GOVERNMENT OF PAKISTAN
MINISTRY OF COMMUNICATIONS
NATIONAL HIGHWAY AUTHORITY

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AXLE LOAD STUDY

ON

NATIONAL HIGHWAYS

NTRC - 304

July, 1995

NATIONAL TRANSPORT RESEARCH CENTRE (NTRC)

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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

Over loading by commercial trucks in Pakistan is a serious problem. The heavily over loaded trucks stress the road structure beyond safe bearing capacity. As a result of which the roads break up. The government has to spent billions of rupees every year to repair the roads. The local truck body makers are producing wider and elevated truck bodies which enables the truck owners to over load to reduce haulage cost. On our highways, it is common practice for the conventional 2-axle and recently introduced multi-axle trucks to over load. Their tyres are also over inflated far in excess of their normal pressure resulting reduction of their contact areas with road surface. The excessive wheel loads with reduced tyre contact areas exert pressures far in excess of safe bearing capacity of the road pavement structure. When over loaded trucks run on flexible road pavement having unbound bases, signs of distress (rutting) soon appear after the facility is opened to traffic. This results in an early pavement failure and investments in road construction worth billions of rupees are wasted every year.

Unfortunately, there is no legal axle load limit legislation for trucks plying on the roads in the country. The practice of plying trucks without any axle load restrictions has damaged the country's roads and the situation demands immediate imposition of axle load restrictions by the concerned authorities. Some studies have been done in the past to estimate the degree of over-loading by trucks. The first such study was carried out by the National Transport Research Centre (NTRC) in 1982. The study covered country-wide axle load measurements at 35 stations for the 3rd Highway Project. The traffic composition at that time mainly consisted of 2-Axle

Bedford trucks which accounted for 96.5% of the trucks. Other configurations such as three axles and more were quite insignificant in numbers. The damaging factor of the two axle trucks was found as 3.2 as compared to the 18,000 pounds standard axle. NTRC also carried out a survey of Multi-Axle Vehicle in 1982. Although, the survey did not cover any axle load measurement but the study provided detailed composition of multi-axle vehicles. Various other studies were carried out by different consultants but their overage was either limited to a single road or the number of observations made was small. No comprehensive axle load study was done subsequent to the 1982 NTRC Axle Load Study.

The National Highway Authority (NHA) approached NTRC for undertaking the present study. It covers axle load measurements at 30 stations on the national highway network. The study emphases on measurements of axle loads of all kinds of trucks, measurements of traffic volume, tyre inflation pressure, type and make of commercial vehicles and commodity carried by the trucks.

The objective of the study is to assess the present degree of over-loading by goods vehicles. Since 1982, there has been significant increase in the vehicle axle loads. There is an urgent need for re-evaluation of axle load situation and fresh computation of Equivalent Standard Axles (ESAs) that could be used for the design of new road pavements and overlaying the existing pavements. The study explains variation in ESAs with respect to vehicle type, commodity carried, tyre pressures etc. and also to pinpoint stations of high over loading.

The survey was carried out in two rounds spread over a period of six months between March 30, 1994 to September 4, 1994. Observations at each station were made for at least 24 hours in each direction and in case of dual carriageway and heavily trafficked roads, measurements were made for 48 hours. A total of 4,768 goods vehicles were weighed out of which 4599 were loaded and 169 were in empty condition. All the categories of loaded trucks have been covered in the study. The observations were cross checked with vehicle load measurements by road side weigh bridges installed by private parties and the difference in figures checked within acceptable limits.

Some important results obtained from the survey are as follows:

i) **Traffic Volume**
Traffic volume for 24 hours on all stations was served. Considerable variations of volume were observed at different stations. The traffic volume ranged from a minimum value of 688 vpd on Quetta-Nowshki section of N-40 to a maximum value of 20,750 vpd on Rawalpindi-Chablat section of N-5.

ii) **Commercial Vehicles in Traffic Mix**
The proportion of commercial vehicles was observed to vary from a minimum value of 6.43% at D.G.Khan-Taunsa section to a maximum value of 76.2% at Hyderabad-Larkana section. On the average, the proportion of commercial vehicles on 30 stations as a percentage of total traffic volume has been observed as 35%.

iii) **Composition of Commercial Vehicles**
The composition of various axle configurations of commercial vehicles was found as tabulated below:

COMMERCIAL VEHICLES AS A % OF TOTAL VOLUME

Configuration	2-Axle	3-Axle	3-Axle Trailer	4-Axle	5 & 6 Axle	Total
%age	68.9	21.50	1.20	6.5	1.90	100

iv) **Proportion of Discrete Axle Configurations**

While comparing it with 1982 study, significant variations in proportion of various axle configurations has taken place. In the 1982 study, the two axle commercial vehicle constituted more than 96% of the total commercial vehicles which has found to be reduced to 68.9% showing an upward trend in use of multi-axle vehicles. 3-Axle rear tandem commercial trucks on roads have increased from 1% in 1982 to 23% in 1994.

v) **Distribution of Commercial Vehicles by Make**

As regards the vehicles make, a total of 14 makes were observed plying on the roads during the survey. The Bedford trucks still dominate the scene and accounts for about 53% of total trucks population followed by Hino which are 23%. Among the multi-axle vehicles Japanese make vehicles are significant. However, Bedford trucks (96.5% in 1982), are gradually depleting from the truck fleet on our roads. The population of Hino, Nissan, Isuzu trucks vehicles were negligible in 1982 which now constitute about 44% truck fleet.

MAKE-WISE DISTRIBUTION

S.No	Make	No.	%Age
1.	Bedford	2518	53
2.	Hino	1116	23
3.	Nissan	756	16
4.	Isuzu	229	5
5.	Others	149	3
6.	Total	4768	100

vi) **Distribution of Loaded and Empty Vehicles**

The distribution of loaded and empty vehicles according to axle configuration is given at next page:

DISTRIBUTION OF LOADED & EMPTY VEHICLES

Description	Code	Loaded	Empty	Total
2-Axle Single	1.2.	3153	116	3269
3-Axle Single	1.2-2	130	8	138
3-Axle Tandem	1.22	985	28	1013
4-Axle Single	1.2+2.2	38	5	43
4-Axle M.Tandem*	1.22-2	4	-	4
4-Axle R.Tandem	1.2-22	234	8	242
5-Axle Tandem**	1.22-22	9	1	10
6-Axle T.Tridem	1.22+222	37	3	40
Others	-	4	-	9

4594 169

* Only 4 vehicles of this category were encountered during survey, therefore are not included in further analysis.

** Only 9 vehicles of this category were sampled. Damaging effect of this type is based on this limited sample.

vii) **Distribution of Commercial Vehicles According to Commodity**

The distribution of vehicle according to commodity carried show that mainly manufactured products, food and agriculture, fuel and lubricants, mining and quarry materials are carried by the trucks. No significant difference was observed in the type of commodities carried out by various types of trucks as compared with 1982 study. But visible trend in specific commodities carried according to axle configuration was noticed e.g.; the vehicles with more than 3-Axles mainly carried manufactured products & food items.

viii) **Average Axle Loads**

Average axle loads for loaded and empty vehicles for various axle configurations are given at next page:

AVERAGE AXLE LOADS (TONNES)

Description	Code	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Gross
2-Axle Single	1.2	4.93	11.13					16.06
3-Axle Single	1.2-2	6.74	12.59	12.17				31.51
3-Axle Tandem	1.22	6.74	12.37	12.51				31.61
4-Axle Rear Tandem	1.2-22	5.39	11.50	10.90	10.75			38.53
5-Axle Tandem	1.22-22	5.55	9.28	9.28	10.27	10.95		45.33
6-Axle Tandem Tridem	1.22+222	6.43	10.37	10.67	10.49	10.99	10.5	59.45

ix) **Distribution of Load Over Front and Rear Axles**

The distribution of load over front and rear axles for various axle configurations are as under:

DISTRIBUTION OF LOAD OVER FRONT & REAR AXLES

Description	Code	Front	Rear1	Rear2	Rear3	Rear4	Rear5
2-Axle Single	1.2	31	69				
3-Axle Single	1.2-2	21	40	39			
3-Axle Tandem	1.22	21	39	40			
4-Axle Rear Tandem	1.2-22	14	30	28	28		
5-Axle Tandem	1.22-22	12	20	20	24	24	
6-Axle Tandem Tridem	1.22+222	11	17	18	18	18	18

x) **Equivalent Standard Axles Per Vehicle**

a) AS PER RN31: The average value of Equivalent Standard Axles (ESAs) for various axle confi-gurations of commercial vehicles were calculated in accordance with Road Note 31 & are as below:

AVERAGE ESAs PER VEHICLE

Description	Code	ESAs
2-Axle Single	1.2	6.49
3-Axle Single	1.2-2	16.62
3-Axle Tandem	1.22	18.48
4-Axle Single	1.2+2.2	19.00
4-Axle Rear Tandem	1.2-22	17.30
5-Axle Truck	1.22-22	19.59
6-Axle Tandem Tridem	1.22+222	27.96
Tractor Trollies	-	1.19

There is however considerable variation in the values of ESAs at different stations. For example, for 2 axle trucks, the highest value of 23.59 was found at Karachi-Gaddani section, while a minimum value of 3.32 was found at Okara-Lahore section. Similarly, for 3-axle trucks (Rear Tandem) the maximum value of ESAs was found to be 46.54 on Karachi-Gaddani section and minimum of 6.94 on Quetta-Chamman section. The highest ESAs for 2 & 3 axle trucks at Karachi-Gaddani section is primarily due to carriage of heavy iron scrap, a product of Ship Breaking Industry at Gaddani.

b) AS PER AASHTO Design Guide 86: The average value of Equivalent Standard Axles (ESAs) for various axle configurations of commercial vehicles were also calculated in accordance with AASHTO Design Guide 86 & were found as under:

AVERAGE ESAs PER VEHICLE (AS PER AASHTO)

Description	Code	ESAs
2-Axle Single	1.2	4.67
3-Axle Single	1.2-2	11.65
3-Axle Tandem	1.22	8.84
4-Axle Single	1.2+2.2	12.99
4-Axle Rear Tandem	1.2-22	10.35
6-Axle Tandem Tridem	1.22+222	10.90

is however considerable variation in the values of ESAs at different stations. For example, for 2 axle trucks, the highest value of 13.09 was found at Karachi-Gaddani section, while a minimum value of 2.65 was found at Okara-Lahore section. Similarly, for 3-axle trucks (Rear Tandem) the maximum value of ESAs was found to be 20.27 on Karachi-Gaddani section and minimum of 3.99 on Quetta-Chamman section. The highest ESAs for 2 & 3 axle trucks at Karachi-Gaddani section is primarily due to carriage of heavy iron scrap, a product of Ship Breaking Industry at Gaddani.

xi) **Rear Axle Load Distribution**

The distribution of vehicles according to rear axle load is as follows:

REAR AXLE LOADS DISTRIBUTION

Range (Tonnes)	%Age	Cum. %Age	%Age Above Range Value
0.00- 8.15	11.82	11.82	88.18
8.16- 9.99	14.57	26.39	73.61
10.00-10.99	12.92	39.31	60.69
11.00-11.99	17.36	56.67	43.33
12.00-12.99	15.68	72.35	27.65
13.00-13.99	12.16	84.51	15.49
14.00-14.99	6.51	91.02	8.98
15.00-19.99	8.56	99.58	0.42
20.00-above	0.42	100.00	0.00

The above table reveals that about 73.61% of the rear axle loads exceed 10 tons while 43.33% exceed 12 tons value and 27.65% exceed 13 tons rear axle load. In other words, if a legal limit of 12 tons for rear axle is applied in the country then 43.3% of rear axles has to be brought under control.

xii) **Comparison of Present Study with 1982 Study**

The results of the present study are compared with 1982 Axle Load study as following:

a) The proportion of 2-axle trucks in 1982 was 96.5% whereas at present,it has reduced to 69%

b) The proportion of multi-axle trucks in 1982 was about 4% which has now increased to 31% in 1994.

c) The 1982 study covered only 2-axle trucks while the present study covers all axle configurations ranging from 2-axle trucks to 6-axle truck trailers having tandem and tridem configurations.

d) The damaging effect factor for 2-axle truck in 1982 was found to be 3.37 while it has now increased to 6.49 based on RN31 approach while its value is 4.67 as per AASHTO procedures for the same category.

e) As regards multi-axle vehicles, the 1982 study was limited only to NLC fleet and that too very limited vehicles were covered whereas the present study takes in to account multi-axle vehicles owned by private sector as well. The private sector long vehicles were not on roads in 1982. As such, the comparison of damaging effect of multi-axle vehicles with the 1982 study is not possible.

xiii) **Comparison of EASs with Previous Studies**

Comparison of Equivalent Standard Axles for different axle configuration worked out earlier by different consultant with the present study is as follows:

COMPARISON OF ESAs WITH OTHER STUDIES

Description	Code	NTRC 1982	ACE 1988	R.R&M 1989	NESPAK 1989	Present (RN31)	NTRC (AASHTO
2-Axle Single	1.2	3.37	4.96	6.33	7.4	6.49	4.67
3-Axle R.Tandem	1.22	-	7.63	24.82	26.72	18.48	8.84
4-Axle Single	1.2+2.2	-	9.77	9.68	-	19.00	12.99
4-Axle R.Tandem	1.2-22	11.4	18.07	24.46	25.05	17.30	10.35
5-Axle Tandem	1.22-22	5.5-9.2	6.95	12.64	28.30	19.59	-
6-Axle T.Tridem	1.2+222	-	9.04	-	22.56	27.96	10.90

xiv) **Situation in Other Developing Countries**

Excessive truck axle loads is a general problem of the developing countries. Some countries have taken the initiative and have restricted their axle load as given below:

Country Name	Legal Axle Load Limit (Tonnes)
Ethiopia	8.0
Nigeria	10.0
Turkey	8.2
Kenya	8.0
Jordan	12.0
Abu Dhabi	No Limit
Qatar	No Limit
West Malaysia	8.0
U.K.	10.0

xv) **Axle Load Legal Limit for Pakistan**

Based upon the results of this axle load survey, axle load legal limit in Pakistan may be decided jointly by the transporters, concerned government authorities, consultants and National Transport Research Center (NTRC).

1 INTRODUCTION

1.1 Problem

Like most other developing countries, trucks in Pakistan carry loads much in excess of their rated capacity. The local truck body makers are producing wider and elevated truck bodies which enables the truck owners to over load to reduce haulage costs. The tyres are also over inflated far in excess of their normal pressure resulting in reduction of their contact areas with road surface. The excessive wheel loads with reduced tyre contact areas exert pressures far in excess of safe bearing capacity of the road pavement structure. When over loaded trucks run on flexible road pavements having unbound bases, signs of distress (rutting) soon appear after the facility is opened to traffic.

Traffic volume on roads is increasing each year with marked increase in Axle Loads and total loads carried by commercial vehicles. Therefore the frequency and magnitude of the axle loads being applied on the roads is increasing and the highway authorities are facing the serious problems of maintenance, rehabilitation and reconstruction of existing roads together with designing future roads to meet the criteria for much higher traffic loadings.

Axle load survey is now a pre-requisite for highway planning, designing and maintenance. Inspite of the vital importance of the data, its collection and use has not been made in any systematic manner prior to 1982 study. Instead, rules of thumb have been followed and in some cases ratios and approximations developed in other countries such as Road Note 29 of UK which are not relevant to our conditions have been used.

The result of the axle load surveys help to determine the correct thickness of various pavement layers to withstand the anticipated axle loads. The present practice in all most all the countries is to convert vehicles axle loads into standard axle load of 8165 kg (18000 lbs) and to determine equivalent standard axles (ESA's) for the design life of the pavement say 10 or 20 years.

The tendency of overloading is progressively getting worse due to the introduction of newer and more powerful trucks with heavier and wider bodies and transfer of goods traffic from rail to road. This has been the major reason for carrying out a country-wide axle load study.

1.2 Objectives of the Study

The main objective of this study is updation of 1982 study and to assess the degree of present over-loading by goods vehicles plying on the roads. The study covers country-wide axle load measurements on the main national highways to find out variations with respect to type of vehicle, commodity, volume, tyre pressure and to calculate damaging effect of different axle configurations.

1.3 Axle Load Studies Done in the Past

Following studies were carried out by different government organisations and consultants in the past:

1.3.1 NTRC Axle Load Study 1982

NTRC carried out a country wide axle load survey at 35 stations as a requirement for the 3rd highway project financed by IDA/World Bank. This was the first study carried out in the country for the measurement of axle loads. Prior to this study; rules of thumb were followed & in some cases ratios and approximations developed in other countries were used.

However, results of this study were widely used by consultants and authorities concerned with National and Provincial Highways for designing new pavements and improvement of existing road pavements. According to the traffic composition at that time 2 axle Bedford trucks were dominant & accounted for about 96.5% of the vehicles, followed by Nissan and Hino. According to their damaging effect, a loaded vehicle was found equal to 3.2 standard axle and an empty vehicle equal to 0.12 standard axles.

The survey also covered a limited number of NLC multi-axle vehicles. Eighty seven numbers of such category were measured. In terms of damaging effect, equivalent standard axles of 8165 kg (18000 lbs) for various types of loaded vehicles were as follows:

Make	18 Kip Equivalent Standard Axles
5-Axle Tankers	9.2
5-Axle Trucks	5.5
4-Axle Mercedes Truck Trailer	11.4
4-Axle Mercedes Traction Unit	8.8
Fiat	8.2
Hino	9.7

1.3.2 Multi Axle Vehicle Survey 1982

NTRC also carried out a multi-axle vehicle survey in 1982 to determine the proportion of multi axle vehicles in the traffic stream. Although this survey did not cover any axle load measurement, but it provided detailed composition of various types of multi axle vehicles.

1.3.3 ACE Study 1988

Associated Consulting Engineers (ACE) prepared an Axle Load report of Indus Highway (N-55). The study mainly takes into account the traffic conditions on N-55. A total of 2640 vehicles on 17 stations were surveyed. According to this survey, the damaging factor for loaded vehicles ranged between 0.814 for tractor trolley to 18.066 for the 4 axle rear tandem prime mover with trailer.

1.3.4 Road Research and Material Testing Institute Study 1989

The Road Research ad Material Testing Institute of Punjab Highway Department conducted an axle load survey in 1989 covering a total of 302 vehicles including 52 tractor trollies. Only loaded vehicles were surveyed. The survey was carried out around Lahore and Faisalabad.

1.3.5 NESPAK Study 1993

National Engineering Services, Pakistan Limited (NESPAK) carried out an axle load survey of Sheikhupura-Multan-D.G.Khan Motorway in 1993. A total of 658 vehicles were surveyed which comprised 2 axles and multi-axle vehicles. Being the latest study as compared to ACE and NTRC 1982 study; the equivalent standard axles/vehicles was found much higher. It was found 7.4 for 2 axle trucks as compared to 3.2 by NTRC 1982 study. The equivalent standard axle/vehicle was found equal to 28.3 for 5-axle truck trailer as compared to 9.2 for the same category of vehicles in 1982.

Comparison of ESA's for different axle configurations worked out by consultants with the present study is given at as under:

COMPARISON OF ESAs WITH OTHER STUDIES

Description	Code	NTRC 1982	A.C.E 1988	R.R & MTI 1989	NESPAK 1989	Present RN31	NTRC ASHO
2-Axle Single	1.2	3.37	4.96	6.33	7.4	6.49	4.67
3-Axle R.Tandem	1.22	-	7.63	24.82	26.72	18.48	8.84
4-Axle Single	1.2 +2.2	-	9.77	9.68	-	19.00	12.99
4-Axle R.Tandem	1.2-22	11.40	18.07	26.46	25.05	17.30	10.35
5-Axle Tandem	1.22 -22	5.5-9.2	6.95	12.64	28.3	19.59	-
6-Axle T.Tridem	1.2+ 222	-	9.04	-	22.56	27.96	10.90

1.4 Structure of the Report

Technical information on various aspects of axle load such as load distribution, effect of various factors on pavement stresses, axle configuration, average axle loads, the AASHO Road Test and equivalent standard axles are discussed in Chapter 2, while the different equipments used for axle load measurements are described in Chapter 3. Chapter 4 deals with methodology adopted for the study and Chapter 5 provides information on traffic volumes, proportion of trucks in traffic stream and statistical data related to traffic composition. Analysis of data containing average axle loads of different axle configurations at different sections of national highways are presented in Chapter 6, while the damaging factors of different type of trucks in terms of equivalent standard axles are presented in Chapter 7 of the report.

