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A Study on Dieselisation of Sibi-Khost Section with GEU-15 and GMU-15 Group-IV Diesel Locomotives

BY

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A STUDY ON DIESELISATION OF SIBI-KHOST SECTION WITH GEU-15 AND GMU-15 GROUP-IV DIESEL LOCOMOTIVES.

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SYNOPSIS

In the present day space era of spectacular scientific and technological innovations, speed up of existing operations of a Transport System is a MUST. Speed up on a Railway or a section of it is equally inevitable rather imperative for it to remain viable otherwise it will go out of business.

The speed up strategy on a Railway System essentially consists of:

(i) Increase of prevailing axle loads;
(ii) Increase of Direct Speed;
(iii) Increase of Indirect Speed.

The study under reference is an exercise towards speed up of operations on Sibi-Khost Section of the Pakistan Railways through the well-known mechanism of utilization of locomotives of not only a little higher axle loads but that of better technology as the existing XA class steam locomotives of Group V are to be replaced by GEU-15 and GMU-15 D.E. Class locomotives of Group IV. Besides, the maximum sectional speed is programmed to be raised from 40 KMH to 60 KMH.

Not surprisingly, all the above radical improvements have to be ploughed in by the famous methodology of "Increase of Maintenance Effort" rather than the choice of costly replacements of existing infrastructural elements involving major investments which Pakistan Railways can hardly afford under the prevailing financial crisis.

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1. INTRODUCTION

Most difficult Sibi-Khost terrain of Baluchistan is served by Railways only, there being virtually no roads. The Railway too degenerated over the years and lifted averagely 4 wagons a day from the entire section of 133 km length. Passenger services faired no good either. Of two passenger trains one remained cancelled throughout and the other ran 10 to 12 hours late with frequent failures. The agony of common man could be well imagined. It was under such trying circumstances that the following study was undertaken with a view to finding whether dependable though heavier axle load diesel locomotives with lesser rail bending moments rather than existing outmoded and unreliable though with lesser axle load but having greater rail bending moments XA class steam locomotives could be commissioned on this section for retrieving the situation. The study as would be seen has established that D.E. Locos of heavier axle load could safely be utilized for hauling heavier loads. Thanks to the keen interest evinced by the then Chairman, Railway Board Mr. Abul Kalam, the section has since been dieselised as from 21st October, 1982 after the acceptance of the recommendations of the study. Naturally as a consequence the people of the area and the Government of Baluchistan heaved a sigh of relief.

1.1 Track Features

Sibi Khost Section is 133 Kilometer long with a ruling gradient of 1 in 200 between Sibi-Nari and 1 in 42 between Nari-Khost and with the sharpest curve of 10 degree. The section between Sibi-Nari about 13 KMs is fit for Group-III locomotives while section from Nari to Khost is fit for Group-V locomotives. At present trains are run with XA class steam locomotives on this Section.

1.2 Load Limitations

Load of trains on Sibi-Khost Section with XA locomotives are indicated as under:

Section	Up direction
Sibi-Nari	30 wagons = 600 tonnes
Nari-Harnai	16 wagons = 220 tonnes
Harnai-Khost	12 wagons = 150 tonnes
	Down direction
Khost-Sharigh	20 wagons = 280 tonnes
Sharigh-Nari	20 wagons = 320 tonnes
Nari-Sibi	30 wagons = 600 tonnes

1.3 Speed and Restrictions

The maximum sectional speed between Sibi-Nari is 30 KMH and between Nari-Khost is 40 KMH. However, due to large number of permanent/temporary engineering speed restrictions, speed on Sibi-Khost Section varies from 15 KMH to 40 KMH.

1.4 Traction and Problems

Ten XA Class steam locomotives are based at Sibi for working passenger, goods, ballast and relief trains.

The average life of XA locomotives is about 55 years. In addition to their old age, the following factors have contributed to their deteriorated condition:

i) Shortage of steam maintenance staff.
ii) Poor workmanship of skilled and semi-skilled staff available for maintenance of steam locomotives.
iii) Muddy boiler feed water available throughout the section.
iv) Extreme weather conditions.
v) Short/Non-supply of material.

vi) Boiler steel fire box with steel tube plates and piece-welded and stretched boiler tubes, which are not allowed as per rules, have also now been allowed on locomotives working on this division.

