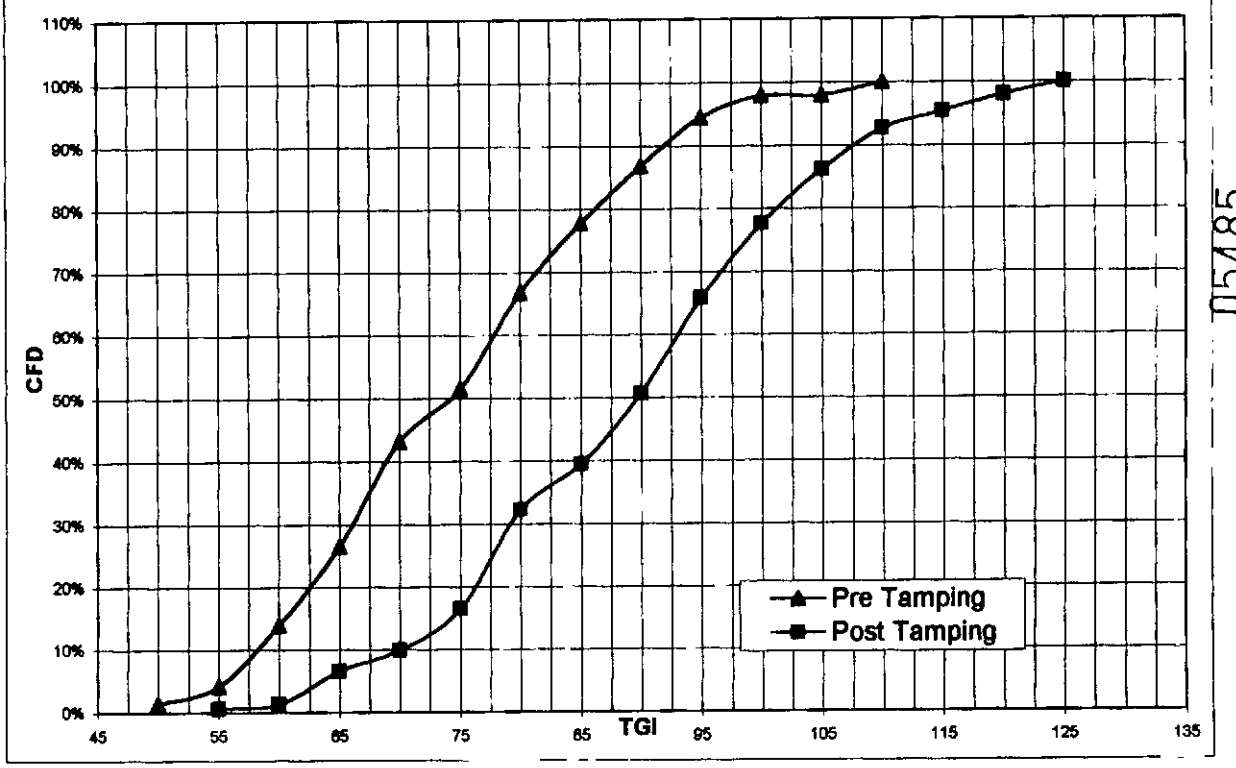

CFD for pre & post tamping readings of "B" route SER,
MSS 105 kmph
CFD
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
40
50
60
70
80
TGI
90
100
110
120
130
Pre tamping
Post tamping