Results are presented in the form of.tables and diagrams and discussed in the text where necessary. Tables containing additional information which are not presented in the text are referred in the paragraphs and appended at the end of the report.

2 TECHNICAL BACKGROUND.

2.1 General

Axle loads are one of the two principal factors for determination of the pavement thicknesses, the other factor being the load bearing capacity soil. It is therefore very important to know the exact distribution of axle loads at a particular section for which the flexible pavement is to be designed. Prior to NTRC 1982 study for determination of the damaging effect of the axle loads, rules of thumb have been followed & in some cases, ratios and approximations developed in other countries which were not relevant to our conditions were used. However, NTRC 1982 study revealed a high degree of overloading prevailing in the country which necessitated using factors for pavement design which are at par with the vehicle loads in the country.

2.2 Load Distribution

The load of a vehicle is transmitted to the road surface through the tyre contact area and distributed through successive layers of the structure to the sub-soil on which the road structure rests. If the sub-soil deflects, the over-laying flexible pavement will deform to a similar shape and the structure will fail. The primary function of pavement design is to protect the sub-soil by distributing the applied vehicle load in such a way that maximum pressure applied to the sub-soil is within limits of its load bearing capacity. A system of layers of different specifications such as sub-base, base and surface course etc., make such a load distribution in a complex way. The design of flexible pavement is affected by several factors, important ones being load of the traffic, load bearing capacity of the soil, quality of available materials and environmental factors etc. On an initial simplifying assumption, the wheel load distribution of a pneumatic tyre on uniform granular material is in the form of a cone supported by surrounding materials having a slope of approximately 45 degrees. The area over which load is spread increases with the depth and intensity of pressure decreases proportionately as shown in Fig. 2.1. Intensity of pressure is reduced with depth. Thus, if an allowable unit pressure q for a particular sub-grade soil is given, the required thickness of cover can be readily determined for the maximum truck wheel load that is likely to be experienced using the following equation:

$$p = q \quad (a + d)$$

$$d = \frac{p}{q} - a$$

where

q = Average pressure on the sub-grade caused by a wheel load p acting through base and sub-base material.

= Circumference of the Circle 22/7 = 3.1416

a = Radius of Circular Contact area

d = depth of pavement structure

2.3 Pressure Bulb Theory

A bulb of pressure is a surface obtained by connecting points of equal stress on the various horizontal planes at various depths. The pressure Bulb Theory explains the distribution of load when applied to the soil through a circular object. The pressure at any one point on the surface of a bulb is the same as at any other point. Because the contact area between a tyre and the ground approximates a circle, the theory can be applied to pressure in the soil under tyres with slight modification. Fig. 2.2 illustrates the pressure bulb.

2.4 Effect of Various Factors on Pavement Stresses

Pavement stresses are affected by many factors such as:

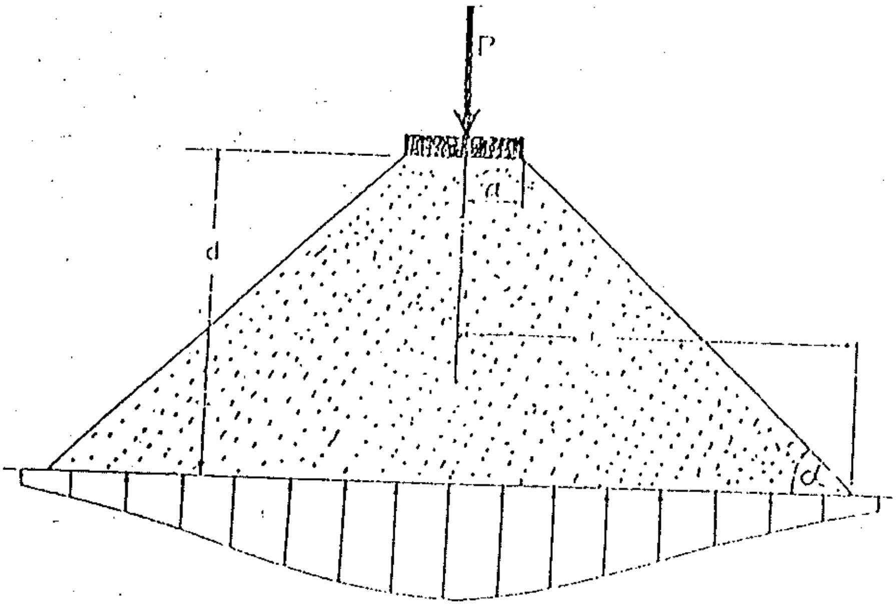


Fig. 2.1 LOAD DISTRIBUTION THROUGH GRANULAR MATERIAL

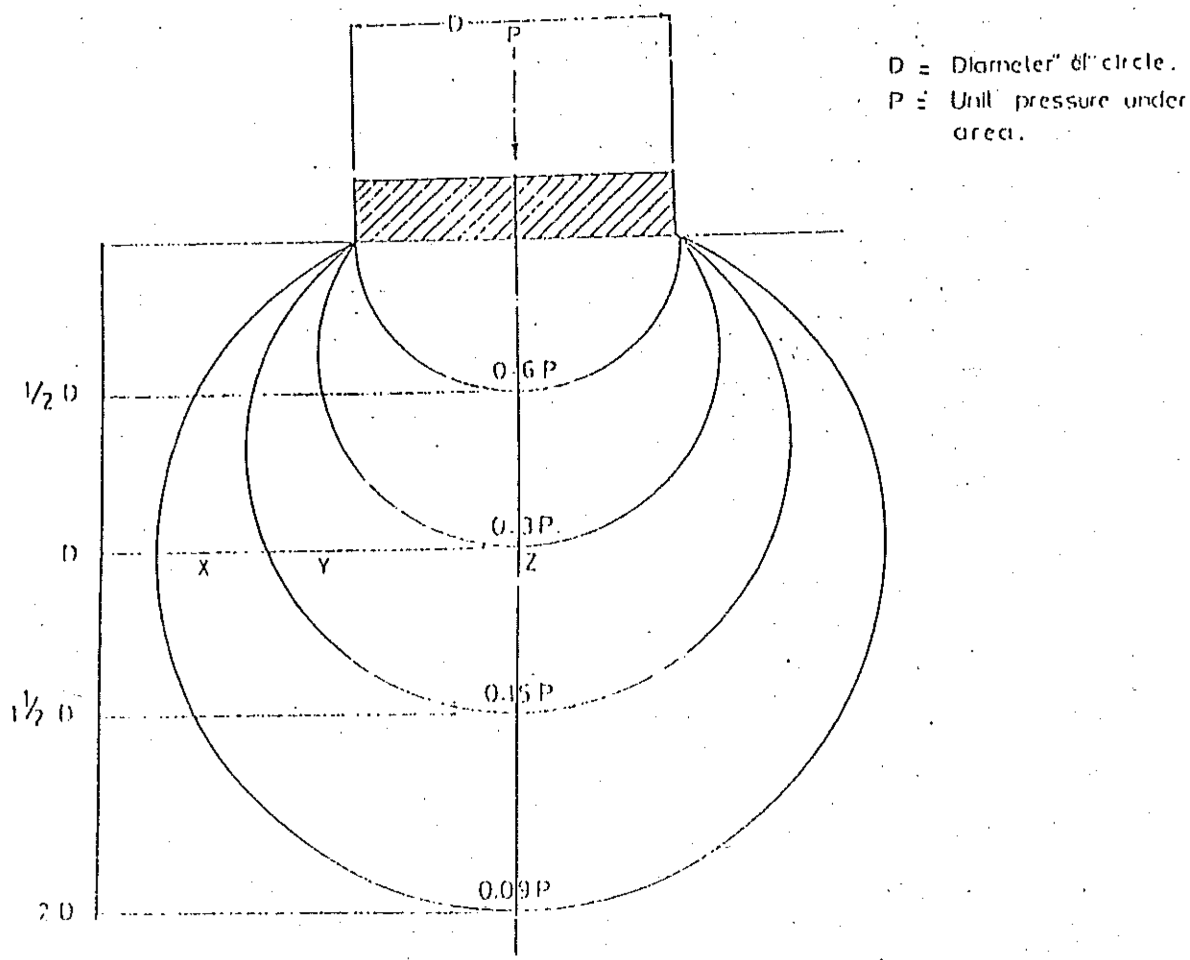


Fig. 2.2 VARIATION IN PRESSURE WITH DEPTH UNDER A LOAD

2.4.1 Tyre Size

Tyre size determines the area of contact with the road surface which in turn determines the area of load distribution and unit load. The smaller size tyres will make a sharp curve with the road surface and the area of contact would be small and unit load more. The stress or pressure would thus vary directly with size of the tyre.

2.4.2 Tyre Pressure

For a given size of tyre, the area of contact with road surface will inversely vary with tyre pressure. The higher pressure would result in smaller contact area and vice versa. The unit load will therefore directly vary with tyre pressure. However, given the tyre pressure, increase in load would not increase the stress as much as the increase in load. As the area of contact would also increase with increase in load, the unit pressure would not increase as much as the increase in load. The relationship between tyre pressure, area of contact, pressure on the road surface and stress on soil are given in Fig. 2.3 Fig. 2.3 (a) indicates how the contact area decreases as the inflation pressure increases. Fig. 2.3 (b) indicates the manner in which the actual pressure is transmitted to the surface in a non-linear fashion as the inflation pressure increases. At any given time, the applied surface pressure is always considerably greater than vertical pressure on the pavement surface. Fig. 2.3(c) also indirectly reflects the role of the tyre pressure inducing stresses in the pavement. The effects of high inflation pressures are most pronounced in the upper layers of pavement and have relatively little differential effects at greater depths.

2.4.3 Wheel Load

It would be seen from the above that as the wheel load is increased, the tyre deflects and the contact area is increased. As a result, the peak unit pressure applied to the carriageway shows only a very small increase. The additional wheel load has however, the affect of causing the vertical stress at the pavement subgrade interface to be increased in direct proportion to the extra load. Thus it is clear that as the wheel load is increased the depth of pavement must also be increased so that the allowable subgrade stress is not exceeded.

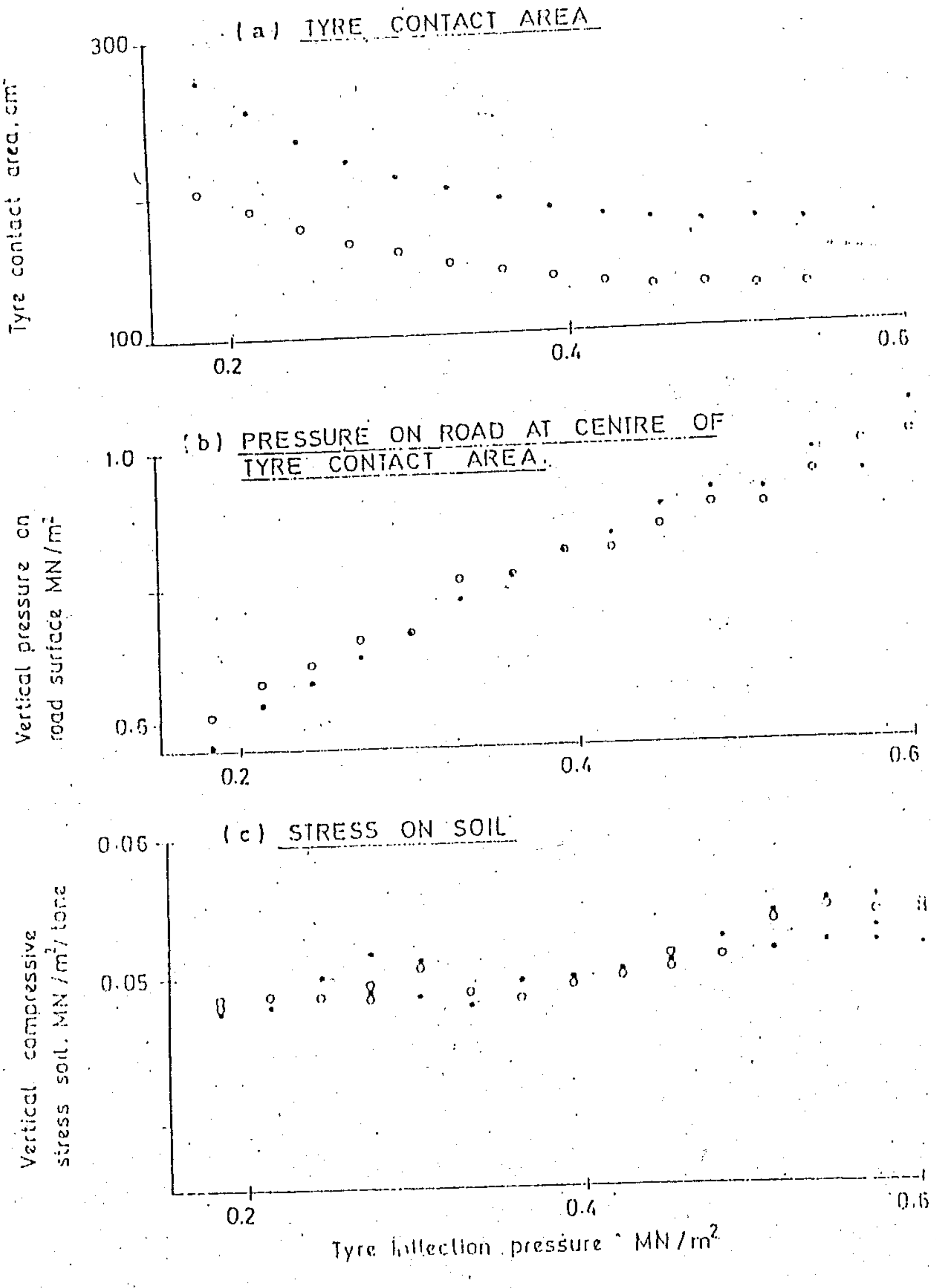


Fig. 2.3 RELATIONSHIP BETWEEN TYRE PRESSURE, PRESSURE ON THE ROAD AND STRESS ON SOIL

2.4.4 Dual Wheels

Almost all buses and trucks in Pakistan have dual rear wheels which can influence the stress distribution and deflections within and below the highway pavement. The most definitive investigations into the effect of various wheel arrangements have been carried out on airport pavements where they are of significant importance because of the greater wheel loads. Theoretically, it can be shown that the single wheel load required to reproduce the same maximum stresses in a homogeneous material as are given by a dual tyred assembly is

$$p_e = p + \frac{pz}{(z^2 + s^2)^{5/2}}$$

Where

p_e = equivalent single wheel load

p = load on each dual-tyre

z = depth to the plane being stressed and

s = distance between the centers of individual tyres.

The relationship clearly illustrates the two most important features of the dual-tyred assembly. Firstly the calculated stresses at the pavement surface (when z = o) are only due to the individual wheels of the assembly and there are no interacting effects. Secondly, the distance between the tyre centers plays an important part in the stress distribution beneath the surface. At greater depths, however, where the s-value is small in comparison with depth, the stress due to the dual-tyres becomes near additive. Fig.2.4 illustrates the same.

2.4.5 Axle Configurations

Axle configurations have a pronounced effect on stress distribution and deflections. In the AASHO Road Test, Liddle separated axle configurations into single and tandem axle sets and deduced that the damaging power of the tandem axle sets was less than that of the two single axles together carrying the same load.

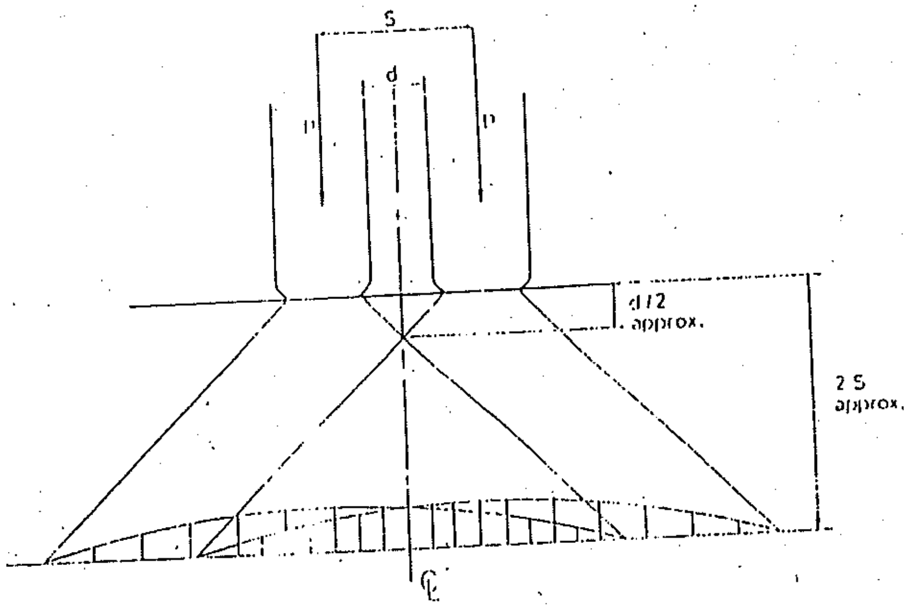


Fig. 2.4 VERTICAL STRESS UNDER DUAL TYRE ASSEMBLY

2.4.6 Static Versus Moving Load

Tests have indicated that stresses tend to decrease as the vehicle speed increases from creep speed to about 24 km/h. Above 24 km/h the values tend to be constant. The vehicle speed effect is most noticeable on particular sections of roadway. For instance, for a given volume of traffic, greater thicknesses and or quality of paving materials may be required for pavements in urban areas than for those in rural areas because of the lower average speeds in urban areas. Similarly pavement requirement for uphill gradients may be more demanding than for downhill gradients.

2.4.7 Repetition of Loads

Although the effect of material fatigue on highway pavement behaviour is little understood at this time, there is no doubt that it plays a critical role in pavement failure. The cracking of the surface may be the result of fatigue characteristics of the bituminous material itself or it may reflect the effect of repeated loading on the road base, sub-base and/or subgrade materials.

2.5 Standard Axle Load

There are large variations in axle loads of different categories of vehicles and different vehicles of the same category due to differences in the type and amount of cargo carried. Accordingly, to bring all axle loads to a uniform scale, different axle loads can be converted to standard equivalent axles on the basis of damaging effect to the road structure.

2.6 Damaging Effect of Axle Load

The damage caused to the road structure is related to its axle loads, hence it is essential to know the relationship between the pavement damage and the axle load in order to carry out proper and adequate structural design for the roads. However, the relationship between the axle load and the damage it causes to the road structure can only be obtained from full-scale experiment.

2.7 AASHO Road Test

The most widely used relationship between vehicle loading and pavement performance was derived from the AASHO Road Test (Highway Research Board (1962)) and W J Liddle (1962). This test involved running vehicles of different loading characteristics, for a period of up to two years, over test tracks containing lengths of flexible and concrete pavement of different formulations and observing and measuring the condition of the pavements as they deteriorated under the traffic loading. The test was carried out over the period 1958-60 at Ottawa, Illinois, where the subgrade soil is a wind-blown loess and where weather conditions are typical of the Northern USA i.e. a continental climate with hot summers and cold winters. The data were subjected to a complex statistical analysis and amongst the results which emerged was a generalized conclusion that the relative damage to both flexible and rigid pavements varied approximately as the fourth power of the applied wheel load. It is this relationship that provides the basis for assessing the effects of vehicle loading in most current methods of pavement design. The relationship was codified by converting the estimated spectra of axle loadings into an equivalent number of repetitions of a standard axle load of 18,000 lb (8165 kg).