1.5 Resultant Operational Difficulties

In view of the deteriorated condition of the XA class locomotives, the train operations, passenger and goods have been suffering a very serious setback resulting in;

a) Loss of heavy passenger and goods revenue. There is practically no competition from the road traffic on account of absence of any worth-while motor-way, therefore the carriage of all the goods including coal etc., and passengers is dependent on the Railway.

b) Lot of criticism from the public, provincial authorities and public sector corporations such as WPIDC etc.. is being faced on account of extremely unsatisfactory passenger and goods rail services.

c) Heavy expenditure is being incurred in the maintenance of various railway assets against very poor returns.

It may not be out of the way to furnish further information as under:

- During the year 1981-82 total earnings of Sibi-Khost section (excluding Sibi) was Rs.81,68,918/-. During the same year an average of 259 wagons were loaded monthly.
- 4,817 tonnes furnace oil costing Rs.62,51,310/- was consumed for running trains on Sibi-Khost section during 1981-82.

1.6 Objectives

1.6.1 Apparent but Unfeasible Solution

Under the circumstances, dieselization of Sibi-Khost section has remained under consideration of the Railway administration during the past to bring about radical improvement in the progressively deteriorating train operations on the section. The obvious and early solution has appeared to be the utilization of ALU-12 D.E. class locomotives belonging to Group V. The Quetta Division has been requesting for advance basing of 4 to 6 ALU-12 D.E. locomotives at Sibi to surmount the train operation difficulties mentioned above.

Due perhaps to various plausible reasons, the dieselization of Sibi-Khost section has not been considered feasible by basing of ALU-12/ALU-95 locomotives at Sibi.

1.6.2 Viable Goals

Instead the immediate solution has been alluded to be firstly the upgradation of Sibi-Khost section for operations with GEU-15 and GMU-15 D.E. locomotives falling in Group IV which are already touching Sibi shed. Secondly the maximum permissible sectional speed has to be raised from 40 to 60 KM per hour. All these improvements have to be introduced by intensifying the 'Maintenance Effort' in the realm of Track, Bridges and Rolling stock etc., without involving major investments to replace the various existing infrastructural elements.

1.7 Prospects

With the dieselization and increase of speed on Sibi-Khost Section, it is expected that the earnings will increase considerably in addition to improving punctuality of passenger trains on the Section.

2. TECHNICAL APPRAISAL FOR UPGRADATION OF SECTION FOR OPERATION OF GEU-15 AND GMU-15 D.E. CLASS LOCOMOTIVES AND INCREASE OF SECTIONAL SPEED FROM 40 TO 60 KMH.

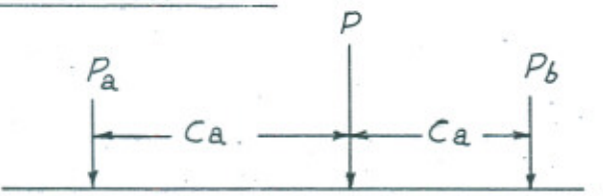
2.1 Design Convention

The most critical aspect from the traditional view point towards design of a rail section and track as a composite unit has been the determination of rail bending moments caused by vertical loads including their dynamic effect when in motion. Several types of calculations which comply with these demands exist on almost all the technically advanced railways of the world which have been progressively revised with the passage of time after making extensive trials, experiments and technical research. Had this been not the case then the French National Railways (S.N.C.F) would not have accomplished the feat of attaining a speed of 330 KMH on existing ordinary tracks as early as in 1955, notwithstanding the fact that these very ordinary tracks during the earlier construction days had been designed to take speeds of the order of 100 KMH or so only which speeds were prevalent on most of the so-called advanced Railways of the world prior to Second World War. Unfortunately Pakistan Railways have lagged far behind in this vital aspect of revising its mechanism of relevant Design Code and strategy most probably for lack of meaningful research activities. Pakistan Railways are still following very faithfully the Design Code for track structure design evolved on the Indian Railways during twenties and even earlier. Such postulations no longer hold good as confirmed by the plying of higher axle loads accompanied by higher speeds on the existing networks on many of the advanced railways of the world including Indian Railways, by improving the track and rolling stock maintenance effort quantitatively and qualitatively without major investments.

2.2 Current Situation

Most current practices for calculation of rail bending stresses under moving vertical railway axle loads have been devised on the West German Railways (D.B). Incidentally Japanese National Railways Experts deputed under United Nations ESCAP aegis to study upgradation of Tehran-Mashed Section of Iranian State Railways for increase of speed from 95 KMH to 120 KMH had also adopted the German practice in 1971-72 to analyse the adequacy of the existing Rail and Track structure from design consideration aspect. Furthermore Pakistan Railways design of mono-block prestressed concrete sleeper being manufactured in Sukkur Sleeper Factory and that of 100 lbs Rail section had been adopted keeping in view the West German Railways relevant design practices.