05484

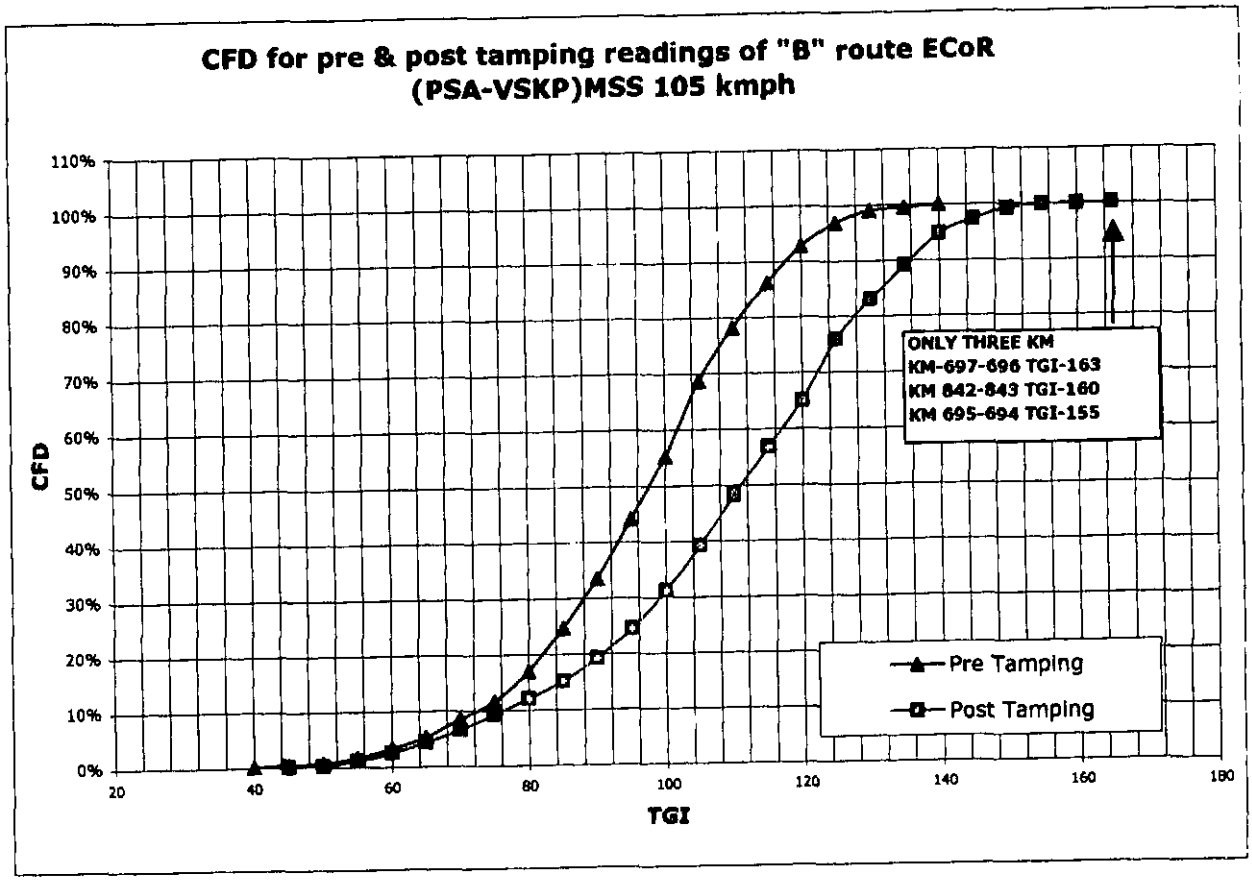
CFD for pre & post tamping readings of Bilaspur-Jharsuguda section of SECR (MSS 110 kmph)