2.8 Equivalence Factors

The equivalence factor of an axle load is defined as the number of passages of an axle load carrying a standard axle load of 8,165 kg (18,000 lbs) which would do the same damage to a road as one passage of standard axle. Other researchers have also analysed the Road Test Data to derive relationship between equivalence factor and axle loads. The results of the AASHTO road test have indicated that the stresses induced and the damaging effect caused to the road pavement by an axle load higher than the standard axle load increases not in direct proportion to the load but by a power of standard load. The most commonly value used for the power is 4.5. Two approaches are commonly used by various highway agencies in the world these days for determination of equivalency factors. The first one is the AASHTO Guide 1986 and the second is the RN31, UK approach. The AASHTO, 86 provides equivalency factors for various axle loads of single, tandem and tridem axles. The equivalency factors are further based on the type of pavement, structural number (SN) of the pavement and Terminal Serviceability Indes (Pt) of the pavement. Since most of the recent major highway designs have indicated structural number of '5', it was considered appropriate to assume a value of " 5 " as SN. A terminal serviceability index value of " 2.5 " was adopted. Load equivalency factors adopted in this study as per AASHTO are placed at Annexure 2-A. In the second approach i.e. RN31, UK, all axles are assumed as single axles. The tandem axles are treated as two single axles and tridem axles are treated as the three single axles. The equivalency factor of each single axle in this approach are worked out as follows:

$$\text{Equivalency Factor} = \left(\frac{\text{Axle Load in Tonnes}}{8.16} \right)^{4.5}$$

Thus, according to RN31 approach, the damaging effect of a vehicle having a payload of 10 tons is 2.75 ESA, while it increase to a value of 46.4 ESA when its payload increases to 22 tonnes (Fig.2.5). Similarly if Equivalence factor given in AASHTO 86 are used, the effect of a vehicle having a payload of 10 tonnes is 2.54 ESA, which increases to a value of 27.11 ESA when its payload increases to 22 tonnes.

2.9 Analysis Methodology Used for the Study

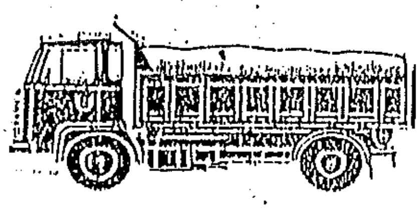
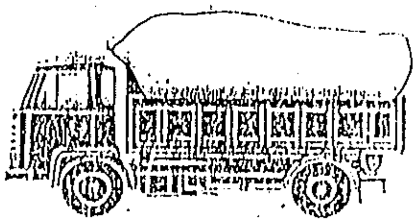
During survey, each commercial vehicle was weighed by weighing each axle of the vehicle separately. Various options were considered for analyzing the collected data for getting the equivalent standard axle value for the vehicle. There has been no assessment of the validity of the AASHO results to roads in developing countries where the climate, environment, soil types, pavement stiffness and other factors are very different to those where the road test was carried out. Literature in this regard was also studied. Liddle, in his analysis of the AASHO road test data had separated axle configurations in single and tandem axle sets. He deduced that the damaging power of tandem axle sets was less than that of two single axles together carrying the same load.

Although Liddle's analysis is widely accepted, other authors such as Shook and Finn analyzing the same data concluded that when tandem axle assemblies carry axle loads greater than 8,165 kg (18,000 lb) they cause more pavement damage than two single axles carrying the same total load.

There is some uncertainty about the validity of the equivalence factors derived from the AASHO test for assessing the damaging effect of traffic on highways in tropical environments. In view of the different interpretations made of the same data it is felt appropriate for this study to analyze the survey data using both the approaches i.e. taking all axles as single axle and using equivalence factor derived from the 4.5 power law and also the factors were derived by using the AASHTO Design Guide 1986 as the alternate approach.

2.10 Axle Load Spectra in Different Countries

Most of the commercial vehicles in Pakistan are driven by the owner themselves and due to economic reasons, there has always been tendency of overloading. Similarly in most of the other developing countries, it is not

Properly Laden Vehicle	**Over Laden Vehicle**
	
All Up Weight 16 Tonnes	All Up Weight 28 Tonnes
Axle Load 6t 10t	Axle Load 9t 19t
Equivalent Standard Axles +0.25 2.50 *0.36 2.18 Total ESAs = Pavement damaging effect +2.75 *2.54	Equivalent Standard Axles +1.55 44.9 *1.51 25.6 Total ESAs = Pavement damaging effect +46.6 *27.11
Pay Load 10 Tonnes	Pay Load 22 Tonnes

+ According to RN31, UK.

* According to AASHTO Design Guide, 1986

Fig. 2.5: EFFECT OF VEHICLE OVER-LOADING ON PAY LOAD & PAVEMENT DAMAGE

uncommon to find two axle trucks with much heavier axle loads. Axle loads as high as 20 tonnes are also observed. The tyre pressures are also in excess of normal values. The effect of the heavy axle loads and the high tyre pressures is to increase many fold the damage caused by the tyres to the pavement. Thus, it is not surprising that newly constructed flexible pavements, particularly those with unbound bases, frequently show signs of distress shortly after they are opened to traffic. Rolt (1981) has examined the implications of vehicle overloading on overall transport costs and it is evident that vehicle overloading is seriously handicapping the improvement of the road networks in many developing countries. An indication of the extent of this overloading can be seen from the data in Table below:

EXAMPLES OF AXLE LOAD SPECTRA MEASURED ON MAIN ROADS

Percentage of axle loads above

Country	8 (tonnes)	10 (tonnes)	12 (tonnes)	14 (tonnes)	16 (tonnes)
Ethiopia	45*	34	24	15	-
Jordan	77	58	45*	28	14
Kenya	67*	52	30	4	-
Nigeria	-	30*	10#	-	4
Qatar	43	36	27	14	13
Turkey	28*	17	7	4	-
Malaysia	12*	4	2	-	-
U.K	7.5	4*	3	2	-

* Legal limit of axle load (tonnes).

Percentage at 13 (tonnes).

All industrialized countries have vehicle construction and use regulations prescribing limits on the size and weight of commercial vehicles and enforcement is quite strict. In Western Europe these regulations are being unified under the auspices of the European Community. There is now a wide range of multi-axle vehicles available and, with the advent of container-traffic, more of these are coming into greater use on the roads in developing countries. The proposed E.C. loading limits for them are at next page:

PROPOSED E.C. LIMITS ON SIZE & WEIGHT OF 2 & 3-AXLE VEHICLES

Vehicle	Length (m)	Width (m)	Gross Weight (tonnes)	Axle Load (tonnes)
2-Axle rigid	12.0	2.5	18	11.5
3-Axle rigid	12.0	2.5	25	11.5
3-Axle articulated	16.5	2.5	(1)	(1)

(1) No specified limit. At the discretion of member states.

In the USA the regulations concerning the size and axle loading of commercial vehicles vary considerably from State to State. Although limits on gross vehicle weights are generally higher than in Europe, maximum axle loadings are generally lower. This perhaps reflects the vigor with which State Highway Departments have striven to protect their road pavements.

In both Europe and North America the regulation on vehicle dimensions and loading are quite strictly enforced. Some developing countries have similar regulations but, with very few exceptions, it has proved quite impossible to enforce them. The spectra of axle loading in most countries are far heavier than on roads in Europe and North America. It seems unlikely that the level of enforcement will improve very quickly and road pavements must be designed so that they can carry vehicle loads that are much heavier than those operating in industrialized countries.

3 AXLE LOAD MEASURING EQUIPMENTS

3.1 General

In many developing countries road traffic is growing rapidly both in volume and in the size and weight of the vehicles using the roads. As a consequence highway engineers concerned with designing new roads or strengthening of existing roads in developing countries require reliable information about the distribution of the axle loads of existing traffic, and where possible information on national or regional axle load trends.

To provide adequate information on axle load distribution, road side axle loads surveys are required. Such surveys can conveniently be carried out by using the following wheel-weighing devices namely, Static Weighing Bridges, Weigh in Motion Equipments and TRL portable wheel weighing unit with digital indicator.

3.2 Static or High Speed Weigh-In-Motion

Weighing trucks using static weigh bridges is time consuming and expensive. In developed countries the high speed weigh-in-motion weigh bridges are commonly used because they have made regulations about the weight, height and length of the vehicles. The high speed weigh-in-motion system automatically selects vehicles which don't conform to weight, height and length requirements at high speed. A brief description about high speed weigh in motion system developed and used in Australia is given below.

The High Speed Electronic Mass Unit (HSEMU) automatically checks weight, height and length and classifies each vehicle as it drives over axle sensors and weigh plates. It instantly decides whether the vehicle conforms to regulation. If vehicle confirms, the system guides it back on to the highway with no delay incurred. If the vehicle is non-conforming, the computer gives a set of traffic lights to direct the vehicle to specific enforcement weight bridge. Operations in a control room are alerted if a vehicle is over weight, over length and/or over height in two ways. Firstly, if a non-regulation vehicle pass over the weigh plates, an alarm sounds in the control room secondly, traffic lights controlled by the HSEMU System are within view of the control room. Because the system automatically screens out vehicles that conform, the station can operate with minimal staff and its efficiency is a key benefit of the HSEMU system. Cost-recovery can be expected in the short term. A typical HSEMU layout may be seen at Annex 3-A.

3.3 Equipment Used for This Study

The portable weigh bridge developed by the Overseas Unit of the Transport and Road Research Laboratory (TRL) was used for this study. TRL has used this portable weighing unit in many parts of the world for axle load surveys.

3.4 Specifications of the Weighing Unit

The portable weighing unit have the following specifications. The weight of the unit should not exceed 50 kg as it is considered that 50 kg can be handled by one person if necessary and can be carried in an average private motor car. The size of the weighing platform should be as large as possible to facilitate the positioning and weighing of large dual-wheel assemblies. The thickness of the weighing platform should be as small as possible to minimise the difference in level between the wheel being weighed and the other wheels of the vehicle when the unit is being used on level ground and the accuracy should be within + 2 percent. (Although + 5 percent would be adequate for pavement design purposes, the higher accuracy would enable the unit to be used for the enforcement of legal axle-load limits and for checking the weight of test trucks used for making deflection measurements on existing roads).

3.5 Survey Equipment and Installation

The equipment consists of an aluminum alloy weighing platform (weigh bridge) shown in Plate-1 (Annexure 3-B), a readout unit, shown in Plate 2 (Annexure 3-C), and a 12-volt car battery. The dimensions of the weighbridge are 700 x 500 x 90 mm and it is 44 kg in weight. Ordinary the system has a measuring range of 0-10,000 kg, however, it is capable of measuring accurately up to 20,000 kg with minor adjustments. Under field conditions of use, has an overall accuracy of + 2% of full scale. The equipment is not adversely affected by high temperatures or humidities.

The weigh bridge platform should be installed on smooth, dry and horizontal surface. The weigh bridge should be installed in a pit with its top face level with the surrounding road surface. The design of a typical pit is shown in Annexure 3-D. If the platform is not evenly supported over its base area, then, when loaded, distortion of the frame may be sufficient to cause errors in reading or may permanently damage the platform. Therefore before using the weighing unit, the surface should be cleared of any debris, area with undulations or small pot holes should be avoided.

If the surface is unavoidably uneven or has high spots, their effect can be minimized by using sheet of load spreading material such as plywood or rubber about 6mm thick underneath the platforms.

3.6 Survey Sites

The survey site was so selected to make it possible to carry out survey of the traffic easily and safely. Each survey point was selected on a clear stretch of road with good visibility, to give ample time to driver to slow down and stop. The sites were so positioned to avoid junction or other turning. A typical layout for survey site is shown in Annexure 3-E. Advanced working signs were also used to give indication to driver about the survey.

3.7 Survey Teams

The teams comprising of 4 members undertook survey work in shifts of eight hours. One person was deputed to control the traffic on the road and to direct vehicle into the weighing areas. The second person was deputed to direct the vehicle within the weighing area to drive slowly on the weigh bridge and position its wheels centrally on the platform. The third person was used to record the wheel loads & the fourth person was deputed to carry out a classified traffic count.

3.8 Reliability of the Equipment

According to manufacturers, this weighing unit and data recording equipment have been used for survey of traffic entering and leaving in Abu Dhabi Island in the Trucial States. The weighing unit and dial indicator have been used for the measurement of wheel loads at Quarry Bayadat in the Emirate of Abu Dhabi and in Qatar. The axle loads in excess of 19,000 kg were recorded. The weighing time and the associated equipment performed satisfactorily in both these surveys. The accuracy of results was good and error due to temperature drift were considered negligible over the duration (less than half minute) of weighing unit of a weighing operation. During the present survey the axle loads upto 24.65 tons were encountered.

3.9 Preliminary Testing

The calibration of the equipment was done in the following manner. First of all complete all the connections. Switch-on the 12 volt D.C. supply switch on the front panel of the portable weighing indicator unit. Press the CHECK VOLTS button. The display will indicate the voltage level of the battery supply. This level should not be less than 11 volts. If it is less, recharge the internal battery, or power the unit from an external 12 volts D.C. sources. Allow the unit to warm up for 5 to 10 minutes. Adjust the SET ZERO to obtain a reading of 0.00 on the display. Press the CHECK CAL button. The display should now read 5.55. If necessary, adjust the SET CAL control to obtain a reading of 5.55 whilst holding the CHECK CAL button. Release the button. The reading should now return to 0.00. Repeat if necessary.

The system may be checked in a simple way be applying a load to the platform. The display will then indicate the value of the load. For example if a person stands on the selected platform, the display might indicate 7 divisions. Each small division is 10 kg or 22 pounds and the display would therefore be indicating a weight of 70 kg or 154 pounds.

3.10 Calibration of the Weighbridge

The weighbridge equipment, as supplied by the manufacturer, is calibrated against a proving ring and any further re-calibrations by the user are useful but not essential. A periodic check of the sensitivity may be made using a known load. When a reliable and accurate loading device is available, the calibration can be carried out in the following manner.

First of all complete all the connections. Place the platform of the weighbridge on the plywood sheet. Apply load through a 25 cm x 38 cm plate or block of wood (i.e. the area equivalent to a tyre contact area at 10 tonnes wheel load) in increments of 1000 kg, to the full value and note the corresponding readings on the weighbridge indicator. The calibration line is then obtained by plotting the load measured by the indicator against the corresponding value of the load applied by the machine.

4 METHODOLOGY

4.1 Selection of Survey Points

A country wide Axle load Survey was carried out by NTRC in 1982. The survey points were selected jointly by NTRC and NHA and were mostly located near the district boundaries., the present study was aimed to update the previous study. Therefore, the survey points were selected on National Highways near the previous stations of 1982 study. A map showing survey points is given at Annexure 4-A.

The number of survey points covered on different National Highways are as below:

Sl. No.	Road Section	No. of Survey Points
1.	N-5	16
2.	N-25	2
3.	N-35	3
4.	N-40	1
5.	N-55	5
6.	N-65	1
7.	N-70	2
	Total	30

The stations were selected in such a way as to obtain the representative values of axle loads for that particular road section.

4.2 Survey Timing and Duration

The survey was conducted for 24 hours starting from 10.00 a.m. Out of the 30 stations, 11 stations were on relatively low volume roads where the axle load measurements were made for 24 hours. While at 19 stations where traffic volume was high, a 24 hours in bound and 24 hours out bound i.e. 48 hours traffic volume measurements were carried out. The first round of survey was started from southern region of the country on 30-03-1994 from Karachi-Gaddani section (1st station) and was ended on 16-05-1994 at Lahore-Gujranwala section (15th station). The second round of the survey was started on 26-07-1994 from Wazirabad-Gujrat section (16th station) and was ended on Quetta-Nowshki section (30th station), the last station in the southwestern region of the country. A complete schedule of survey was approved by the NHA and was sent to I.G.Police of four provinces to get the police assistance and may be seen at Annexure 6-B.

The second round schedule was revised due to some unavoidable circumstances and the field work, which had to be completed on 31-07-1994, was actually completed on 04-09-1994.

4.3 Selection of Vehicles

NTRC had installed 20 Permanent Traffic Stations on National Highways. The results show that on most roads the axle load distribution of the traffic moving in one direction is about the same as that traffic moving in opposite direction. Significant differences between the two streams occur, only, on roads serving quarries, cement factories, textile industries etc. Similarly, on some routes, special vehicles are in regular use, for example in timber extraction areas and mining areas. The loading is quite different in both directions as compared to other sections.

Damage caused to road pavements structure by passenger cars and light vehicles is negligible as compared with that caused by loaded commercial vehicles. Therefore, in this survey only commercial goods vehicles with 2-Axle, 3-Axle, 4-Axle and more than 4-Axles were measured. A total number of 4,768 trucks were surveyed over 30 stations as shown in Table 4.3.

4.4 Measurement of Axle Loads

After the installation of weighing machine, the few vehicles coming from one side were stopped for weighing and one or two vehicles moving in the same direction were kept waiting. Others were allowed to pass. Once a queue in one direction was cleared, vehicles coming from the other side were stopped for weighing. This procedure was adopted where traffic volume was low and where 24 hours axle load measurements were made for both directions. But where the traffic volume in each direction was high, 24 hour axle weighing was done in each direction. Plate showing weighing of truck at site may be seen at Annexure 4-B.

4.5 Police Assistance

I.Gs of four provinces were requested to provide police assistance for this study because police assistance was necessary for stopping and managing the traffic at survey points. Almost at every station, two policemen were provided by the local police station of the rank of Constable/Head Constable. In the presence of policemen, the drivers obeyed the instructions of survey staff. It also ensured safety of survey staff during night time measurements and in remote areas. It was also noticed that in the absence of policemen some drivers did not stop. It is therefore, recommended that survey may be conducted in the presence of police to deal with any traffic problem.

Police was requested that during the axle load survey, they would not check the driver's license or documents of vehicle and would not challan the vehicle. Particularly, overloaded vehicles were not allowed to be questioned by the police in any case.

4.6 Questionnaire

In the previous axle load study of NTRC, a questionnaire was prepared by NTRC to collect information about vehicle, goods transported, and for origin and destination of the vehicle. The same with modifications was adopted for this study. The sample of the questionnaire is placed at Annexure 4-C.

5. TRAFFIC VOLUME AND PROPORTION OF TRUCKS

5.1 Traffic Volume

Traffic volume studies are conducted to furnish the engineer with the factual information he needs, both to identify the magnitude of traffic problem and to provide him with the data required for a quantitative approach to the solution of the problem. The studies must be so designed and carried out that data provided are adequately accurate and unbiased and the cost of data collection & processing is within the limits of available manpower, funds & time.

A volume or flow study is the measure of the time rate of vehicles passing a specific point on a roadway. It is one of the fundamental measurements of the importance of a road. Traffic volume estimation can be subdivided into two basic categories; annual average daily traffic (AADT) and annual vehicle miles of travel (AVMT). The average annual daily traffic is the number of vehicles that pass a particular point on a road way during a period of 365 days. While AVMT is basically a system measure of traffic, AADT is a point-specific measure. The count may be stratified by time of day, direction of travel, and type of vehicle.

Traffic studies for a highway provides quantitative information about the various types of vehicles using the highway. Traffic volume data will indicate the appropriate levels of service for which new highways should be designed and directly affect geometric features, such as carriageway widths, number of lanes, horizontal and vertical alignments and maximum permissible grades.

It is quite interesting to note that in 1982, the proportion of 2 axle commercial vehicles was about 99% while the proportion of 3 and more axle trucks was only 1% of the truck fleet. Hence, during the last decade, there has been tremendous increase in the growth of multi-axle vehicle trucks. The three and more axle trucks are being preferred and are gradually replacing 2 axles trucks. On average, the proportion of various axle truck configurations as observed on thirty stations was found as at next page:

No. of Axle Trucks	Proportion
2-axle	68.9%
3 axle	22.7%
4 axle	6.5%
5 axle and more	1.9%

The major increase is in case of 3 axle trucks; the trucks having a rear tandem axle. It is also evident that two and three axles together form 92% of the truck population.

5.5 Distribution of Trucks by Make

Make of the commercial vehicles was also recorded alongwith other details. Fourteen different types of vehicle makes were identified. Out of these, Bedford constituted the major proportion i.e. 52.7%. This was followed by Hino which constituted 23.4%, Nissan 15.8% and Issuzu 4.80%. The make wise distribution of truck fleet may be seen in the following Table:

MAKE WISE DISTRIBUTION OF TRUCKS

S.No	Make	No.	%Age
1.	Bedford	2518	53
2.	Hino	1116	23
3.	Nissan	756	16
4.	Isuzu	229	5
5.	Others	149	3
6.	Total	4768	100

Although, the Bedford Trucks still constitute the major proportion of the truck fleet; however, while comparing it with the proportion of Bedford trucks in 1982 (96.5%), one finds that the Bedford Trucks are gradually depleting from the truck fleet on our roads. The Japanese makes are gradually replacing the Bedford trucks. The proportion of Hino and Nissan Trucks which was negligible in 1982, now constitute more than 40% of truck fleet. If this trend continues, which seem to be most likely, the Bedford trucks may be mostly replaced by the Japanese makes very soon.