2.3 Design Considerations



Wheel loads and load distances
(decisive load P)

2.3.1 Formula

In accordance with the West German Railways practice, the maximum bending moment of the rail under a stationary single load is determined by the formula.

$$M_p = K. P. a$$

2.3.2 Description and Assumptions

In this formula K is the co-efficient of the wheel base, which is decided by the influence of the two adjacent axles P_a and P_b (shown in the fig.) on the bending moment under the central wheel P.a is the spacing of the sleepers. It is, however, reasonably presumed that this

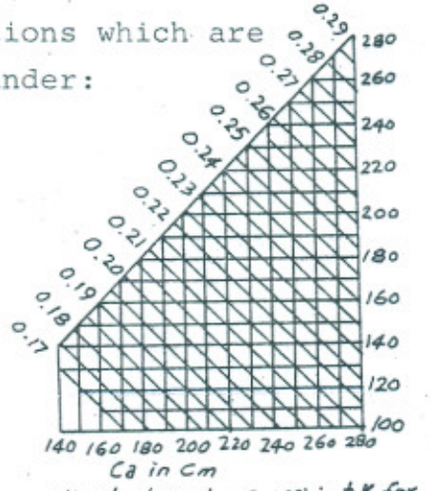
influence is small compared with the load P and because the adjacent loads P_a & P_b differ slightly from P thus causing no perceptible inaccuracy in actual results. Moreover, the influence of further distant loads beyond P_a and P_b is considered to be very insignificant and stands disregarded. The co-efficient of the wheel base K depends on the mean wheel base viz C mean $= \frac{C_a + C_b}{2}$ (All values in Cm). In the worst critical case when C_a and C_b are both $\geq$ = 280 Cm then Cmeans effect is never greater than 280 Cm. In this situation the single load case materializes and the adjacent loads are so far separated from P that they no longer perceptibly influence the bending moment at P resulting in the maximum bending moment created under this single load condition when the value of K also stands at its maximum of 0.290.

All other conditions of loads and wheel spacings (C_a & C_b) varying from case to case depending upon different types of locomotives and Rolling stock the values of K are derived from a number of sets of equations which are represented through a graph shown as under:

(i) For $C_a < 280$ Cm and
$C_b < 280$ Cm (Centre load),
$K = 0.057 + \frac{C_a + C_b}{2400}$

(ii) For $C_a \geq 280$ Cm and
$C_b < 280$ Cm (End load)
$K = 0.174 + \frac{C_b}{2400}$

(iii) For $C_a \geq 280$ Cm and
$C_b \geq 280$ Cm (single load)
$K = 0.290$ (Maximum attainable)



(b) Wheel spacing Coefficient K for given load distance Ca and Cm.

3. COMPARATIVE STUDY OF MAXIMUM RAIL BENDING MOMENTS UNDER AXLE LOAD GROUPS OF XA, GEU-15 & GMU-15 LOCOMOTIVES.

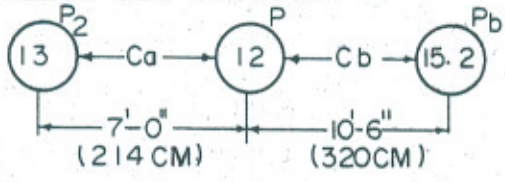
Let us now perform an actual check based on the Design considerations stated in para 2.3 above in respect of the above-mentioned three locomotives.

3.1 XA Class Steam Locomotive

The various axle loads and wheel spacing arrangements of this locomotive may please be referred to figure 1 mentioned at page-82.

It may be feasible to analyse different situations to arrive at the most critical and worst case under which maximum Rail Bending Moments are created.