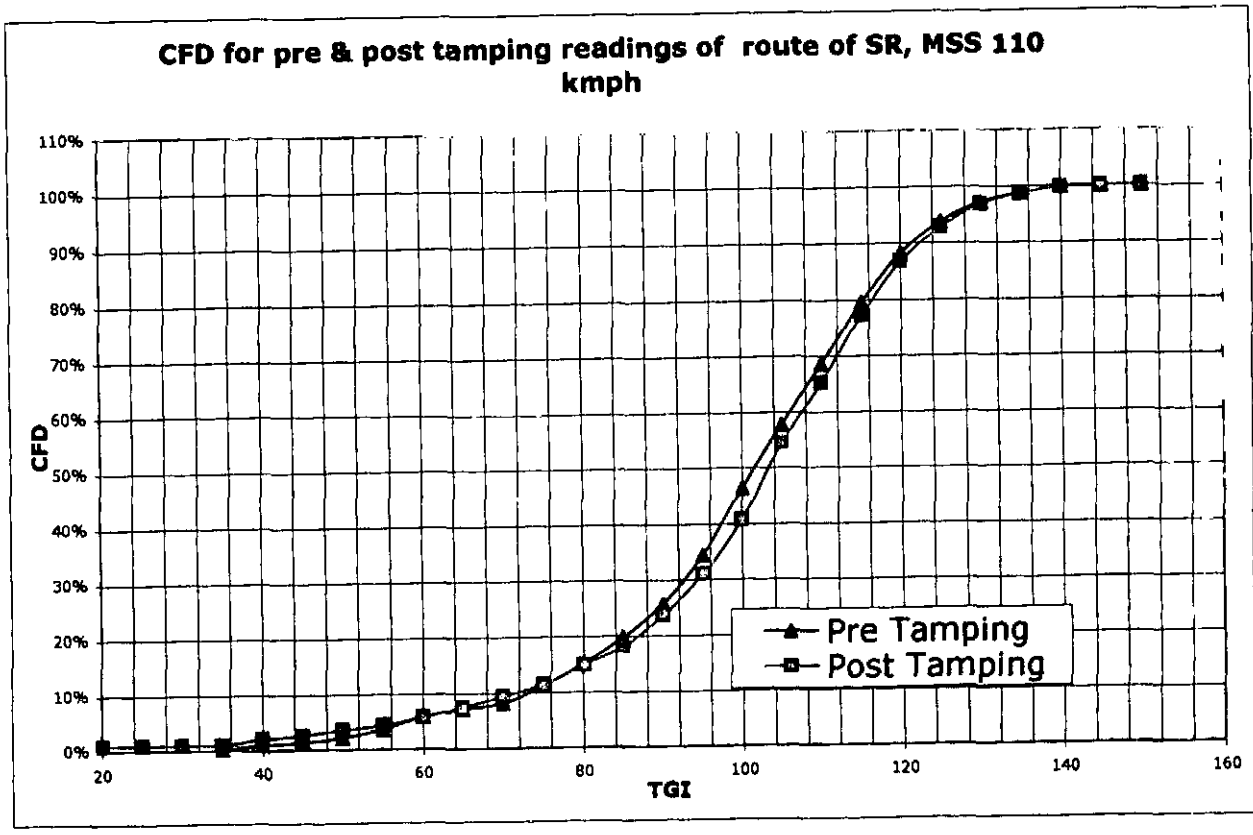


CFD for pre & post tamping readings of Bilaspur-Nagpur section of SECR (MSS 105 kmph)