5.6 Distribution of All Trucks According to Axle Configuration

The distribution of all trucks weighed during survey according to axle configuration was as under:

Description	Code Weighed	Trucks	%Age
2-Axle	1.2	3269	69
3-Axle (Single)	1.22	138	3
3-Axle (Tandem)	1.2+2.2	1013	21
4-Axle (Single)	1.2-2.2	43	9
4-Axle (M.Tandem)	-	4	-
4-Axle (R-Tandem)	1.2-22	242	-
5-Axle (Tandem)	1.22-22	10	-
6-Axle (Tandem Tridem)	1.22+2.22	40	8
Others	-	9	-
Total		4768	100

5.7 Growth Rate of Trucks

The most interesting and important aspect is that within the truck fleet, the different axle configuration show different growth rates. The growth rate for truck fleet in the country during the last decade is around 9%. To obtain the growth rates of multi axle vehicles during the period 1982 to 1994, it was not possible to compare 1982 report data with the 1994 data as in 1982, the multi axle vehicles (> 2 axles) constituted only 1% of our trucks fleet, which has now increased to 31%. As such 1986 traffic count data was used with 1994 truck volume data to obtain the general trend of growth of different axles configurations of trucks. A comparison on 10 stations have been shown in Table below. The graphical presentation of the data is shown in Fig 5.7, which indicates general trend of growth rates of 2 axles, 3 axles and more than 3 axle trucks. As can be seen, the growth rates of 2-Axle trucks on these stations ranges from almost negligible to 8% except on one station where it was 17.48%.

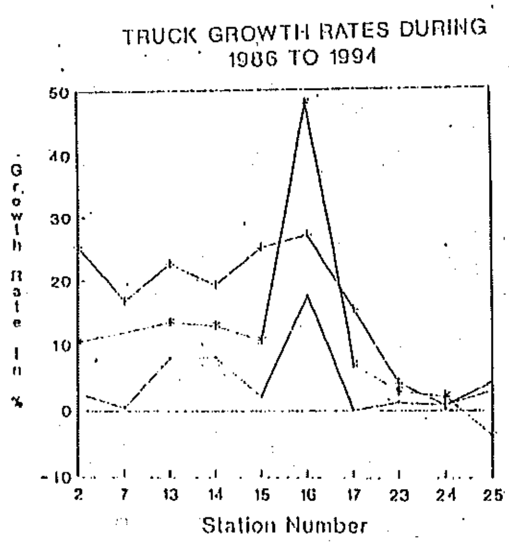
TRUCK GROWTH RATES DURING 1986 TO 1994 PERIOD

Number of Axles

St.No.	Station	2-Axles	3-Axles	> 3-Axles
2	Karachi-Hyderabad	2.63	25.37	10.42
7	Jaccobbabad-Sibbi	0.46	16.79	0*
13	Multan-Sahiwal	7.92	22.64	13.43
14	Okara-Lahore	7.98	19.28	12.88
15	Lahore-Gujranwala	2.13	25.07	10.62
16	Wazirabad-Gujrat	17.48	27.02	47.88
17	Gujrat-Jhelum	0.05	15.42	6.97
23	Chablat-Nowshera	1.21	4.08	2.86
24	Nowshera-Peshawar	0.79	0.85	2.08
25	Peshawar-Tourkham	2.98	4.18	-3.82

* Not encountered

Fig. 5.7



_._ 2-Axle Truck

-+- 3-Axle Truck

-*- < 3-Axle Truck

However, the growth rates of multi-axles have a range of about 1% to 27%. The growth rates of multi-axle vehicle are about 2-4 times the growth rates of the 2-Axle trucks at respective stations. Moreover, it is also evident that growth rates of multi-axle vehicle on most of the stations is much higher than the general growth rate (9%) of truck fleet in the country. Also on some stations, the growth rates are much higher as compared to others or previous data. As on Karachi-Hyderabad section, the growth rate of 3-Axle trucks is 10 times of 2-Axle trucks. The growth of 2-Axle trucks on most stations is more or less stagnant and on the average much less than the average growth rate of the truck fleet in the country.

6 AXLE LOADS

In research work correct interpretation of data is as important as collection of data and unless right conclusions are drawn the acquisition of numerical results has little value, or no value at all. It is worthwhile to note that although the prime objective of the survey was to determine the axle loads of goods vehicles of different axle configurations and to determine their damaging effect in terms of equivalent standard axles, however, comprehensive information was collected, ranging from make, type of vehicle, commodities carried, origin and destination of trucks alongwith tyre pressures etc. which are cardinal indicators of socio-economic activity of the region as well as the country.

A comprehensive statistical methodology was designed to extract the right information from the data and later to draw inferences. Retrospectively data was matched and compared with other contemporary studies as well as with NTRC-1982 study.

Statistical analysis and interpreted results spread over tables, bar charts, and graphs and explanations wherever felt necessary have been provided.

6.1 Scope and Coverage of Survey

In total, 4768 trucks of various axle configurations were weighed at 30 survey stations, comprising both loaded and empty vehicles. Table at Annexure 6-A provides the number of trucks weighed at each station, alongwith survey station and highway section. Also the schedule of survey alongwith duration can be seen at Annexure 6-B.

6.2 Axle Configuration

Each axle is represented by a digit usually a 1 or 2 depending on how many wheels are on the end of the Axle. Tandem axles are indicated by recording the digits directly after each other. A decimal point is placed between the code for a vehicle's front & back wheels. The code for trailers is recorded in the same way as for trucks but is separated from the truck code by a "+" sign. Semi Trailers or articulated trailers are separated by a "-" sign.

For example code 1.2 means that the vehicle has a front axle with a single wheel and a rear axle having a pair of wheels on either side. This is the most common configuration observed during this study. Code 1.22 means single wheel on front axle and there is a tandem axle in the rear having dual wheels. Code 1.2-22 type of vehicle consists of a truck mounted trailer having a tandem axle in the rear, the front axle of the truck and the common axle in the middle are single axles and so on. A complete axle configuration and codes of trucks is presented in Figure 6.2.

6.3 Survey Timings and Duration

All stations where truck traffic volume was low, 24 hours survey was carried out while where truck traffic was high, 48 hours split survey was carried out, with 24 hour in each direction.

6.4 Composition of Trucks by Axle in Truck Volume

All the vehicles surveyed were classified according to discrete axle configuration. Also equally important is that the market share of multi axles has increased from a non-existent in 1982 to more than 30 % in 1994. The table shows the respective percentages by axle configuration. It is evident that 2 and 3 axles together form 92% of the truck population.

6.5 Distribution of Loaded and Empty Trucks

Table 6.5 provides distribution of loaded and empty vehicles among discrete axle configurations for the truck surveyed.

TABLE 6.5

DISTRIBUTION OF LOADED & EMPTY TRUCKS

Sl. No.	Description	Code	Loaded	Empty	Total
1	2-AXLE	1.2	3153	116	3269
2	3-AXLE (Single)	1.2-2	130	8	138
3	3-AXLE (R. Tandem)	1.22	985	28	1013
4	4-AXEL (Single)	1.2+2.2	38	5	43
5	4-AXLE (M. Tandem)	1.22-2	04	-	4
6	4-AXLE (R. Tandem)	1.2-22	234	8	242
7	5-AXLE (Tandem)	1.22-22	9	1	10
8	6-AXLE (T. Tridem)	1.22+222	37	3	40
9	OTHERS	-	9	-	9
		Total	4599	169	4768

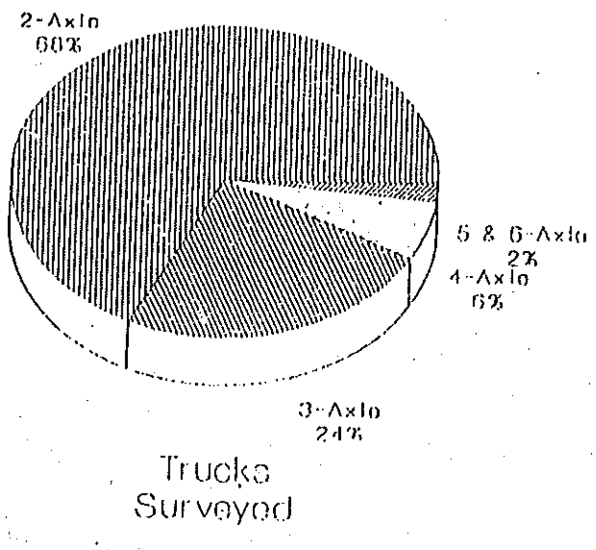


Fig. 6.5 COMPOSITION OF TRUCKS BY AXLE SURVEYED

6.6 **Distribution Of Trucks According To Gross Loads 2-Axle Trucks.**

This type of truck was observed on all the 30 stations, out of which 13 stations have the average gross load of 15 to 16 tonnes while at 10 stations, the average gross load was observed between 16 to 17 tonnes. At other 17 stations, average gross load was greater than 17 tonnes.

3-Axle Single Trucks. This type of truck was observed at 15 stations only. At 7 stations, the average gross load of this type lies between 25 to 30 tonnes, while at the other 8 stations the average gross load was observed between 30 to 40 tonnes.

3-Axle Tandem Trucks. This type of truck was observed at 28 stations. At 10 stations, the average gross load was between 25 to 30 tonnes, while on 17 stations, it was between 30 to 40 tonnes and only at one station, the average gross load was greater than 40 tonnes.

4-Axle Single Trucks. This type of truck was observed on 8 stations. At 5 stations, the average gross load lies between 35 to 40 tonnes, while at the remaining 3 stations, the average gross load lies between 40 to 50 tonnes.

4-Axle Mid Tandem Trucks. The average gross load of this type of truck was found to be 35 tonnes.

4-Axle Rear Tandem Trucks. This type of trucks were observed on 19 stations. At 9 stations, the average gross load was observed between 30 to 40 tonnes while at the 10 stations, it was above 40 tonnes.

5-Axle Tandem Trucks. The average gross load of this type of truck was found about 45 tonnes.

6-Axle Tandem Tridem Trucks. This category was observed on 10 stations only. It constitutes 1% of truck population but carries very large gross load. Loads upto 80 tonnes have been recorded. But usually they carry loads between 60 to 70 tonnes.

6.7 Distribution Of Front And Rear Axle Loads

The distribution of front and rear axle loads for different types of axle configurations in terms of ratios is shown in Table 6.7.

TABLE 6.7

DISTRIBUTION OF FRONT & REAR AXLE LOADS

Description	Code	Front	Rear1	Rear2	Rear3	Rear4	Rear5
2-Axle	1.2	31	69	-	-	-	-
3-Axle Single	1.2-2	21	40	39	-	-	-
3-Axle Tandem	1.22	21	39	40	-	-	-
4-Axle Rear Tandem	1.2-22	14	30	28	28	-	-
5-Axle Tandem	1.22-22	12	20	20	24	24	-
6-Axle T.Tridem	1.22+222	11	17	18	18	18	18

6.8 Average Axle Loads Of All Trucks For All Stations

Average axle loads at 30 stations were calculated in accordance with the described axle configurations. Tables 6.8.1 to 6.8.9 placed at statistical appendix provide the average axle loads for each axle configuration including maximum and minimum, standard deviation and variance values among the 30 stations.

6.8.1 Average Axle Loads Of 2-Axle Trucks

2-Axle trucks dominate the truck composition making 2/3rd of the total truck population. A total of 3269 trucks including 116 empty were weighed in this category. Table 6.8.1. at the statistical appendix lists average axle load for all the 30 stations combined with standard deviation, minimum and maximum values and variance. In this class of truck, average loads are highest at Karachi-Gaddani section with gross average axle load of 19.31 tonnes, which is 22% higher than the average gross load for all stations combined, mainly due to the fact that mostly, steel scrap from ship breaking industry of Gaddani is transported through this section of highway, while Lahore-Okara section has minimum average gross load of 14.27 tonnes and is 13% lower than the average gross load for all stations combined for 2-axle trucks.

6.8.1.1 Distribution of Load Over Front & Rear Axles for 2-Axle Trucks Loaded.

The average gross load for loaded trucks was 16.06 tonnes for all stations combined while that on front axle was 4.93 tonnes and on rear axle was 11.13 tonnes, resulting in an average load distribution between front and rear axles in ratio term as 31:69 when compared with NTRC 1982 study, the results are nearly similar which also shows a ratio of 31:69 between front and rear axle.

Empty. The average gross load of the empty 2-axle truck, was 6.57 tonnes, while that on the front axle, it was 2.97 tonnes and on the rear axle, it was 3.60 tonnes. For empty 2-axle truck, the ratio between front and rear axle was found to be 45:55.

6.8.1.2 Average Axle Load According to Make for 2-Axle Trucks

In all, 4 major makes were identified out of 18 listed at Annexure 6-C. The number of observations for each make shows that Bedford dominate the scene with lion's share of 76% while Hino, Isuzu and Nissan constitute 17%, 4% & 2% respectively. While other makes like Ford, Mazda etc are 1%. Statistical details of 2-axle trucks by different makes is given in the table given at next page:

BEDFORD 2-AXLE TRUCK

	Front (tonnes)	Rear (tonnes)	Total (tonnes)
Average	4.74	10.70	15.44
Standard Deviation	0.95	2.55	3.25
Varicean	0.90	6.52	10.54
Maximum Value	8.50	22.00	28.13
Minimum Value	2.10	2.45	4.80

HINO 2-AXLE TRUCK

	Front (tonnes)	Rear (tonnes)	Total (tonnes)
Average	5.74	12.78	18.52
Standard Deviation	1.06	2.86	3.61
Variance	1.12	8.15	13.00
Maximum Value	10.18	24.65	31.03
Minimum Value	2.95	4.30	7.91

ISUZU 2-AXLE TRUCK

	Front (tonnes)	Rear (tonnes)	Total (tonnes)
Average	5.45	12.95	18.40
Standard Deviation	1.26	3.81	4.53
Variance	1.58	14.53	20.48
Maximum	9.25	24.60	31.30
Minimum Value	2.93	3.44	6.37

NISSAN 2-AXLE TRUCK

	Front (tonnes)	Rear (tonnes)	Total (tonnes)
Average	6.07	13.38	19.45
Standard Deviation	1.19	2.81	3.74
Variance	1.42	7.87	13.97
Maximum Value	8.45	22.54	29.85
Minimum Value	3.30	4.70	8.00

From above tables, it is observed that the Nissan has the average gross load of 19.45 tonnes, the highest one, while the Bedford has an average gross load load of 15.45 tonnes which is the lowest. The table given below provides the comparison for 2-axle loaded truck by different makes for average gross load.

COMPARISON OF 2-AXLE TRUCKS BY MAKE

Sl. No.	Make	Average Gross Load (tonnes)	Ratio
1.	Bedford	15.45	1.00
2.	Hino	18.53	1.20
3.	Isuzu	18.40	1.19
4.	Nissan	19.45	1.26
5.	Mazda	7.17	0.46

6.8.1.3 Average Axle Loads According to Commodity Carried for 2-Axle Trucks.

Major commodities transported by 2-axle trucks are mining and quarrying items having an average gross load of 18.04 tonnes follows by fuel and lubricant items having an average gross load of 16.85 tonnes. Details of statistical analyses for different commodities carried by this type of truck is given in Table 6.8.1.3 at statistical appendix.

6.8.2 Average Axle Loads of 3-Axle Single Trucks.

This type of truck constitute a meager proportion of the total truck population. It is note worthy that trucks in this category were found in sizeable amount only on five sections among the 30 stations surveyed. Four sections are between Wazirabad-Chablat on N-5 and one between Peshawar-Kohat on N-5. Primarily, this type of truck are owned by NLC while the private ownership is very small. In all 138 trucks of this type were surveyed with 130 loaded while 8 were empty. Average axle loads with standard deviation for both loaded and empty vehicles are listed in Table 6.8.2 at statistical appendix.

6.8.2.1 Distribution of Load Over Front & Rear for 3-Axle Single Trucks.

Loaded. The average gross load of loaded trucks for this type was found to be 31.5 tonnes with 6.74 tonnes on the front axle and 12.59 tonnes and 12.17 tonnes on rear1 and rear2 axles respectively. The ratio of the loads among the axles is in the order of 21:40:39.

Empty. The average gross load of the empty trucks of this type is found to be 12.17 tonnes with 3.85 tonnes on the front axles and 4.38 tonnes and 3.94 tonnes on the respective rear axles. The distribution is found to be as 32:36:32.

6.8.3 Average Axle Load of 3-Axle Trucks (Rear Tandem).

This type of truck occupy the second largest chunk of the total truck population, and their percentage among trucks composition has risen sharply over the last decade. In all 1013 trucks of this configuration were weighed including 985 loaded and 28 empty. Table 6.8.3 at statistical appendix provides average axle loads for front, rear1 and rear2 axles and gross load, with maximum and minimum value alongwith standard deviation. As explained earlier average axle load for this type of truck at Karachi-Gaddani section is the highest. While the Quetta-Chaman section is the lowest, closely followed by Okara-Lahore section.

6.8.3.1 Distribution of Load Over Front and Rear Tandem

Loaded. The average gross load for this type of loaded vehicle was found to be 31.61 tonnes with 6.74 tonnes at front, 12.37 tonnes at rear1 and 12.51 tonnes at rear2 axle. The distribution in terms of ratio is found to be 21:39:40 or simply the ratio on front and rear tandem is 20:80.

Empty. The average gross load of the empty vehicle in this category was found to be 10.84 tonnes with a distribution of 3.55 tonnes, 3.85 tonnes and 3.45 tonnes on the front axle & rear axles. The distribution of load in terms of ratio is found to be as 32:36:32 for the front, rear1 & rear2 axles respectively.

6.8.3.2 Average Axle Load According to Make for 3-Axle Rear Tandem.

In all six major makes of this type of truck were observed. Details of different makes for this type of truck according to makes are given in following tables.

BEDFORD 3-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Total (tonnes)
Average	5.91	12.13	11.74	29.78
Standard Deviation	0.79	2.26	1.82	4.21
Variance	0.62	5.11	3.32	17.73
Maximum Value	7.55	17.00	14.66	36.21
Minimum Value	4.28	8.72	6.70	19.70

HINO 3-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Total (tonnes)
Average	6.59	12.01	12.09	30.69
Standard Deviation	1.37	2.63	2.76	6.11
Variance	1.87	6.91	7.61	37.35
Maximum Value	10.35	20.18	19.79	48.07
Minimum Value	2.99	4.38	0.00	11.69

ISUZU 3-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Total (tonnes)
Average	6.27	10.48	11.17	27.92
Standard Deviation	1.05	2.54	2.91	5.92
Variance	1.10	w6.44	8.49	35.07
Maximum Value	8.61	17.95	21.00	47.45
Minimum Value	4.10	5.40	5.00	17.00

MERCEDES 3-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Total (tonnes)
Average	8.44	12.92	13.64	35.01
Standard Deviation	1.58	2.30	2.03	4.55
Variance	2.50	5.30	4.14	20.66
Maximum Value	12.09	19.10	19.35	50.54
Minimum Value	5.40	8.33	10.90	28.08

NISSAN TRUCK 3-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Total (tonnes)
Average	6.48	12.32	12.35	31.15
Standard Deviation	1.53	2.68	2.67	6.14
Variance	2.33	7.20	7.12	37.76
Maximum Value	10.79	18.85	20.60	47.97
Minimum Value	3.44	4.05	3.60	12.03

From the above tables, it is cleared that the Mercedes make in this category of trucks has the highest average gross load of 35.01 tonnes follows by Nissan which carries the average gross load of 31.15 tonnes.