3.1.1 Case -1

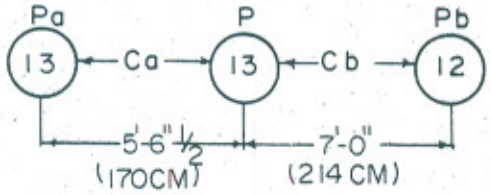


From Graph Page 68
K = 0.264

So, $M = 0.264 \times \frac{12}{2} \cdot a$

$= 1.584\ a$ Tonnes Cm

3.1.2 Case-2

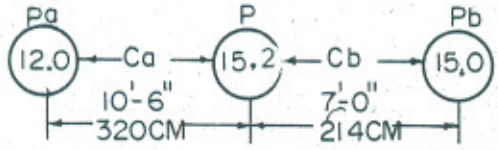


$K = 0.057 + \frac{C_a + C_b}{2400}$ (Equation for Centre load when Ca < 280 Cm & Cb < 280 Cm)

$= 0.217$

So $M = 0.217 \times \frac{13}{2} \cdot a = 1.41\ a$ Tonnes Cm

3.1.3 Case-3

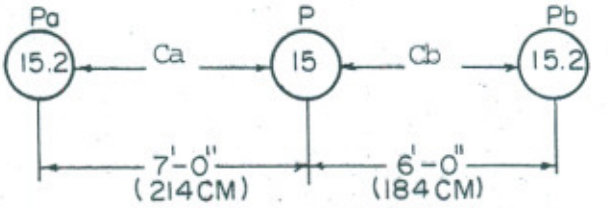


$K = 0.174 + \frac{C_b}{2400} = 0.174 + \frac{214}{2400}$ (Equation for end load when Ca > 280 Cm and Cb < 280 Cm)

$= 0.264$

So $M = 0.264 \times \frac{15.2}{2} \cdot a = 2.0064\ a$ Tonnes Cm

3.1.4 Case-4



$$K = 0.057 + \frac{Ca + Cb}{2400} = 0.057 + \frac{214 + 184}{2400} = 0.223$$

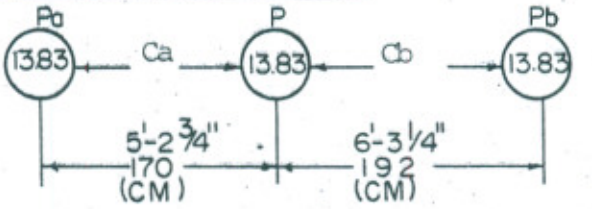
(Equation for centre load when Ca is $<$ 280 Cm and Cb is $<$ 280 Cm)

So $M = 0.223 \times \frac{15}{2} a = 1.6725\ a$ Tonnes Cm.

3.1.5 Result It will be seen that Case-3 is the worst and produces the maximum rail bending moment of 2.0064 a Tonnes Cm. Therefore Max. rail Bending moments for XA class locomotive are 2.0064 a Tonnes Cm.

3.2 GEU-15 D.E. Class Locomotive

3.2.1 Case-I

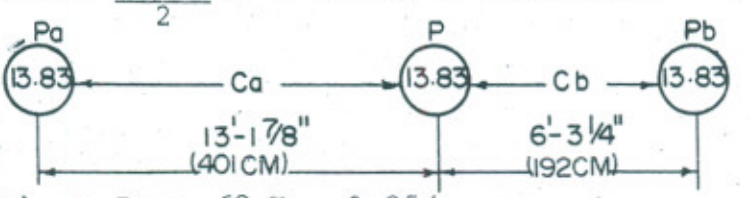


$$K = 0.057 + \frac{Ca + Cb}{2400} = 0.057 + \frac{192 + 170}{2400} = 0.208$$

Equation for Centre load when Ca is $<$ 280 Cm and Cb is $<$ 280 Cm

So $M = 0.208 \times \frac{13.83}{2} a = 1.4498\ a$ Tonnes Cm

3.2.2 Case-2



From Graph on Page 68 K = 0.254

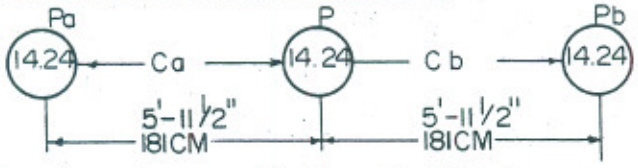
So $M = 0.254 \times \frac{13.83}{2} a = 1.7577\ a$ Tonnes Cm

3.2.3 Result It may be noticed that Case-2 is the worst

and produces the maximum rail bending moment of 1.7577 a Tonnes CM Therefore Max. rail Bending moments for GEU-15 D.E. class locomotive are 1.7577 a Tonnes Cm.