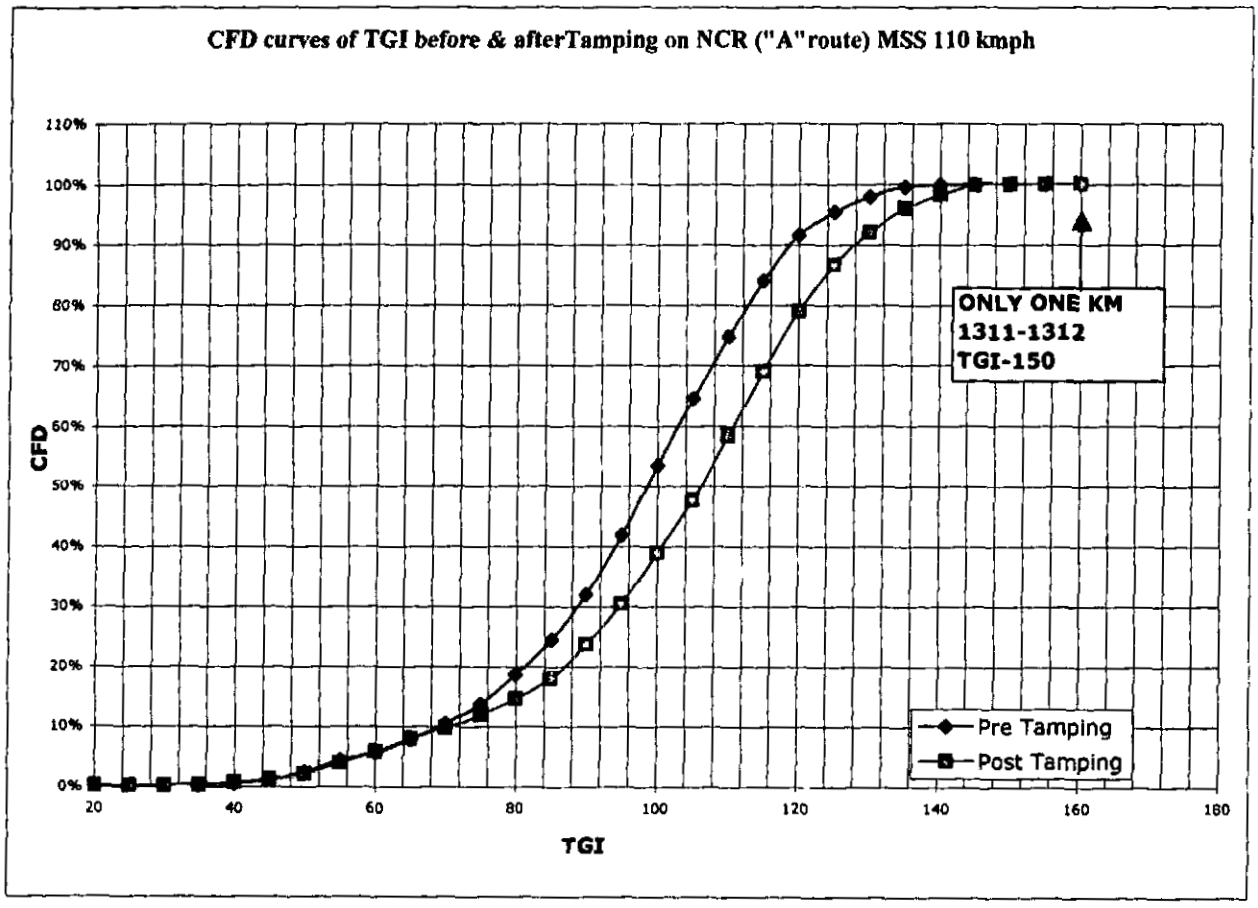


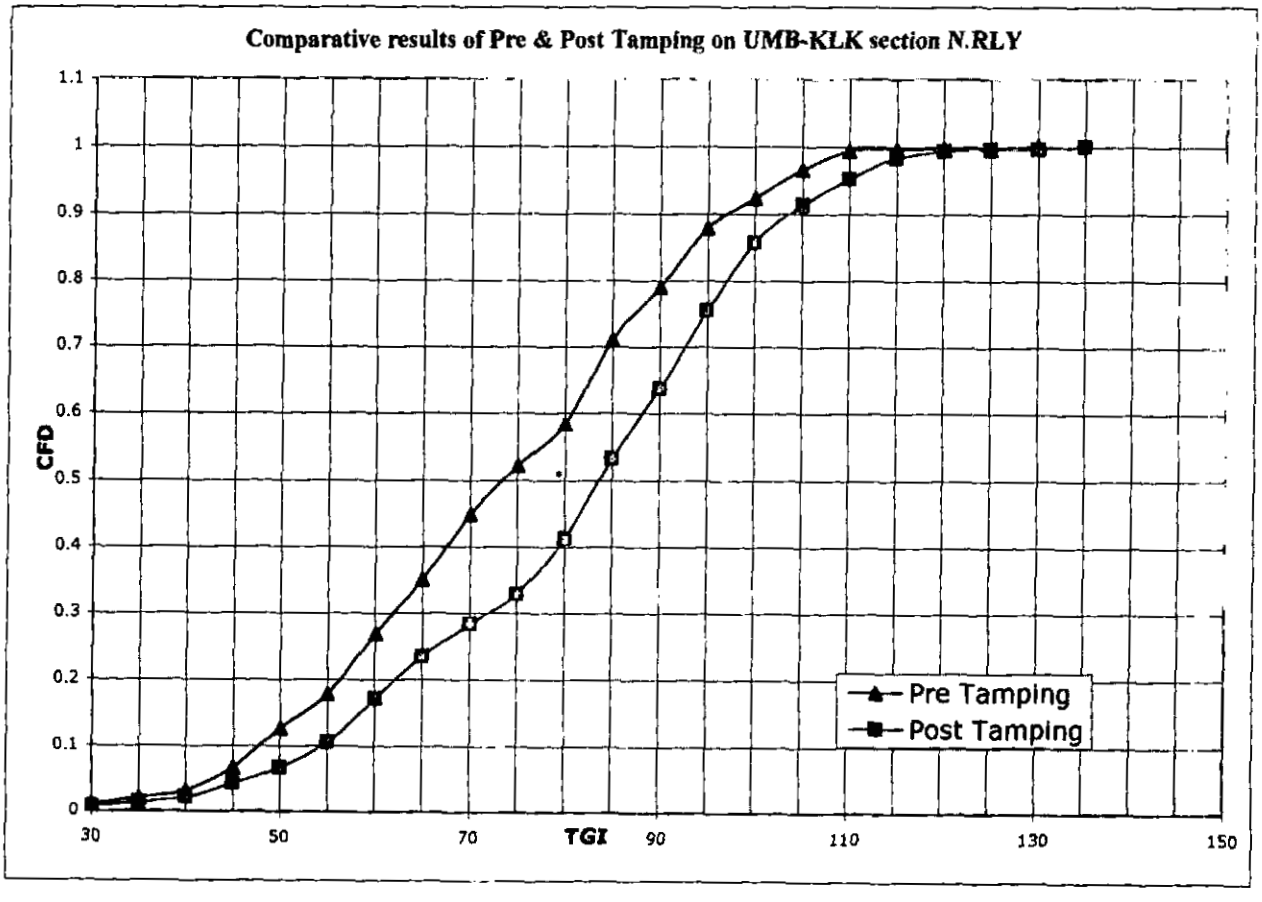
05485


CFD for pre & post tamping readings of "B" route ECoR (PSA-VSKP)MSS 105 kmph
CFD
TGI
ONLY THREE KM
KM-697-696 TGI-163
KM 842-843 TGI-160
KM 695-694 TGI-155
Pre Tamping
Post Tamping


CFD for pre & post tamping readings of route of SR, MSS 110 kmph
CFD
TGI
Pre Tamping
Post Tamping

05486


CFD curves of TGI before & afterTamping on NCR ("A"route) MSS 110 kmph
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CFD
20
40
60
80
100
120
140
160
180
TGI
ONLY ONE KM
1311-1312
TGI-150
Pre Tamping
Post Tamping


Comparative results of Pre & Post Tamping on UMB-KLK section N.RLY
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CFD
30
50
70
90
110
130
150
TGI
Pre Tamping
Post Tamping

05487

ACKNOWLEDGEMENT

This report has been prepared by Shri Ashish Bansal, DTM-IV under the guidance of Shri Vijay Sharma, EDTM. Sh S.N. Singh EDTM, Railway Board has provided useful inputs and guidance from time to time during the analysis of data and preparation of report and has also facilitated the collection of data from various Railways. Shri Virender Singh, SSRE/TM & Shri Sandeep Agarwal have rendered valuable help in the analysis of data and printing of report. Shri S.C. Sinha, ARE/TM/UG has been instrumental in collecting the data from Allahabad division and NWR.

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