COMPARISON OF 3-AXLE REAR TANDEM TRUCK

Sl. No.	Make	Gross Loads (tonnes)	Ratio
1.	Bedford	29.78	1.00
2.	Hino	30.69	1.03
3.	Isuzu	27.92	0.94
4.	Mercedes	35.01	1.18
5.	Nissan	31.15	1.05

6.8.3.3 Average Axle Load According to Commodities Carried by 3-Axle Rear Tandem Trucks.

Major commodities transported by 3-axle rear tandem truck are mining and quarrying items having an average gross load of 34.28 tonnes following by bulk manufacture items with a value of 33.62 tonnes. Details of statistical analyses for different commodities carried by this type of truck is given in table 6.8.3.3 at statistical appendix.

6.8.4 Average Axle Loads of 4-Axle Single Trucks.

This axle configuration constitutes a small percentage of truck population, like 3-Axle Single trucks. Table 6.8.4 at statistical appendix provides average axle load for 8 stations, where this type of trucks were observed, alongwith the standard deviation, minimum & maximum values.

6.8.4.1 Distribution of Load Over Front & Rear Axle.

Loaded. Average gross load of the trucks in this category was found to be 39.71 tonnes, with 5.92 tonnes, 11.66 tonnes, 11.23 tonnes and 10.89 tonnes on front, rear1, rear2 and rear3 axles respectively. Similarly, load distribution in ratio among the axles is as 14:30:28:28.

Empty. Average gross load of the empty trucks in this category was found to be 17.19 tonnes, with 4.43 tonnes, 4.42 tonnes, 4.23 tonnes and 4.11 tonnes on front, rear1, rear2 and rear3 axles respectively. The distribution of load among the axles in ratio form is as 29:29:21:21.

6.8.4.2 Average Axle Load According to Make for 4-Axle Single Trucks.

In all 3 major makes were identified on the road out of that 18 listed in Annexure 6-C. A number of observations for each make shows that Nissan dominate the scene followed by Mercedes and Isuzu. The average gross load of 40.92 tonnes was observed on Nissan while 37.95 tonnes, 35.19 tonnes on Mercedes and Isuzu respectively.

Comparison. A comparison of average gross load carried by three different makes in this category of trucks is shown in table below.

COMPARISON OF MAKES OF 4-AXLE SINGLE TRUCKS

Sl. No.	Make	Gross Loads (tonnes)	Ratio
1.	Isuzu	35.19	1.00
2.	Mercedes	37.95	1.08
3.	Nissan	40.92	1.16

6.8.4.3 Average Axle Load According to Commodity for 4-Axle Single Trucks.

Major commodities carried by this type of truck are the fuel and lubricants items with an average gross load value of 34.67 tonnes follows by bulk manufactured items with an average gross load value of 42.22 tonnes. Details of statistical analyses for different commodities carried by 4-axle single type trucks is given in Table 6.8.4.3 at the statistical appendix.

6.8.5 Average Axle Loads of 4-Axle Mid Tandem Trucks.

On all the 30 stations, only 4 trucks of this type were observed, it is, therefore, supposed that they do not contribute to truck composition. However, the average gross load of this type is 35.14 tonnes with 5.69 tonnes, 10.42 tonnes, 9.64 tonnes, 9.40 tonnes on front, rear1, rear2 and rear3 axles respectively.

6.8.6 4-Axle Rear Tandem Trucks.

This category of truck ranks third on percentage basis for total truck population, constituting 5% of the total truck composition. Their numbers have been rising significantly over the last few years. In all 242 trucks of this type of trucks were weighed on 19 stations. Loaded trucks numbered 234 while empty were 8. Table 6.8.6 at statistical appendix provided an average axle loads with minimum and maximum alongwith standard deviation for the loaded and empty trucks.

6.8.6.1 Distribution of Load over Front & Rear Axles for 4-Axle Rear Tandem Trucks.

Loaded. The gross average load of this type of truck is 37.89 tonnes with 4.91 tonnes on front axle, 12.28 tonnes on rear1, 10.35 tonnes on rear2 and 10.41 tonnes on rear3 axle. Similarly load distribution in terms of ratio for loaded trucks of this type is 16:30:27:27.

Empty. The average gross load of this type of truck in empty state is 19.56 tonnes with 4.07 on front, 5.11 tonnes on rear1, 5.32 tonnes on rear2 and 5.06 tonnes on rear3.

6.8.6.2 Average Axle Loads According to Make for 4-Axle Rear Tandem Trucks.

In all 4 major makes were identified for this type of trucks out of that 18 listed in Annexure 6-C. A number of observations for each make shows that Hino has beared the highest gross load with the value of 40.19 tonnes.

HINO 4-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Rear3 (tonnes)	Total (tonnes)
Average	4.89	13.01	10.56	11.73	40.19
Standard Deviation	0.91	3.73	3.08	3.46	10.55
Variance	0.83	13.93	9.49	12.00	111.27
Maximum Value	7.15	21.10	16.35	17.70	60.35
Minimum Value.	3.56	5.63	6.20	6.03	22.74

MERCEDES 4-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Rear3 (tonnes)	Total (tonnes)
Average	5.46	12.47	10.57	10.31	38.81
Standard Deviation	1.04	2.22	1.92	1.45	4.73
Variaenc	1.07	4.93	3.67	2.10	22.41
Maximum Value	7.29	14.37	13.55	12.82	44.77
Minimum Value	4.40	7.45	7.50	7.84	30.96

ISUZU 4-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Rear3 (tonnes)	Total (tonnes)
Average	5.01	11.58	10.77	9.84	37.19
Standard Deviation	0.62	2.78	2.89	2.24	7.20
Variance	0.38	7.74	8.37	5.02	51.78
Maximum Value	6.11	15.73	15.36	14.56	48.61
Minimum Value	3.72	7.10	6.70	6.50	24.84

FIAT 4-AXLE REAR TANDEM TRUCK

	Front (tonnes)	Rear1 (tonnes)	Rear2 (tonnes)	Rear3 (tonnes)	Total (tonnes)
Average	6.58	11.81	9.42	7.69	35.51
Standard Deviation	1.26	1.19	1.33	1.81	1:45
Variance	1.58	1.41	1.76	3.27	2.10
Maximum Value	7.75	13.48	10.94	10.43	37.81
Minimum Value	4.66	9.79	7.61	5.31	33.34

6.8.6.3 Average Axle Loads of 4-Axle Rear Tandem according to Commodities Carried.

Major commodities transported by 4-Axle Rear Tandem type trucks are food items with a value of average gross load of 42.25 tonnes follows by bulk manufacture items having a value of average gross load of 41.82 tonnes. Statistical analyses of different commodities carried by this type of trucks is mentioned in Table 6.8.6.3 in the statistical appendix.

6.8.7 Average Axle Loads of 5-Axle Tandem Trucks.

Out of the 30 stations surveyed, only 10 trucks of this type were observed. Therefore, it is supposed that this type of trucks does not contributed any significant part in the spectrum of trucks. The average gross load of this type of trucks was observed as 47.17 tonnes for loaded ones, while for the empty this value is 23.44 tonnes.

6.8.8 Average Axle Loads of 6-Axle Tandem Tridem Trucks

6-Axle Tandem Tridem trucks contributed only 2% of the total population of trucks. But they carry very high gross load upto 80 tonnes. Table 6.8.8 at statistical appendix provides the statistical analysis where this type of truck were observed.

6.8.8.1 Distribution of Load Over Front & Rear Axles

Loaded. Average gross load of the trucks in this category was found to be 58.68 tonnes with 6.11 tonnes, 10.34 tonnes, 10.56 tonnes, 10.56 tonnes, 10.77 tonnes and 10.38 tones on front, rear1, rear2, rear3, rear4 and rear5 axles respectively. It is clearly seen that the average load on the rear axles of this type of trucks is nearly equally distributed.

Empty. The average gross load of the empty 6-axles tandem tridem trucks was 23.35 tonnes, with 5.29 tonnes, 3.17 tonnes, 3.49 tonnes, 3.11 tonnes, 4.03 tonnes, on front, rear1, rear2, rear3, rear4 and rear5 respectively.

6.8.8.2 Average Axle Load According to Make for 6-Axle Tandem Tridem Trucks.

In all, 4 major makes were identified in this type of trucks. Mercedes bears the highest gross load with a value of 65.96 tonnes in this class of trucks. Average gross loads of other makes in this class of trucks is mentioned in the following tables.

AVERAGE AXLE LOADS OF 6-AXLE TANDEM TRIDEM TRUCKS BY MAKE

Make	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
Mercedes	6.37	11.88	11.61	11.81	12.96	11.33	65.96
Mitsubishi	7.03	10.50	11.03	10.59	10.50	9.70	59.33
Renault	6.42	9.47	9.93	8.10	9.13	9.42	52.47
Volvo	5.88	8.45	9.06	9.93	10.33	10.59	54.24

6.8.8.3 Average Axle Loads of 6-Axle Tandem Tridem Trucks by Commodities Carried.

Major commodities transported by 6-axle tandem tridem trucks are agriculture items, bulk manufacture items and food. The average gross load of this type of truck was found highest in the case of agriculture commodities with a value of 66.57 tonnes. Details of statistical analysis for different commodities carried by this type of truck is given in Table 6.8.8.3 at statistical appendix.

6.8.9 Average Axle Loads of Tractor Trollies

During the survey, nine tractor trollies were weighed. The average gross load of tractor trolly was found to be 9.36 tonnes. On the front axle, average axle load was 0.55 tonnes, while on the rear1 and rear2 axle, the average axle load was 2.19 tonnes and 6.63 tonnes respectively.

6.9 Load Spectrum

The high rate of deterioration of pavement due to high axle load is a matter of grave concern for highway agencies as well as for designers, planners and maintenance agencies. As huge amount of finances are required to construct highways and to maintain them, therefore for a developing country like Pakistan, it is an enormous burden on the scares national resources.

Keeping in mind the utmost importance of the over loading problem, it is tried in this survey to depict the true picture of distribution of axle loads among the all axles weighed.

6.9.1 Rear Axle Load Spectra

The damaging effect of front axle loads on the road pavement structure is not significant. Therefore, rear axles of all the trucks according to discrete axle configuration were analysed and results are provided in table 6.9.1 at statistical appendix. Following table shows the spectrum of rear axle loads by taking all axles together.

REAR AXLE LOADS SPECTRA FOR ALL AXLE CONFIGURATION

Range (tonnes)	Freq.	Percent	Cum%	% Above Range Value
0 - 8.16	623	11.82	11.82	88.18
8.16 - 9.99	936	14.57	26.39	73.61
10.00 - 10.99	830	12.92	39.32	60.69
11.00 - 11.99	1115	17.36	56.68	43.33
12.00 - 12.99	1007	15.68	72.36	27.65
13.00 - 13.99	781	12.16	84.52	15.49
14.00 - 14.99	418	6.51	91.03	8.98
15.00 - 19.99	550	8.56	99.60	0.42
20.00 & above	26	0.40	100	0.00

It is evident from the above table that 73.31% of rear axle loads exceed 10 tonnes and 43.33% exceed 12 tonnes while only 27.33% exceed the 13 tonnes value.

Table 6.9.1 depicts cumulative percentages for 2-Axle configuration for each station, alongwith average values standard deviation and maximum and minimum values. Karachi-Thatta section has the maximum percentages of 83.33 and 54.17 rear axles exceeding 12 tonnes and 13 tonnes axle load respectively. Haripur-Abbottabad section has percentages of only 14.29 and 2.75 exceeding 12 tonnes and 13 tonnes axle load respectively. While on Okara-Lahore section, 15% exceed 12 tonnes value while 5.6% exceed 13 tonnes axle load. It can be deduced from the table 6.9.1 that on the average 40% of rear axles exceed 12 tonnes while 23% exceed 13 tonnes axle load value.

In the 3-Axle (Single) configuration 64% of rear axles exceed 12 tonnes and 41% exceed 13 tonnes axle load. While for 3-Axle rear tandem which constitute 20% of truck population,it can be seen from table 6.8.6 that these trucks are heavily laden,consequently 58% of rear axles exceed 12 tonnnes axle load while 41% exceed 13 tonnes axle load. It can be observed from table 6.9.3 that at Karachi-Gaddani section only 17% rear axles are below 13 tonnes axle load, but their numbers are relatively very small as compared to 2-Axle trucks on that section. In case of 4-Axle (rear tandem) trucks around 52% rear1 axles exceed 12 tonnes while 32% of rear2 and rear3 exceed 13 tonnes axle load value. Similarly for 6-Axle trucks which form a very small percentage of trucks, 30% of rear1, rear2 and rear3 axles exceed 12 tonnes axle load, while the percentage for rear4 and rear5 axles exceeding 12 tonnes value was found as 38 and 32 respectively. For 13 tonnes axle load the concurrent rear axles percentages were determined as 14, 14, 22, 37 and 32 respectively for the 6-Axle trucks.

It was found that rear axles of trucks carrying basic manufacture, bulk manufacture and food items exceed 12 tonnes and 13 tonnes values by a wide margin.

6.10 Tyre Pressure Measurements

For economic reasons, the trucks are mostly overloaded. To offset the effect of overloading, tyres are over-inflated far in excess of their normal pressure capacity.

The measurements of tyre pressure was not included in the scope of the study. Keeping in view the importance, of this factor, tyre pressures were measured during second round of the survey from station No.16 (Wazirabad-Gujrat) and onward. Following table shows average values of the tyre pressure on front and rear axles of the different axle configurations, while Tables 6.10.1 to 6.10.7 placed at statistical appendix provide the average tyre prssures station wise, alongwith maximum and minimum values.

Average Tyre Pressure

Description	Code	Front	Rear1	Rear2	Rear3	Rear4	Rear5
2-Axle	1.2	109.08	127.67				
3-Axle (Single)	1.2-2	115.40	138.90	138.97			
3-Axle (R.Tandem)	1.22	124.66	137.77	137.91			
4-Axle (Single)	1.2+2.2	117.50	146.25	146.75	145.94		
4-Axle (R.Tandem)	1.2-22	118.06	137.36	137.36	137.36		
6-Axle (T.Tridem)	1.22+ 222	129.17	132.33	133.06	132.91	133.33	132.92

However, it was noticed from the measurements that almost 100% of the tyres are inflated in excess of their rated capacities. Tyre pressures as high as 160 psi was recorded during this survey.

7 EQUIVALENT STANDARD AXLES

7.1 General Description

Traffic is considered in terms of equivalent standard axle load repetitions in the design of pavement. When an axle passes over a point on the pavement, the layers underneath that point are stressed and strained. Most of the strain is recovered over a short period, but some strain remains unrecovered. This residual strain accumulates over time resulting in deterioration of the pavement structure. Many design techniques limit the critical strains below allowable levels but excessive deformation occurs when the pavement layers are continuously overstressed due to heavy load passes.

7.2 Average Equivalent Standard Axles (Equivalence Factors)

The standard Axle is the damage caused to a pavement by the passage of an axle loaded to 8165 kg. The damage caused to the pavement by different axles is converted into equivalent standard loads and are summed up for the design life of the pavement. For this study, two approaches have been adopted to convert axle loads into equivalent standard axles. These are described in para 2.8 of the Chapter-2. The first approach which we may call RN31 (U.K.) approach is based on the 4.5th power law. The second is based on the equivalence factors given in the AASHTO Design Guide, 86. A structural value (SN) of 5.0 and a terminal serviceability index (Pt) 2.5 was assumed for determining equivalence factors from AASHTO Guide.

7.2.1 As Per RN31, UK.

Average equivalent standard axle factors at all the 30 stations were calculated in accordance with the discrete axle configurations. The table given below provides average ESA values for each axle configuration among the 30 stations as per RN31, UK approach.

AVERAGE ESA's FOR THE DISCRETE AXLE CONFIGURATIONS FOR ALL STATIONS (AS PER RN31, UK)

St No	Station	Code 1.2	Code 1.2-2	Code 1.22	Code 1.2+2.2	Code 1.2-22	Code 1.22+222
1	Karachi-Gaddani	23.59	23.37	46.54	9.13	6.15	
2	Karachi-Hyderabad	6.94	26.13	22.05	16.49	25.53	
3	Karachi-Thatta	6.15		22.29	9.61	14.74	8.27
4	Hyderabad-Larkana	5.80	10.49	11.18	12.83	15.55	4.55
5	Sakrand-Kandiaro	5.49	36.08	24.79	28.79	20.97	28.42
6	Khairpur-Rohri	8.66		25.10		28.90	11.68
7	Jaccobbabad-Sibbi	7.58		9.05	7.43		
8	R.Y.Khan-Sadiqabad	5.81		13.13	18.13	11.48	19.84
9	Chanigot-Bahawalpur	7.31	14.45	15.08		25.38	14.39
10	Multan-D.G.Khan	10.86		8.03		20.24	9.49
11	Kashmore-D.G.Khan	5.11		15.42		14.44	
12	Taunsa-D.G.Khan	4.33		10.13		25.81	
13	Sahiwal-Multan	5.73		20.13	11.87	29.58	36.46
14	Okara-Lahore	3.32		10.55		10.24	
15	Lahore-Gujranwala	5.04		21.54		25.59	39.63
16	Wazirabad-Gujrat	5.00	17.91	27.10			69.84
17	Gujrat-Jhelum	6.12	12.78	17.41			
18	Jhelum-Rawalpindi	6.27	26.14	34.37	44.22		76.68
19	Rawalpindi-Chablat	4.89	9.59	11.91	31.52	6.10	
20	Hasanabdal-Haripur	4.47	5.19	15.55			
21	Haripur-Abbottabad	3.98	16.23	19.31			
22	Abbottabad-Manshera	4.92					
23	Chablat-Nowshera	6.06	11.86	21.49		9.13	
24	Nowshera-Peshawar	5.82		14.66			
25	Peshawar-Tourkham	6.51	13.05	23.76			15.18
26	Peshawar-Kohat	4.73	10.88	13.90		9.14	
27	Bannu-D.I.Khan	7.33	15.22	16.26		8.28	
28	Fortminro-Q.Saifullah	5.79					
29	Quetta-Chamman	4.20		6.94			
30	Quetta-Nowshki	6.94		19.65		11.50	
	Average	6.49	16.62	18.48	19.00	17.30	27.96
	Standard Deviation	3.50	7.80	8.32	11.42	7.67	22.81
	Variance	12.26	60.88	69.16	130.41	58.85	520.51
	Maximum Value	23.59	36.08	46.54	44.22	29.58	76.68
	Minimum Value	3.32	5.19	6.94	7.43	6.10	4.55

It is clear from the above table that the value of average ESA/truck for different axle configurations of truck ranges from 6.49 for 2-Axle truck to 27.96 for 6-Axle tandem tridem truck. The highest value of average ESA for 2-Axle truck was 23.59 at Karachi-Gaddani section, while the lowest value of average ESA for 2-Axle truck was 3.32 at Okara-Lahore section.

For 3-Axle(Single) truck, the highest value of average ESA was found as 36.08 at Sakrand-Kandiaro section, while the lowest value of average ESA for 3-axle(single) truck was 5.19 at Hassanabdal-Haripur section. The highest value of average ESA for 3-Axle rear tandem truck is equal to 46.54 and was calculated for Karachi-Gaddani section. While the lowest value of average ESA for the same type of truck was 6.94 at Quetta-Chamman section. The highest value of average ESA for 4-Axle Single truck equals to 44.22 and was found at Jhelum-Rawalpindi section, while the lowest value of average ESA for 4-Axle single truck was 7.43 at Jaccobabad-Sibbi section. Similarly the highest value of ESA for 4-Axle rear tandem truck was determined as 29.58 for Sahiwal-Multan section, while the lowest value of average ESA was 6.10 at Rawalpindi-Chablat section. For the 6-Axle tandem tridem truck the highest average ESA value is equal to 76.68 and was found at Gujrat-Wazirabad section, while the lowest value of average ESA was 4.55 at Hyderabad-Larkana section. Tables 7.2-A to 7.2-H, placed at statistical appendix provide the average equivalent standard axle values for discrete axle configurations.