3.3 GMU-15 D.E. Class Locomotive

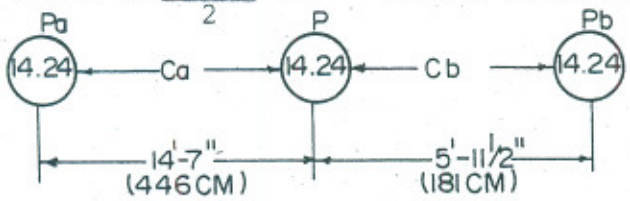
3.3.1 Case-I



From Graph on page 68 K = 0.205

So M = 0.205 x $\frac{14.24}{2}$ .a = 1.4596 a Tonnes Cm.

3.3.2 Case-2



From Graph on Page 68 and as well as from equation $K = 0.174 + \frac{Cb}{2400} = 0.174 + \frac{181}{2400}$

$K = 0.249$

So M = 0.249 x $\frac{14.24}{2}$ .a = 1.7787 a Tonnes Cm.

3.3.3 Result It may be evident that Case 2 is the worst and produces the maximum rail bending moment of 1.7787 a Tonnes Cm.

Therefore Max. rail Bending moments for GMU-15 D.E. class locomotive are 1.7787 a Tonnes Cm.

3.4 Conclusion

The comparative study of Maximum rail bending moments produced made in the foregoing pages indicates the results as under:

S.No.	Class of Locomotive	Worst Case	Max. rail Bending Moment produced	
1	2	3	4	
			Tonnes	Cm
1	XA Steam Locomotive Group V.	Case-3	2.0064	a
2	GEU-15 D.E. Class Locomotive Group IV	Case-2	1.7577	a
3	GMU-15 D.E. Class Locomotive Group IV	Case-2	1.7787	a

It is revealed from the above comparative table that XA Steam Locomotive though belonging to Group V produces maximum rail bending moments greater than both the GEU-15 D.E. class and GMU-15 Class D.E. locomotives belonging to Group IV.

Hence it is reasonably concluded that working of trains with GEU-15 D.E. class and GMU-15 class locomotives on Sibi-Khost section will be safe from the standpoint of technical considerations and operational as well. Effects on Track, Bridges and other structures are expected not to be aggravated than those produced by the operation of XA Class steam locomotives at present.

4. SPEED INCREASE CHECK

4.1 Scope

After concluding that GEU-15 D.E. and GMU-15 D.E. class locomotives can be safely plied on Sibi-Khost section at the prevailing maximum permissible sectional speed of 40 KMH, it is worthwhile to perform a check as to to what extent this speed limit can be raised with these locomotives in future.

4.2 Dynamic Effect

4.2.1 Description

In the foregoing pages, the maximum rail bending moments have been calculated for various stationary axle load groups. It is universally acknowledged that when a wheel is in motion, it aggravates the stress position still further and increases the amount of rail bending moments.. The increased effect is known variously as dynamic effect, impact factor and speed co-efficient etc. This is generally expressed in percentage factor to be multiplied with static wheel load to get the additional load to be added to the stationary wheel load to obtain the maximum rail bending moment. The equation for rail bending moments expressed on page 68 becomes as under:

$M = K.P.\ a.\ \mathcal{L}$ where $\mathcal{L}$ is the speed co-efficient always more than 1 for utilization in this equation.

4.2.2 Values adopted on Various Railway Systems

Different advanced Railway Systems prescribe various values of $\mathcal{L}$ and a few of these are quoted as under:

a) Indian Railways alongwith Pakistan Railways account for the speed factor as per provision of Technical Paper 245 of 1925 on the subject. Some of the values are reproduced below:

Speed KM/H	Speed fact or as per provisions of Technical Paper 245 (1925) of percentage increase over nominal wheel load.		$\mathcal{L}$	
	Track Module 75 kg/Cm²	Track Module 110 kg/Cm²	Track Module 75 kg/C	Track Module 110 kg/C
1	2	3	4	5
41	26.8	21.2	1.268	1.212
72	47.1	37.3	1.471	1.373

1	2	3	4	5
101	66.0	52.3	1.660	1.523
116	75.8	60.1	1.758	1.601
131	86.6	67.8	1.806	1.678
139	90.8	72.0	1.908	1.720

The Indian Railways, however, have modified the above values after extensive research and trials on the Mughal-Sarai-Allahabad section which culminated in the running of famous "Rajdhani Express" in 1969 at a commercial speed of 120 KMH against the test/trial speed of 150 KMH.

The speed factor adopted now by them with WDM-4 D.E. locomotive is as under:

Speed KM/H	Speed factor as percentage increase on nominal wheel load as observed for WDM-4 D.E. locomotive.	L
41	21.8	1.218
72	28.0	1.280
101	39.8	1.398
116	45.0	1.450
131	44.3	1.443
139	49.6	1.496

It may be observed from the above table that when the track is well maintained to specified track - geometry parameters the speed factor is considerably reduced.

b) On the Belgian National Railways, following are the table values used normally for co-efficient of speed:

Speed KM/H	Co-efficient of Speed $\mathcal{L}$
60	1.05
70	1.10
90	1.15
100	1.25
120	1.35
140	1.45

c) On the West German Railways the table values used for co-efficient of speed are as under:

V in KM/H	$\mathcal{L}$	V in KMH	$\mathcal{L}$	V in KMH	$\mathcal{L}$
0	1.000	65	1.148	125	1.410
5	1.001	70	1.170	130	1.431
10	1.004	75	1.190	135	1.451
15	1.010	80	1.211	140	1.470
20	1.017	85	1.233	145	1.488
25	1.026	90	1.255	150	1.506
30	1.036	95	1.278	155	1.523
35	1.049	100	1.300	160	1.538
40.	1.062	105	1.322	170	1.564
45	1.077	110	1.345	180	1.583
50	1.094	115	1.368	190	1.592
60	1.111	120	1.389	200	1.600

It may be observed that speed co-efficient values of Belgian and West German Railways are even lesser than those adopted by Indian Railways in 1969 towards the running of Rajdhani Express.

4.3 Conclusion

It may reasonably be concluded from the foregoing to adopt speed factor values obtained by Indian Railways during tests/trials of Rajdhani Express for increase of speed on Sibi-Khost section. In order to increase speed

from 60 KMH from 40 KMH let us see the difference of speed factors.

According to Technical Paper 245 of 1925 the designed speed factor for a speed of 41 KMH = 26.8% whereas the speed factor in case of Rajdhani Express of Indian Railways in 1969 for a speed of 60 KMH = $21.8 + \frac{(28.0-21.8)}{72-41} \times (60 - 41) \times \frac{1}{100}$

$= 21.8 + 6.8 = 28.6\%$

Thus against the designed speed factor of 26.8% for a speed of 41 KMH, the speed factor for proposed speed of 60 KMH comes to 28.6% which is 28.6 - 26.8 = 1.8% more, the excess being just 7% which can be easily ignored and the increased speed of 60 KMH can be permitted provided tracks are well maintained to specified track geometry parameters.

If, however, we take into account the speed factors of Belgian and West German Railways, the then P.R. speed factor viz 26.8% for 41 KMH is more than sufficient for speeds of 60 KMH when compared with Belgian Railways of 5% and West German Railways of 11.1%. Hence speed of 60 KMH on Sibi-Khost Section with GEU-15 and GMU-15 D.E. class locomotives can be permitted safely.

5. RECOMMENDATIONS

5.1 Phase I - Dieselization of Sibi-Khost Section

5.1.1 Stage I - Induction of GEU-15 and GMU-15 for haulage of Passenger and Goods Traffic on Sibi-Khost Section.

5.1.1.1 To begin with GEU-15 and GMU-15 diesel electric locomotives shall start hauling passenger and goods trains between Sibi-Khost replacing old XA class steam locomotives subject to the augmentation of Track, Bridges and other structures maintenance effort as under:

a) Track maintenance labour alongwith complement of gang tools, equipment and various imprests will be increased by 20% on trial basis for one year initially which position will be reviewed afterwards with a view to either enhancing or reducing this percentage increase based on actual experience and results gained during the year.

b) Ultrasonic Testing of Rails

All rails on the section will be ultrasonically checked prior to introduction of dieselization and all seriously flawed rails will be replaced. Subsequently such checks will be performed periodically in a planned manner.

c) Wear Checking of Rails

All rails especially in sharp curves will be checked for wear. Rails especially in sharp curves worn beyond 5% in weight and or exceeding wear limits in respect of Table, side and combinedly as prescribed in Way and Works Manual will be replaced.

d) All major bridges will be kept under strict watch and observation. The existing speed restrictions will continue and if considered necessary both by Bridge Branch and Divisional Way and Works Branch, the same can be intensified for the trial period of one year.

e) On some selected bridges the Bridge Branch will carry out tests and trials for measuring stresses, deflections and distortions etc., for which necessary instrumentation will be done by the Bridge Branch.

f) Maintenance efforts for other structures, embankments and protection works will be intensified by making full use of the current revenue budgetary allocations. If considered necessary, the Divisional Way and Works Branch during the trial period of one year may allocate more funds by giving preference to the section remaining, however, within the overall divisional allotment of funds in this category.