7.2.2 Directional Distribution of ESA's as per RN31, UK.

Equivalent Standard Axle values for discrete axle configuration were also calculated by direction wise for all 30 stations. Tables 7.2-a to 7.2-h placed at Statistical Appendix provide the direction-wise values of these factors. It is observed from these tables that the value of ESA's for 2-Axle truck at Karachi-Gaddani section is 11.49 while its value is 32.77 at Gaddani-Karachi section. Similarly, a big difference between the values is observed for this particular type of trucks, at Multan-D.G.Khan ESA's value is 2.95 as compared to 16.04 for D.G.Khan-Multan section. For 3-Axle Rear Tandem Truck, the value of ESA's for Karachi-Hyderabad Section was 35.58 as compared to 9.16 for Hyderabad-Karachi Section. Similarly, a difference of ESA's values in each direction was observed at Karachi-Gaddani, Karachi-Thatta, Khairpur-Rohri and Noshki-Quetta Section. For 4-Axle Rear Tandem truck, the major difference of ESA's value was observed at Khairpur-Rohri, Karachi-Hyderabad, Lahore-Gujranwala and Multan-Sahiwal sections.

7.2.3 As Per AASHTO Design Guide 86

Average equivalent standard axle at all the 30 stations were calculated in accordance with the discrete axle configurations based on AASHTO Design Guide 86. The table given below provides average ESA values for each axle configuration among 30 stations.

AVERAGE ESA's FOR THE DISCRETE AXLE CONFIGURATIONS FOR ALL STATIONS (AS PER AASHTO)

St No	Station	Code 1.2	Code 1.2-2	Code 1.22	Code 1.2+2.2	Code 1.2-22	Code 1.22+222
1	Karachi-Gaddani	13.09	16.40	20.27	7.87	4.50	
2	Karachi-Hyderabad	4.94	11.22	9.98	12.32	13.70	
3	Karachi-Thatta	4.40		10.55	7.76	8.84	6.57
4	Hyderabad-Larkana	4.60	8.49	5.66	9.09	9.28	3.25
5	Sakrand-Kandiaro	4.17	23.91	11.37	19.53	10.96	11.84
6	Khairpur-Rohri	5.90		11.44		15.69	6.81
7	Jaccobbabad-Sibbi	4.25		4.85	8.57		
8	R.Y.Khan-Sadiqabad	4.37		6.31	10.45	7.24	10.37
9	Chanigot-Bahawalpur	5.22	11.18	7.34		14.53	6.75
10	Multan-D.G.Khan	7.37		4.55		12.01	5.10
11	Kashmore-D.G.Khan	3.84		7.58		9.49	
12	Taunsa-D.G.Khan	3.33		5.26		14.93	
13	Sahiwal-Multan	4.26		9.55	9.30	16.21	17.99
14	Okara-Lahore	2.65		5.42		6.75	
15	Lahore-Gujranwala	3.86		10.24		13.86	16.13
16	Wazirabad-Gujrat	3.87	12.24	22.41			16.61
17	Gujrat-Jhelum	4.72	10.13	8.79			
18	Jhelum-Rawalpindi	4.58	16.53	14.98	23.09		22.45
19	Rawalpindi-Chablat	3.72	7.28	6.24	21.94	5.20	
20	Hasanabdal-Haripur	3.51	4.64	7.90			
21	Haripur-Abbottabad	3.21	13.01	9.60			
22	Abbottabad-Manshera	3.82					
23	Chablat-Nowshera	4.45	8.88	10.33		8.74	
24	Nowshera-Peshawar	4.42		7.35			
25	Peshawar-Tourkham	4.94	9.83	11.30			6.21
26	Peshawar-Kohat	3.66	7.40	6.96		11.50	
27	Bannu-D.I.Khan	4.57	11.24	8.28		5.60	
28	Fortminro-Q.Saifullah	4.32					
29	Quetta-Chamman	3.27		3.99			
30	Quetta-Nowshki	4.97		9.16		7.66	
	Average	4.67	11.49	8.84	12.99	10.35	10.84
	Standard Deviation	1.81	4.54	3.42	5.98	3.62	5.86
	Variance	0.02	20.54	11.66	33.36	13.10	34.31
	Maximum Value	13.09	23.91	22.41	23.09	16.21	22.45
	Minimum Value	2.65	4.64	3.99	7.76	4.50	3.25

It is clear from the above table that the value of average ESA/truck for different axle configurations of truck ranges from 4.67 for two axle truck to 10.84 for six axle tandem tridem truck. The highest value of average ESA for 2-Axle truck was 13.09 at Karachi-Gaddani section, while the lowest value of average ESA for 2-Axle truck was 2.65 at Okara-Lahore section.

For 3-Axle Single truck, the highest value of average ESA was found as 23.91 at Sakrand-Kandiaro section, while lowest value of average

ESA for 3-axle(single) truck was 4.64 at Hassanabdal-Haripur section. The highest value of average ESA for 3-Axle rear tandem truck is equal to 20.27 and was calculated for Karachi-Gaddani section. While the lowest value of average ESA for the same type of truck was 3.99 at Quetta-Chamman section. The highest value of average ESA for 4-Axle(Single) truck equals to 23.09 and was found at Jhelum-Rawalpindi section, while the lowest value of average ESA for 4-Axle (single) truck was 7.76 at Jaccobabad-Sibbi section. Similarly the highest value of ESA for 4-Axle rear tandem truck was determined as 16.21 for Sahiwal-Multan section, while the lowest value of average ESA was 4.50 at Karachi-Gaddani section. For the 6-Axle tandem tridem truck the highest average ESA value is equal to 22.45 and was found at Gujrat-Wazirabad section, while the lowest value of average ESA was 3.25 at Hyderabad-Larkana section. Tables 7.3-A to 7.3-H, placed at statistical appendix provide the average equivalent standard axle values for discrete axle configurations mentioning the minimum and maximum, standard deviation and variance values for the 30 stations, along with the distribution of average equivalent axle values for front and rear axles.

7.2.4 Directional Distribution of ESA's as per AASHTO

Equivalent Standard Axle values for all discrete axle configurations were calculated based on directional split as per AASHTO Design Guide, 1986 and are placed at Tables 7.3-a to 7.3-h of Statistical Appendix. It is observed from the table that 2-Axle Single truck has a ESA's value of 7.58 for Karachi-Gaddani as compared to 17.36 for Gaddani-Karachi section. Similarly, the ESA's value is 2.47 for Multan-D.G.Khan section as compared to 10.60 for D.G.Khan-Multan section. In 3-Axle Rear Tandem type truck, the major difference of ESA's value was observed at Karachi-Gaddani section, Karachi-Hyderabad section, Sakrand-Kandiaro section and Noshki-Quetta section.

7.3 Average ESA per Truck in terms of Make

Average values of ESA's per truck in terms of make were calculated by adopting both approaches i.e. RN31, UK & AASHTO, 86 for all the 30 stations.

7.3.1 As per RN31, UK.

Average Equivalent Standard Axle values for discrete axle configuration of trucks according to make based on RN31, UK is described in the following table.

AVERAGE ESAs FOR EACH AXLE CONFIGURATIONS BY MAKE (AS PER RN31, UK.)

Sl No	Description	Conf.Code	Bedford	Hino	Nissan	Isuzu	Mercedese	Other
1	2-Axle	1.2	4.96	11.10	12.96	14.57	-	0.39
2	3-Axle Single	1.2-2	-	18.02	14.78	10.34	16.29	-
3	3-Axle Tandem	1.22	14.00	16.55	18.13	11.74	23.83	-
4	4-Axle Single	1.2+2.2	-	-	24.00	13.55	12.28	-
5	4-Axle Mid Tandem	1.22-2	-	-	-	-	-	-
6	4-Axle Rear Tandem	1.2-22	-	28.72	-	16.10	15.69	9.50
7	5-Axle Tandem	1.22-22	-	-	-	-	-	-
8	6-Axle T. Tridem	1.22+ 222	-	-	-	-	43.96	22.42
9	Others	-	-	-	-	-	-	-

It can be seen from the above table that Bedford make was mainly observed in 2-Axle & 3-Axle configurations, with average equivalent standard axles values of 4.96 and 14.00. The Hino make was chiefly observed in 2-Axle, 3-Axle single, 3-Axle tandem and 4-Axle rear tandem axle configurations with average equivalent standard values of 11.10, 18.02, 16.55 and 28.72 respectively. The make Nissan was mainly observed in 2-Axles, 3-Axle single, 3-Axle tandem, 4-Axle single configurations with the average equivalent standard axle values of 12.96, 14.78, 18.13 and 24.00 respectively. Similarly the make Isuzu was observed in 2-Axle, 3-Axle single, 3-Axle tandem, 4-Axle single & 4-Axle rear tandem axle configurations, with the average equivalent standard axles values of 14.57, 10.34, 11.74, 3.55 and 16.10 respectively.

7.3.2 As per AASHTO Design Guide 86

Average Equivalent Standard Axle values for discrete axle configuration of trucks according to make and based on AASHTO guide is described in the following table.

AVERAGE ESAs FOR EACH AXLE CONFIGURATIONS BY MAKE (AS PER AASHTO DESIGN GUIDE 86)

Sl No	Description	Conf. Code	Bedford	Hino	Nissan	Isuzu	Mercedes	Other
1	2-Axle	1.2	3.12	5.49	7.36	5.58	-	0.39
2	3-Axle Single	1.2-2	-	6.12	9.84	8.54	11.15	-
3	3-Axle Tandem	1.22	5.99	6.83	6.83	4.53	9.40	-
4	4-Axle Single	1.2+2.2	-	9.12	12.36	8.77	19.07	-
5	4-Axle Mid Tandem	1.22-2	-	-	-	-	-	-
6	4-Axle Rear Tandem	1.2-22	-	10.34	-	7.83	9.13	6.15
7	5-Axle Tandem	1.22-22	-	-	-	-	-	-
8	6-Axle T.Tridem	1.22+222	-	-	-	-	13.44	10.90
9	Others	-	-	-	-	-	-	-

It can be seen from the above table that Bedford make was mainly observed in 2-Axle & 3-Axle configurations, with average equivalent standard axle values of 3.12 and 5.99. The Hino make was chiefly observed in 2-Axle, 3-Axle (single), 3-Axle (tandem) and 4-Axle (rear tandem) axle configurations with average equivalent standard values of 5.49, 6.12, 6.83, 9.12 and 10.34 respectively. The make Nissan was mainly observed in 2-Axles, 3-Axle (single), 3-Axle (tandem), 4-Axle (single) configurations with the average equivalent standard axle values of 7.36, 9.84, 6.83 and 12.36 respectively. Similarly the make Isuzu was observed in 2-Axle, 3-Axle (single), 3-Axle (tandem), 4-Axle (single) and 4-Axle (rear tandem) axle configurations, with the average equivalent standard axles values of 5.58, 8.54, 4.53, 8.77 and 7.83 respectively. The other commonly observed make is the Mercedes which was observed in the 3-Axle (single), 3-Axle (tandem), 4-Axle (single), 4-Axle (rear tandem) and 6-Axle (tandem triandem) axle configurations, with the average equivalent standard axle values of 11.15, 9.40, 19.07, 9.13 and 13.44 respectively.

7.4 Average Equivalent Standard Axle Based On Commodities

Average Equivalent Standard Axle values for all discrete axle configurations, by applying both the approaches, based on commodities were calculated.

7.4.1 As per RN31, UK

Average equivalent standard axle values for discrete axle configurations of trucks is described on the basis of commodities carried by the vehicle and is shown in the following table. The commodities are mentioned by their code numbers. The code list is provided at annex-6.D.

AVERAGE ESA FOR EACH AXLE CONFIGURATION BASED ON COMMODITIES (AS PER RN31, UK)

Sl No	Description	Code	Code 100	Code 200	Code 300	Code 400	Code 500	Code 600	Code 700	Code 800	Code 900
1	2-Axle	1.2	5.02	2.04	1.40	2.04	5.64	9.97	1.87	2.21	2.07
2	3-Axle Single	1.2-2	16.19	14.61	-	-	19.38	15.15	10.96	20.46	13.32
3	3-Axle Tandem	1.22	3.95	3.62	2.39	3.61	4.12	4.09	3.20	4.20	3.56
4	4-Axle Single	1.22-2	12.91	-	-	-	22.30	16.93	15.70	-	25.42
6	4-Axle Rear Tandem	1.22-22	16.39	25.02	-	25.73	23.33	15.42	20.95	-	17.64
8	6-Axle T.Tridem	1.22+222	42.12	11.03	-	-	24.45	-	-	-	8.71

The above table clearly shows that the agriculture items are (code 100) transported by all discrete axle configurations of trucks. The average equivalent axle values for trucks transporting agriculture items range from 3.95 for 3-Axle (single) to 42.12 for 6-Axle (tandem tridem) trucks.

The food items (code 200) are nearly transported by all axle configurations of trucks with average equivalent standard values of 2.04 for 2-Axle truck and 25.02 for 4-Axle rear tandem.

The other commonly observed commodity transported by all types of trucks is the bulk manufacture item which covers the item like cement, fertilizer, chemicals etc. The average equivalent standard axle values for the truck carrying commodities of bulk manufacture is 4.12 for 3-Axle tandem truck and 24.45 for 6-Axle tandem tridem trucks.

Fuel and lubricants (code 900) item covers the commodities like petrol, kerosine oil, furnace oil, bitumen etc. Trucks carrying these commodities were observed in nearly all discrete axle configurations. The average equivalent standard values for the trucks carrying fuel and lubricant item is .07 for 2-Axle trucks and 25.42 for 4-Axle single.

7.4.2 As per AASHTO Design Guide 86

Average equivalent standard axle values for discrete axle configurations of trucks is described on the basis of commodities carried by the vehicle and is shown in the following table. The commodities are mentioned by their code numbers. The code list is provided at annex-6.D.

AVERAGE ESA FOR EACH AXLE CONFIGURATION BASED ON COMMODITIES (AS PER AASHTO DESIGN GUIDE 86)

Sl No	Description	Code	Code 100	Code 200	Code 300	Code 400	Code 500	Code 600	Code 700	Code 800	Code 900
1	2-Axle	1.2	5.02	4.28	0.66	4.18	3.12	3.12		5.58	4.28
2	3-Axle Single	1.2-2	-	-	-	-	-	-	-	-	-
3	3-Axle Tandem	1.22	8.02	5.99	0.95	5.99	9.02	9.02	-	10.22	5.22
4	4-Axle Single	1.2+2.2	7.75	-	-	-	13.95	9.18	7.48	-	18.28
5	4-Axle Rear Tandem	1.2-22	8.35	11.02	-	13.80	12.00	6.60	7.20	-	9.70
6	6-Axle T.Tridem	1.22 +222	14.19	5.82	-	-	10.10	-	-	-	-

The above table clearly shows that the agriculture items are (code 100) transported by all discrete axle configurations of trucks. The average equivalent axle values for trucks transporting agriculture items range from 2.10 for 4-Axle single to 14.19 for 6-Axle tandem tridem trucks.

The food items (code 200) are nearly transported by all axle configurations of trucks with average equivalent standard values of 4.28 for 2-Axle truck and 11.02 for 4-Axle rear tandem.

The other commonly observed commodity transported by all types of trucks is the bulk manufacture item which covers the item like cement, fertilizer, chemicals etc. The average equivalent standard axle values for the truck carrying commodities of bulk manufacture is 3.12 for 2-Axle truck & 12.00 for 4-Axle tandem.

Fuel and lubricants (code 900) item covers the commodities like petrol, kerosine oil, furnace oil, bitumen etc. Trucks carrying these commodities were observed in nearly all discrete axle configurations. The average equivalent standard values for the trucks carrying fuel and lubricant item is 4.28 for 2-Axle trucks and 9.70 for 4-Axle rear tendam trucks.

8 CONCLUSIONS

Pakistan like most other developing countries is facing with the dilemma of vehicle overloading. The vehicle loads plying on the roads are much heavier than the strength of road infrastructure of the country. Most of the existing road infrastructure was built 30-40 years ago, when there was no anticipation of the heavier loads of today as the economic activity was low & transportation by trucks was small as compared to railways. But today, the situation has entirely changed and goods transportation by railways has been mostly shifted to road, resulting in rail : road modal split for freight traffic to 14 : 86.

The reason for the heavier axle loads on our roads is not only that fleet of new and more capacious trucks have been introduced which has radically altered the axle load distribution in the country, but also mainly attributed to the overloading tendency of the trucks. In order to compete and keep themselves in the market by keeping the haulage cost at minimum, the truck owners have the tendency of vehicle loading to the extent much beyond their rated capacity. To carry the extra payloads, the truck owners strengthen the body of the trucks by adding extra springs, making the body strong and increasing the height of the truck body. J. L. Hine of TRL in his study on "Pakistan Road Freight Industry" has concluded that truck industry in Pakistan is more efficient as compared to many other developing countries.

Though the haulage cost is reduced by overloading, which results in the economic benefit to the country, but it causes the premature failure of the road pavements. This results in loss of billion of rupees invested in road infrastructure.

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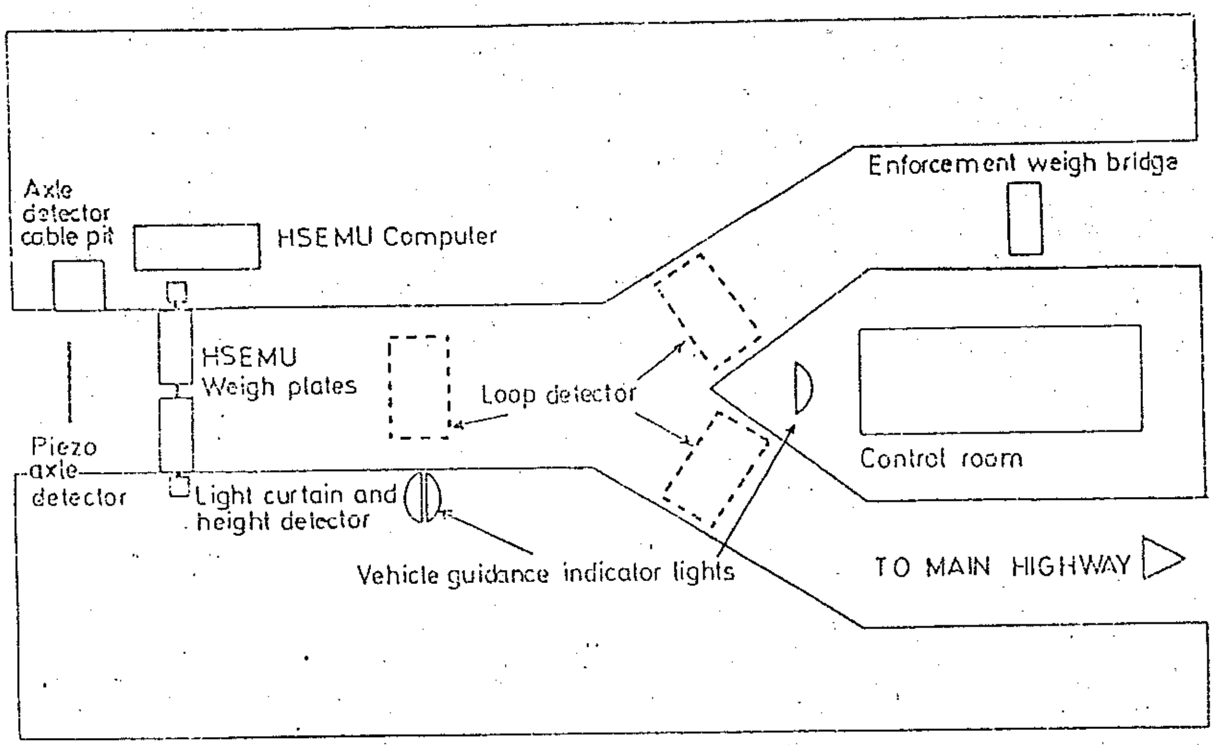
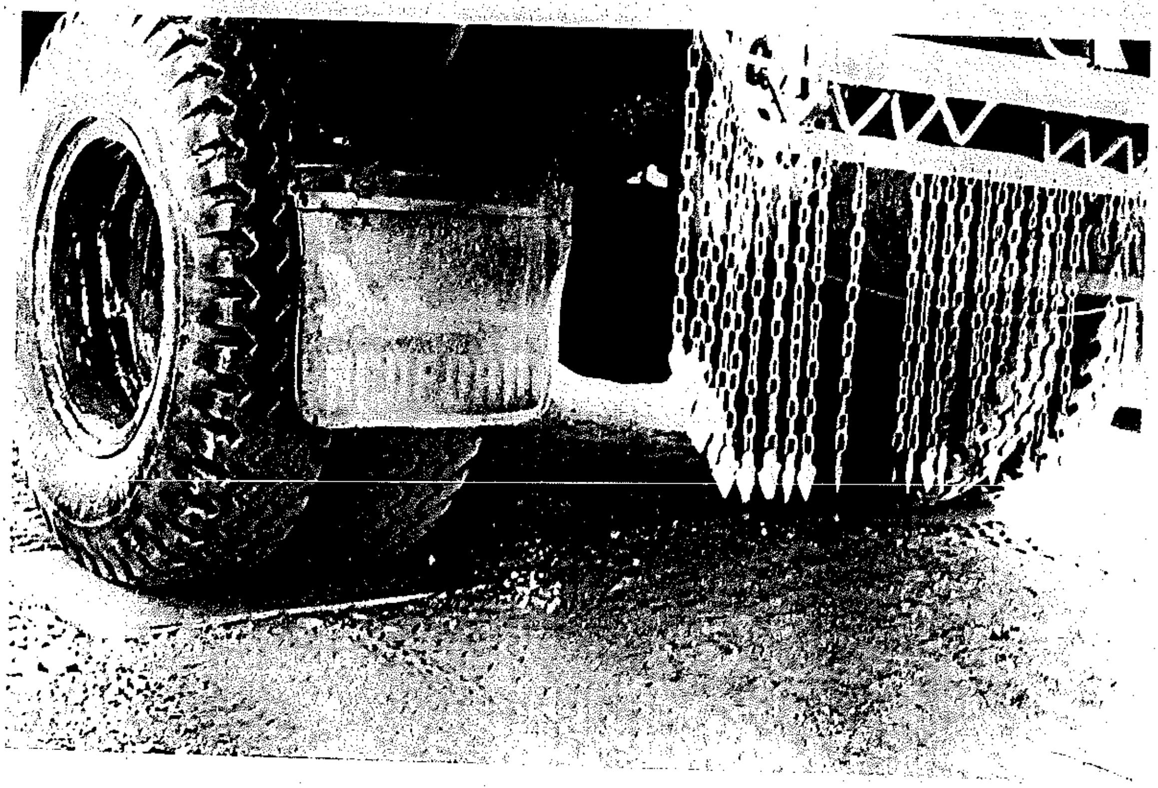
ANNEXURES