5.1.2 Stage II

Action Plan will be initiated to undertake improvement works in respect of Track, Bridges and other structures during the trial period as under:

5.1.2.1 Bridges

Track on all major bridges will be welded by providing suitably designed expansion joints and/or switches on the approaches to adequately cater for the expansion. The welding of track on the bridges will be simultaneously accompanied by the provision of suitable fittings and fastenings of track as per specified international standards and regulations on the subject to avoid stress and distortion of bridge girders/structures avoiding buckles and breakages of track components at the same time. It will be desirable to undertake experiments and trials on a couple of bridges before undertaking the welding work on all the major bridges to gain useful experience.

5.1.2.2 T r a c k

a) Check-railing will be provided on the following curves where these do not exist at present:

Curve No.	KM From	KM To	Degree
67	42/-	42/6	8
74	44/5	44/7-8	8
75	44/7-8	45/6	8
100	56/1	56/6	9.02
104	57/7	57/10	9.02

b) Joint levelling and dehogging operations will be introduced throughout the section. The defects in levels (low joints) including hogging effect are to be measured generally by a rule called "Funicular Rule". The Funicular Rule normally used should be 3.80 meter long or 2.00 meter long depending on the sleeper spacing. Detailed application of Funicular Rule should be studied from the Book "Introduction of Modern Practices of Track Maintenance/ Construction Pakistan Railways (Vol.I)" written by Engr. Mian Ghias-ud-Din and published by Walton Training School.

c) Special maintenance effort for Rail joints will be mounted on the entire section. Necessary application of this effort will be introduced in accordance with the methodology explained in the Book referred to in Para (b) above.

5.2 Phase-II Increase of Maximum Sectional Speed From 40 to 60 KMH.

5.2.1 Improvement of Maintenance Effort

In order to increase the maximum permissible speed of the section to 60 KMH, Maintenance Works in respect of track and other structures will have to be improved generally and in particular carried out as under:

a) Realignment and redesigning of each and every curve will have to be undertaken to make it fit for the increased speed of 60 KMH. Special attention will have to be devoted to the aspects of super-elevation, deficiency of cant and transition etc.

b) Obstructed View and Boulder Falling on Line

In view of the better braking power of the GEU-15 and GMU-15 locomotives, no difficulty or hazard is expected to be faced at the increased speed. However, Divisional Way and Works Branch should prepare a scheme to be carried out in phases to improve the view and also to remove the precariously hanging boulders and rocks.

c) Outstanding Track Renewals should be completed by making efforts at War footing level.

d) Pending and overdue protection works and cleaning operations of Catch Water drains should be executed by making special efforts.

Epilogue: The above study has since been approved and accepted by the Railway Board. As a result Sibi-Khost section has since been dieselized with GEU-15 and GMU-15 diesel locomotives and the train services have been restored with 100% achievements.

References:

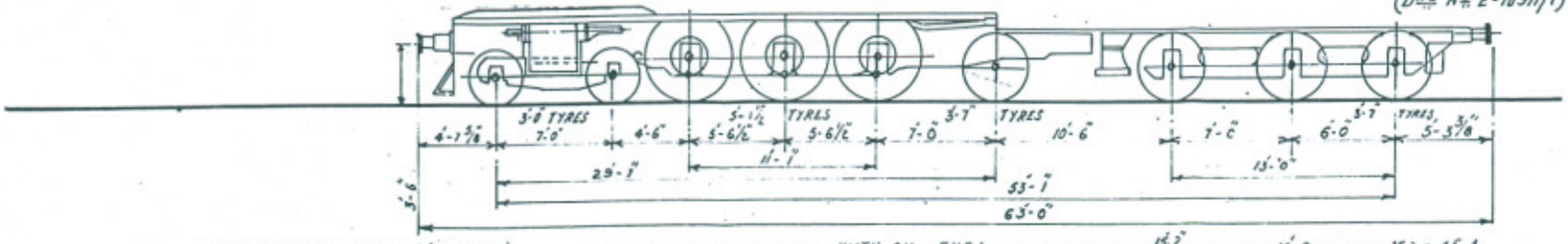
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LIST OF FIGURES

Figure No.	T i t l e
I	Drawing showing Class X A Engine indicating Axle Load and Wheel Spacing. (Drawing No.1)
	Drawing showing Class DE Engine Indicating Axle Load and Wheel Spacing (GEU-15) (Drawing No.40)
	Drawing showing Class DE Engine indicating Axle Load and Wheel Spacing (GMU-15) (Drawing No.45)

CLASS X A ENGINE INDICATING AXLE LOAD & WHEEL SPACING

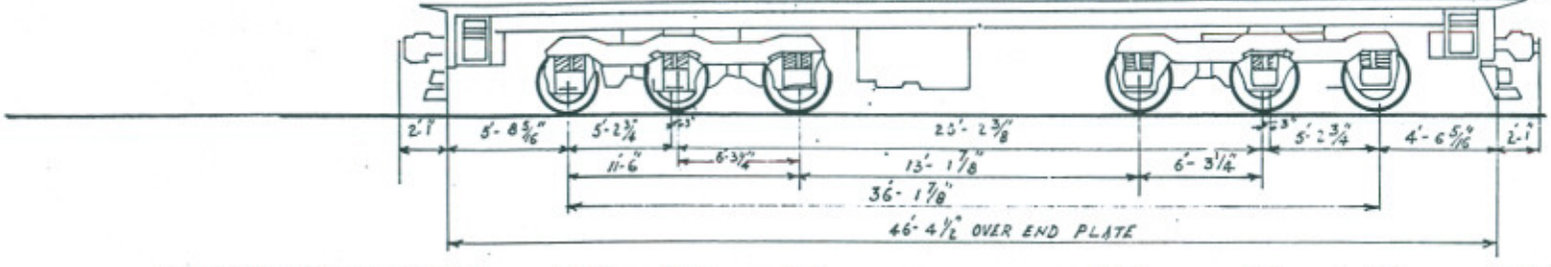
DIAG: No. 1
(Drg. No. E-18911/1)



WEIGHT IN WORKING ORDER (IN TONS)	WITH OIL FUEL	15'-2"	15'-0"	15.2 = 45.4
WEIGHT IN WORKING ORDER (IN TONS)	15.6	13	13	13	12	14.1	14.35	14.1 = 108.85
WEIGHT EMPTY (IN TONS)	15.1	11.8	12	12	10.45	7.88	6.74	6.8 = 82.77

CLASS D.E ENGINE INDICATING AXLE LOAD & WHEEL SPACING (GEU-15)

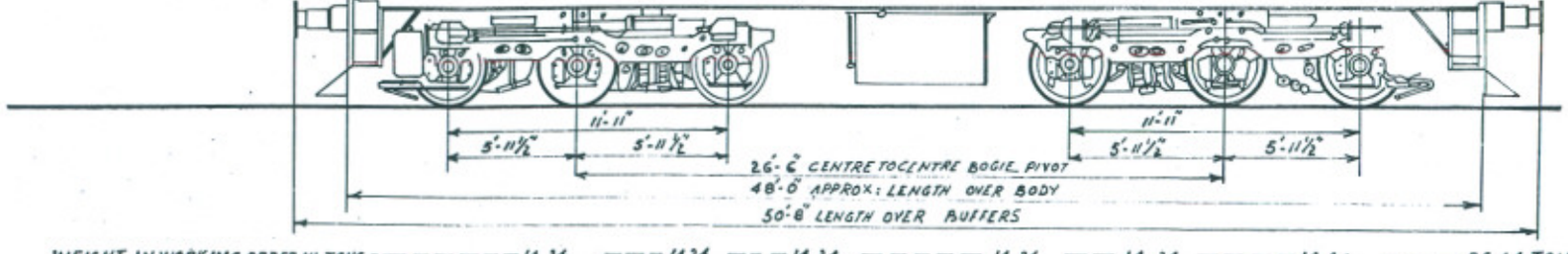
DIAG: No. 40



WEIGHT IN WORKING ORDER IN TONS	13.83	13.83	13.83	13.83	13.83	13.83	83.00 TONS
WEIGHT EMPTY IN TONS							

CLASS D.E ENGINE INDICATING AXLE LOAD & WHEEL SPACING (GMU-15)

DIAG: No. 45
(G.M.C FIG: No. 30888/8)



WEIGHT IN WORKING ORDER IN TONS	14.24	14.24	14.24	14.24	14.24	14.24	85.44 TONS
TOTAL WEIGHT LIGHT OF EACH LOCOMOTIVE	13.376	13.376	13.376	13.376	13.376	13.376	80.26 "