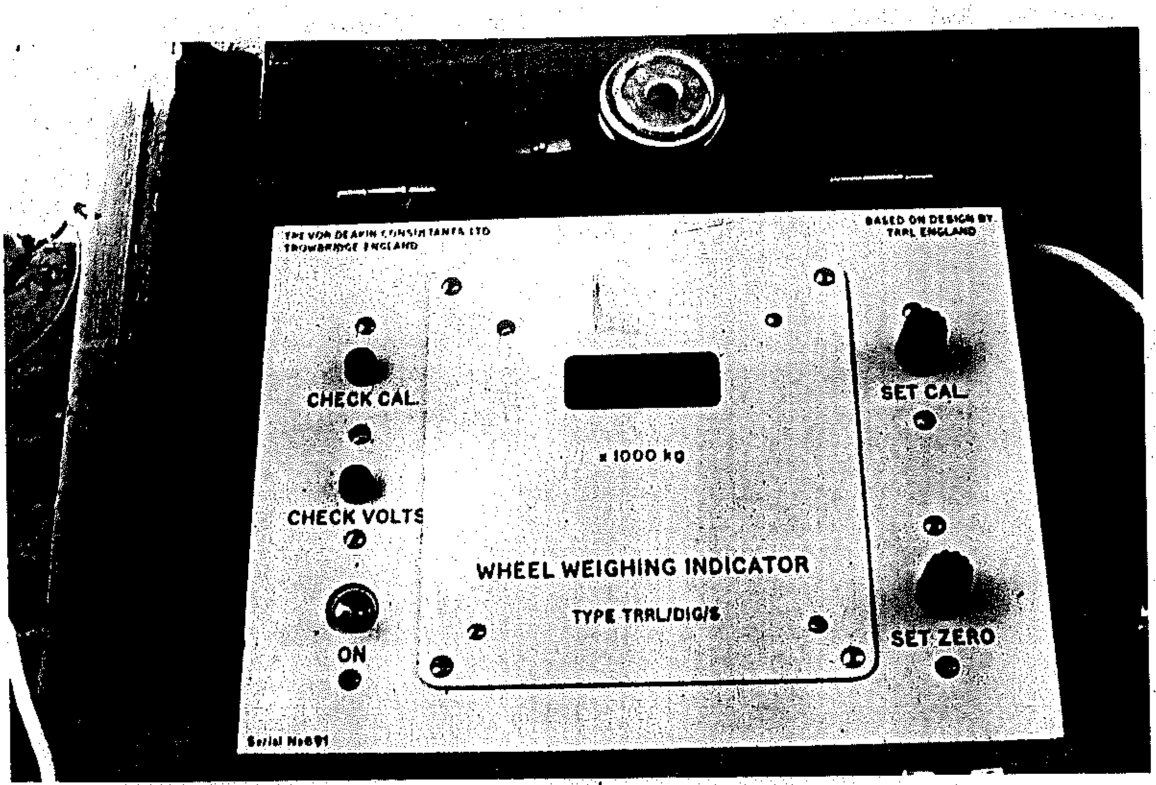


LAYOUT OF THE HIGH SPEED ELECTRONIC MASS UNIT (HSEMU)

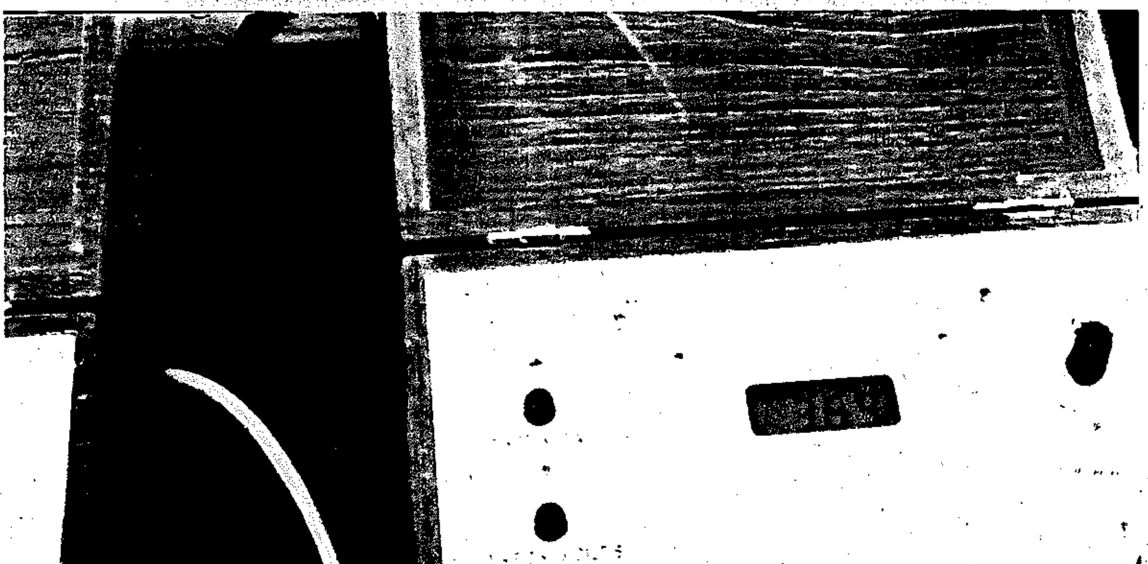


THE WEIGHING PLATEFORM

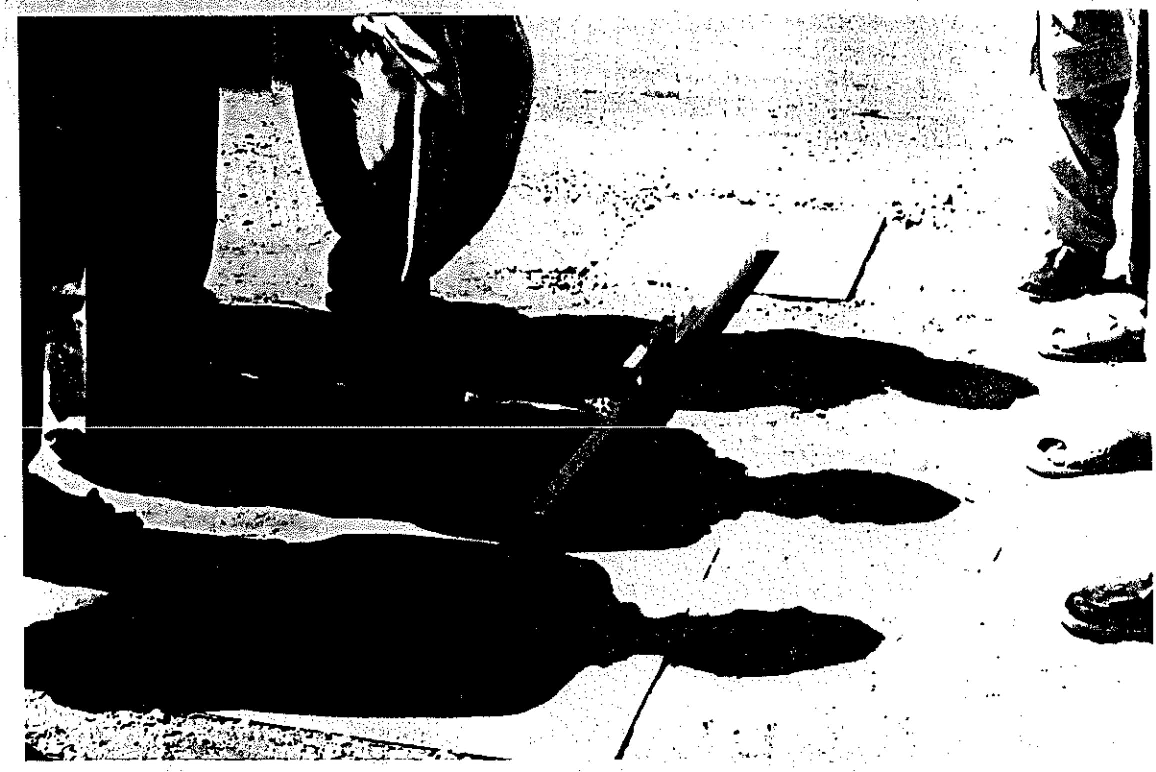
PLATE - 1



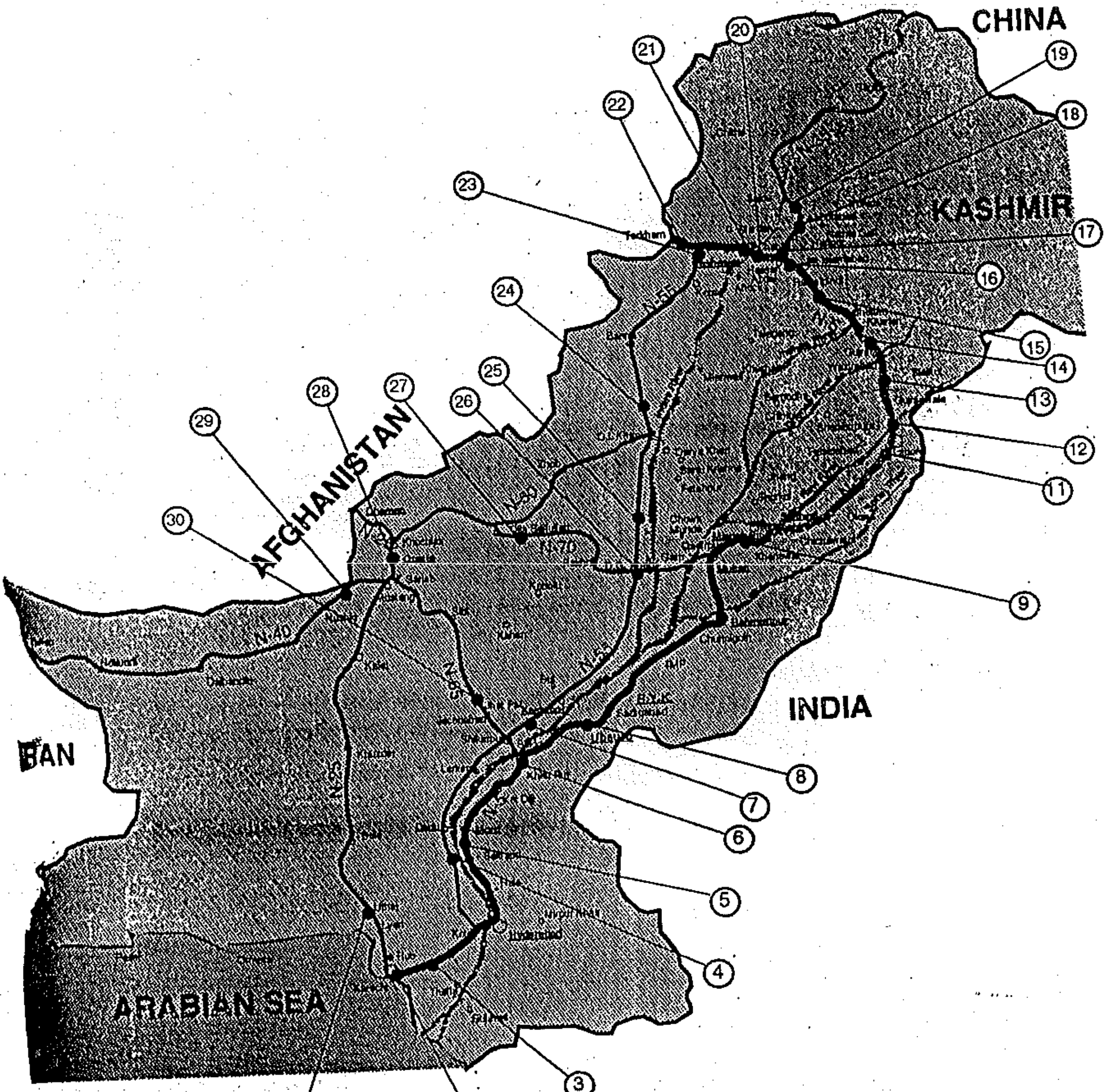
LEFT READOUT UNIT



RIGHT READOUT UNIT
PLATE - 2

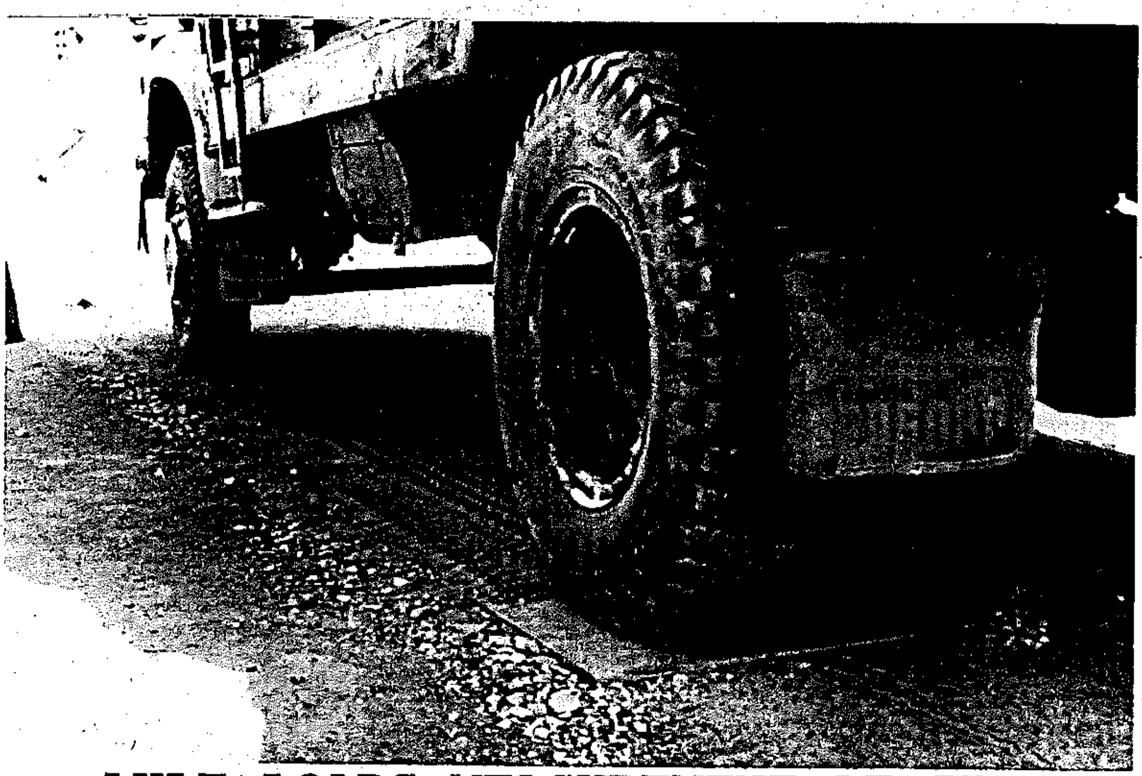


WEIGHBRIDGE LAYOUT



LOCATION MAP OF SURVEY STATIONS

Annexure 4-B



AXLE LOADS MEASUREMENT AT SITE

NTRC/NHA

FORM NO.

NATIONAL HIGHWAY NETWORK

AXLE LOAD SURVEY — 1994

1 Road Section		3 Date	
2 Direction		4 Time	

5 Regn. No.		6 Make	

7 Type of Vehicle (circle relevant no)

Truck	Trailer	Tanker
1	2	3

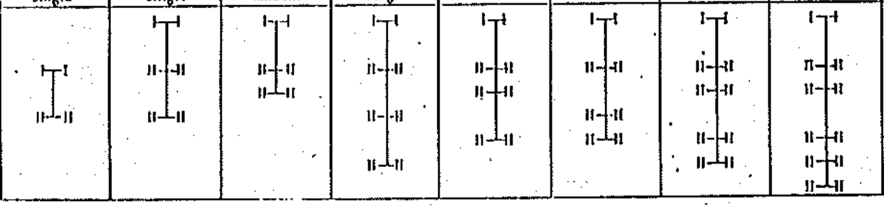
8 Type of body (circle relevant no)

Flat	Half	Full	Covered
1	2	3	4

8 Commodities carried		Unit		Quantity
9 Origin		10 Destination		

11 Axle Configuration (circle relevant no)

1	2	3	4	5	6	7	8	9
2 axle single	3 axle single	3 axle tandem	4 axle single	4 axle mid tandem	4 axle rear tandem	5 axle tandem	6 axle tandem	Other Specify



12 WHEEL LOADS (1000 KG)

Axle	Left	Right
Front		
2		
3		
4		
5		
6		
7		
8		

14 Remarks, if any

Name of Enumerator

Annexure-6-A

NO. OF VEHICLES SURVEYED AT EACH SURVEY POINT

S.No	Road Section	Survey Point	No.of Veh
1.	Karachi-Gaddani	Gaddani More	148
2.	Karachi-Hyderabad	Near Toll Plaza	206
3.	Karachi-Thatta	Dhabegi Post	200
4.	Hyderabad-Larkana	Sehwan Sharif	210
5.	Sakrand-Kandiaro	Nowshero Feroze	207
6.	Khairpur-Rohri	Near Khairpur	199
7.	Jaccobabad-Sibbi	Near Jaccobabad	175
8.	R.Y.Khan-Sadiqabad	Near Sadiqabad	173
9.	Chunigot-Bahawalpur	Near Bahawalpur	171
10.	Multan-D.G.Khan	Near Noor Kubra	172
11.	Kashmore-D.G.Khan	Near Basti Malana	123
12.	Taunsa-D.G.Khan	Kot Sadaruddin	60
13.	Sahiwal-Multan	Near Kacha Khu	172
14.	Okara-Lahore	Near Pattoki	200
15.	Lahore-Gujranwala	Near Kamoki	198
16.	Wazirabad-Gujrat	Gujrat By-pass	147
17.	Gujrat-Jhelum	Sarai Alamgir	148
18.	Jhelum-Rawalpindi	Near Sohawa	147
19.	Rawalpindi-Chablat	Hasanabdal	195
20.	Hasanabdal-Haripur	Laban	99
21.	Haripur-Abbottabad	Buldhair	191
22.	Abbottabad-Manshera	Manshera	172
23.	Chablat-Nowshera	Attock Khurd	175
24.	Nowshera-Peshawar	Chamkani	194
25.	Peshawar-Tourkham	Landikotal	125
26.	Peshawar-Kohat	Near Kohat	142
27.	Bannu-D.I.Khan	Near D.I.Khan	177
28.	Fortminro-Q.Saifullah	Near Lorali	90
29.	Quetta-Chamman	Yaro More	100
30.	Quetta-Nowshki	Near Nowshki	52
		Total	4768

Ist ROUND

S.No	Road Section	H.Way Sect.	Location	Durn.of Surv.	Date
1.	Karachi-Gaddani	N-25	Gaddani More	24	30-03-94 31-03-94
2.	Karachi-Hyderabad	N-5	Near Toll Plaza	48	02-04-94 04-04-94
3.	Karachi-Thatta	N-5	Dhabegi Post	48	06-04-94 08-04-94
4.	Hyderabad-Larkana	N-55	Sehwan Sharif	24	09-04-94 10-04-94
5.	Sakrand-Kandiaro	N-5	Nowshero Feroze	48	12-04-94 14-04-94
6.	Khairpur-Rohri	N-5	Near Khairpur	48	16-04-94 18-04-94
7.	Jaccobabad-Sibbi	N-65	Near Jaccobabad	24	19-04-94 20-04-94
8.	R.Y.Khan-Sadiqabad	N-5	Near Sadiqabad	48	22-04-94 24-04-94
9.	Chunigot-Bahawalpur	N-5	Near Bahawalpur	48	25-04-94 27-04-94
10.	Multan-D.G.Khan	N-70	Near Noor Kubra	48	29-04-94 01-05-94
11.	Kashmore-D.G.Khan	N-55	Near Basti Malana	24	02-05-94 03-05-94
12.	Taunsa-D.G.Khan	N-55	Kot Sadaruddin	24	04-05-94 05-05-94
13.	Sahiwal-Multan	N-5	Near Kacha Khu	48	07-05-94 09-05-94
14.	Okara-Lahore	N-5	Near Pattoki	48	10-05-94 12-05-94
15.	Lahore-Gujranwala	N-5	Near Kamoki	48	14-05-94 16-05-94

2nd ROUND

S.No	Road Section	H.Way Sect.	Loction	Durn.of Surv.	Date
16.	Wazirabad-Gujrat	N-5	Gujrat By-pass	48	26-07-94 28-07-94
17.	Gujrat-Jhelum	N-5	Sarai Alamgir	48	30-07-94 01-08-94
18.	Jhelum-Rawalpindi	N-5	Near Sohawa	48	02-08-94 04-08-94
19.	Rawalpindi-Chablat	N-5	Hasanabdal	48	06-08-94 08-08-94
20.	Hasanabdal-Haripur	N-35	Laban	24	09-08-94 10-08-94
21.	Haripur-Abbottabad	N-35	Buldhair	24	11-08-94 12-08-94
22.	Abbottabad-Manshera	N-35	Manshera	24	13-08-94 14-08-94
23.	Chablat-Nowshera	N-5	Attock Khurd	48	15-08-94 17-08-94
24.	Nowshera-Peshawar	N-5	Chamkani	48	18-08-94 20-08-94
25.	Peshawar-Tourkham	N-5	Landikotal	24	21-08-94 22-08-94
26.	Peshawar-Kohat	N-55	Near Kohat	24	23-08-94 24-08-94
27.	Bannu-D.I.Khan	N-55	Near D.I.Khan	24	25-08-94 26-08-94
28.	Fortminro-Q.Saifullah	N-70	Near Lorali	24	28-08-94 29-08-94
29.	Quetta-Chamman	N-25	Yaro More	24	31-08-94 01-09-94
30.	Quetta-Nowshki	N-40	Near Nowshki	24	03-09-94 04-09-94

* Where Traffic Volume was High,
24 Hours Survey was Carried in each Direction.

TRUCK CODE

Code No	Make
1.	Bedford
2.	B.M.C.
3.	Dodge
4.	Ford
5.	Fiat
6.	Hino
7.	Isuzu
8.	International
9.	Ley Land
10.	Mercedes Benz
11.	Man
12.	Mazda
13.	Mitsubishi
14.	Nissan
15.	Renault
16.	Toyota
17.	Volvo
18.	Others

STATISTICAL APPENDICES

Table 5.1

TRAFFIC VOLUME SUMMARY

S.No	Station Name	F.C.	A.D.	M.C.	RICK	CAR	W/MB	BUS	TR2	TR3	T/TR3	T/TR4	T/TR>4	OTH.	Total
1.	Karachi-Gaddani	0	4	142	0	910	201	275	812	49	6	7	3	3	2412
2.	Karachi-Hyderabad	8	1	280	2	2723	742	1503	6860	1366	50	653	114	33	14335
3.	Karachi-Thatta	41	11	77	4	1789	730	372	2298	192	4	90	319	16	5943
4.	Larkana-Hyderabad	78	69	111	0	252	144	48	312	1519	43	474	53	48	3151
5.	Sakrand-Kandiaro	239	207	337	0	629	345	398	3315	1685	72	687	121	64	8099
6.	Khairpur-Rohri	276	187	1101	20	1549	1092	554	2522	1463	59	422	91	145	9581
7.	Jacobabad-R.Y.Khan	69	112	292	0	818	285	363	749	381	10	4	0	98	3181
8.	Sadiqabad-R.Y.Khan	270	46	586	1	971	474	646	2208	1372	53	590	66	88	7370
9.	Chanigot-Bhawalpur	396	101	920	40	1631	711	564	2722	1403	23	583	111	111	9316
10.	Multan-D.G.Khan	187	44	276	0	930	600	230	1368	271	17	110	10	56	4099
11.	D.G.Khan-Kashmore	555	82	754	0	656	665	270	345	119	46	8	5	104	3609
12.	D.G.Khan-Taunsa	509	101	466	0	319	202	192	88	5	19	13	3	73	1990
13.	Multan-Sahiwal	83	39	251	1	994	273	611	2046	1194	14	426	81	19	6032
14.	Okara-Lahore	459	375	740	3	1697	864	894	2926	1005	61	399	65	80	9568
15.	Lahore-Gujranwala	1138	395	901	4	7217	4303	1290	3334	891	175	163	41	136	19988
16.	Gujrat-Wazirabad	193	42	283	2	2645	1447	727	2665	657	48	89	93	126	9017
17.	Gujrat-Jhelum	307	32	530	3	3479	1744	979	2308	496	8	129	75	17	10107
18.	Jhelum-Rawalpindi	94	6	246	0	3309	2128	931	3139	592	19	57	108	45	10674
19.	Rawalpindi-Chablat	843	474	898	4	8715	3611	1641	3652	652	36	71	57	96	20750
20.	Hasanabdal-Haripur	142	37	248	0	2433	1622	464	781	132	10	7	8	34	5918
21.	Haripur-Abotabad	52	0	106	0	3268	2113	439	939	59	28	0	4	61	7069
22.	Abotabad-Manshera	1	0	83	1	2655	1604	158	607	14	10	0	0	20	5153
23.	Chablat-Nowshera	68	5	63	1	3259	1648	726	2179	187	5	46	38	26	8251
24.	Nowshera-Peshawar	262	100	574	66	10604	4525	1177	1656	198	15	12	8	64	19261
25.	Peshawar-Tourkham	97	4	100	0	3115	1008	580	716	121	47	2	17	98	5905
26.	Peshawar-Kohat	1	0	54	2	1451	1420	224	976	364	19	21	10	8	4550
27.	Bannu-D.I.Khan	464	37	454	10	912	418	147	900	288	19	8	0	65	3722
28.	F.Minro-Qilasaifullah	46	2	184	0	416	156	29	399	5	16	0	1	44	1298
29.	Quetta-Chamman	45	4	50	0	966	167	187	835	122	6	0	0	36	2418
30.	Quetta-Naushki	9	0	95	0	293	93	61	107	12	6	5	1	6	688
	G.Total	6932	2517	11202	164	70605	35335	16680	53864	16813	944	5076	2503	1920	223455
	Average	231	64	373	5	2354	1178	556	1795	560	31	169	50	61	7449
	Standard	262	123	301	14	2424	1164	423	1427	544	33	228	65	40	5222
	Maximum	1138	474	1101	66	10604	4525	1641	6860	1685	175	687	319	145	20750
	Minimum	0	0	50	0	252	93	29	88	5	4	0	0	3	688

Table 6.8.2

AVERAGE AXLE LOADS (TONNES)
3-AXLE SINGLE TRUCK (lOADED)

St.No	Station Name	Front	Rear1	Rear2	Total
1	Karachi-Gaddani	6.95	13.50	13.95	34.40
2	Karachi-Hyderabad	6.68	13.93	13.61	34.22
4	Hyderabad-Larkana	7.15	10.96	11.55	29.67
5	Sakrand-Kandiaro	8.80	15.55	15.60	39.95
9	Chanigoth-Bhawlpur	4.83	11.59	13.46	29.88
16	Wazirabad-Gujrat	7.24	12.30	13.22	32.77
17	Gujrat-Jehlum	7.84	11.98	12.10	31.92
18	Jehlum-Rawalpindi	6.72	14.49	13.14	34.35
19	Rawalpindi-Chablat	6.16	10.72	10.64	27.52
20	Hasanabdal-Haripur	5.60	10.47	9.33	25.39
21	Haripur-Abbottabad	7.13	13.35	12.38	32.86
23	Chablat-Nowshera	6.59	12.27	10.95	29.81
25	Peshawar-Tourkham	6.68	12.83	10.57	30.08
26	Peshawar-Kohat	5.49	11.62	10.64	27.75
27	Bannu-D.I.Khan	7.25	13.22	11.44	32.02
	Average	6.74	12.59	12.17	31.51
	St. Deviation	0.94	1.39	1.60	3.44
	Variance	0.88	1.94	2.57	11.82
	Maximum	8.80	15.55	15.60	39.95
	Mimimum	4.83	10.47	9.33	25.39

Table 6.8.2
(Contd..)

STANDARD DEVIATION OF 3-AXLE SINGLE TRUCK (lOADED)

St.No	Station	Front	Rear1	Rear2	Total
1.	Karachi-Gaddani	1.28	1.45	1.89	3.60
2.	Karachi-Hyderabad	1.76	3.11	2.46	7.11
4.	Hyderabad-Larkana	1.34	2.75	1.82	4.62
5.	Sakrand-Kandiaro	1.34	2.75	1.82	4.62
16.	Wazirabad-Gujrat	0.78	2.30	1.26	3.24
17.	Gujrat-Jhelum	1.05	0.64	0.89	1.95
18.	Jhelum-Rawalpindi	1.60	2.19	1.97	4.47
19.	Rawalpindi-Chablat	1.20	2.37	2.68	5.49
23.	Chablat-Nowshera	0.83	2.18	1.14	3.72
25.	Peshawar-Tourkham	1.27	1.57	2.20	4.41
26.	Peshawar-Kohat	0.96	2.51	2.04	5.24
27.	Bannu-D.I.Khan	0.95	1.27	1.25	1.25
	Average	1.18	2.03	1.78	4.10
	St. Deviation	0.30	0.69	0.55	1.56
	Variance	0.09	0.47	0.30	2.42
	Maximum	1.76	3.11	2.68	7.11
	Minimum	0.78	0.64	0.89	1.25

Table 6.8.2-A

AVERAGE AXLE LOADS (TONNES)
3-AXLE SINGLE TRUCK (EMPTY)

		Front	Rear1	Rear2	Total
	Average	3.85	4.38	3.94	12.17
	St. Deviation	0.45	1.48	0.76	1.02
	Variance	0.21	2.18	0.57	1.04
	Maximum	4.36	7.76	5.05	9.10
	Minimum	3.13	3.52	3.16	6.35

Table 6.8.3

AVERAGE AXLE LOADS (TONNES)
3-AXLE REAR TANDEM TRUCKS (LOADED)

S.No	Station'S Name	Front	Rear1	Rear2	Total
1.	Karachi-Gaddani	8.82	15.38	16.33	40.53
2.	Karachi-Hyderabad	6.27	12.70	12.22	31.19
3.	Karachi-Thatta	7.09	13.45	13.08	33.61
4.	Hyderabad-Larkana	5.95	11.06	10.95	27.96
5.	Sakrand-Kandiaro	7.04	13.42	13.36	33.82
6.	Khairpur-Rohri	6.87	13.12	13.52	33.52
7.	Jaccobabad-Sibbi	6.11	10.51	10.89	27.51
8.	R.Y.Khan-Sadiqabad	6.69	11.58	11.51	29.78
9.	Chunigot-Bahawalpur	6.24	11.09	12.19	29.52
10.	Multan-D.G.Khan	5.72	10.68	10.79	27.20
11.	Kashmore-D.G.Khan	6.54	11.46	12.51	30.51
12.	Taunsa-D.G.Khan	6.47	11.48	11.50	29.44
13.	Sahiwal-Multan	7.18	12.60	12.76	32.54
14.	Okara-Lahore	5.86	10.82	10.99	27.67
15.	Lahore-Gujralwala	7.19	13.24	12.63	33.06
16.	Wazirabad-Gujrat	7.34	13.53	14.63	35.50
17.	Gujrat-Jhelum	7.24	12.31	12.66	32.21
18.	Jhelum-Rawalpindi	7.19	14.68	14.80	36.68
19.	Rawalpindi-Chablat	5.93	11.78	11.28	28.99
20.	Hassanabdal-Haripur	6.47	12.44	12.43	31.53
21.	Haripur-Abbottabad	7.44	13.15	13.08	33.66
23.	Chablat-Nowshera	7.12	13.52	13.63	34.27
24.	Nowshera-Peshawer	6.79	12.22	11.26	30.27
25.	Peshawar-Tourkham	8.56	13.23	13.74	35.53
26.	Peshawar-Kohat	5.99	11.89	12.06	29.94
27.	Bannu-D.I.Khan	6.74	12.72	12.65	32.11
29.	Quetta-Chamman	5.90	9.98	10.52	26.41
30.	Quetta-Nowshki	5.96	12.21	12.17	30.35
	Average	6.74	12.37	12.51	31.61
	Standard Deviation	0.75	1.24	1.33	3.18
	Variance	0.56	1.53	1.77	10.08
	Maximum Value	8.82	15.38	16.33	40.53
	Minimum Value	5.72	9.98	10.52	26.41

Table 6.8.3
(Contd..)

STANDARD DEVIATION OF 3-AXLE REAR TANDEM TRUCKS (LOADED)

S.No	Station'S Name	Front	Rear1	Rear2	Total
1.	Karachi-Gaddani	1.38	2.56	2.31	5.00
2.	Karachi-Hyderabad	1.22	3.48	3.35	7.68
3.	Karachi-Thatta	2.02	1.59	2.33	4.69
4.	Hyderabad-Larkana	1.21	2.70	2.37	5.41
5.	Sakrand-Kandiaro	1.53	2.60	2.96	6.45
6.	Khairpur-Rohri	1.55	2.64	3.19	6.87
7.	Jaccobabad-Sibbi	1.19	2.04	2.03	4.52
8.	R.Y.Khan-Sadiqabad	1.53	1.66	1.91	4.41
9.	Chunigot-Bahawalpur	0.45	2.94	3.21	6.86
10.	Multan-D.G.Khan	1.20	1.47	1.26	3.26
11.	Kashmore-D.G.Khan	1.36	2.37	3.00	6.06
12.	Taunsa-D.G.Khan	0.37	0.85	2.40	1.18
13.	Sahiwal-Multan	1.48	2.52	2.71	5.88
14.	Okara-Lahore	1.16	2.33	2.26	5.24
15.	Lahore-Gujralwala	0.33	2.72	2.53	5.91
16.	Wazirabad-Gujrat	0.76	2.07	1.58	3.89
17.	Gujrat-Jhelum	1.05	2.48	2.68	5.88
18.	Jhelum-Rawalpindi	1.21	2.65	2.19	5.25
19.	Rawalpindi-Chablat	1.16	2.21	1.82	4.78
20.	Hassanabdal-Haripur	1.22	2.16	1.83	4.03
21.	Haripur-Abbottabad	0.97	1.09	2.19	5.00
23.	Chablat-Nowshera	1.43	1.27	1.27	2.65
24.	Nowshera-Peshawer	1.72	3.14	2.75	6.67
25.	Peshawar-Tourkham	1.72	2.14	1.92	3.60
26.	Peshawar-Kohat	1.00	2.26	1.88	4.23
27.	Bannu-D.I.Khan	1.20	1.26	1.34	3.05
29.	Quetta-Chamman	1.23	1.70	1.58	3.51
30.	Quetta-Nowshki	1.22	3.36	3.80	7.73
	Average	1.30	2.22	2.31	4.99
	Standard Deviation	0.35	0.66	0.64	1.52
	Variance	0.12	0.43	0.41	2.32
	Maximum Value	2.28	3.48	3.80	7.73
	Minimum Value	0.37	0.85	1.26	1.18

Table 6.8.3-A

AVERAGE AXLE LOADS (TONNES) 3-AXLE REAR TANDEM TRUCKS (EMPTY)

	Front	Rear1	Rear2	Total
Average	3.55	3.85	3.45	10.84
St.Deviation	0.58	0.61	0.49	1.13
Variance	0.34	0.38	0.24	1.28
Maximum Value	4.80	5.06	4.35	13.11
Minimum Value	2.35	2.75	2.50	9.20

Table 6.8.3.3

AGRICULATURE ITEMS

(Load in Tonnes)

	Front	Rear1	Rear2	Total
Average	6.99	12.52	12.72	32.23
Standard Deviation	1.38	2.32	2.26	5.16
Variance	1.91	5.39	5.09	26.65
Maximum Value	10.45	18.85	18.30	44.70
Minimum Value	6.61	5.79	5.75	15.29

ANIMALS AND ANIMALS PRODUCTS

	Front	Rear1	Rear2	Total
Average	4.96	7.17	7.39	19.53
Standard Deviation	2.35	3.70	3.88	10.86
Variance	1.72	6.29	7.49	38.83
Maximum Value	7.93	12.30	13.68	33.73
Minimum Value	3.42	4.30	4.00	13.26

BASIC MANUFACTURE

	Front	Rear1	Rear2	Total
Average	6.93	13.09	13.35	33.38
Standard Deviation	1.69	3.40	3.37	7.84
Variance	2.84	11.56	12.03	61.39
Maximum Value	12.09	20.18	19.79	50.54
Minimum Value	3.44	5.65	4.80	16.70

BULK MANUFACTURE

	Front	Rear1	Rear2	Total
Average	7.23	13.09	13.30	33.62
Standard Deviation	1.50	2.30	2.42	5.48
Variance	2.26	5.28	5.86	30.03
Maximum Value	10.46	18.03	18.03	44.18
Minimum Value	2.99	6.90	5.32	15.93

FOOD ITEMS

	Front	Rear1	Rear2	Total
Average	6.28	11.62	11.63	29.53
Standard Deviation	1.26	2.15	2.11	4.75
Variance	1.60	4.62	4.44	22.52
Maximum Value	10.30	17.86	17.31	42.73
Minimum Value	4.10	5.06	3.75	13.11

FUEL AND LUBRICANTS

	Front	Rear1	Rear2	Total
Average	6.07	11.46	11.51	29.04
Standard Deviation	1.02	2.09	1.59	4.13
Variance	1.04	4.38	3.79	17.08
Maximum Value	9.72	17.03	15.65	37.53
Minimum Value	3.97	4.32	2.70	13.35

Table 6.8.3.3
(Contd..)

MISCELLANEOUS GOODS

	Front	Rear1	Rear2	Total
Average	5.55	10.43	10.12	29.09
Standard Deviation	1.23	3.00	3.35	7.00
Variance	1.52	8.99	11.24	49.07
Maximum Value	8.38	15.89	16.76	40.05
Minimum Value	3.65	4.05	-	11.69

MINNING AND QUERRYING

	Front	Rear1	Rear2	Total
Average	7.33	13.49	13.46	34.28
Standard Deviation	1.42	2.12	2.28	4.98
Variance	2.00	4.49	5.18	24.78
Maximum Value	10.47	19.27	21.00	47.97
Minimum Value	3.85	8.33	8.40	20.81

RAW MATERIALS

	Front	Rear1	Rear2	Total
Average	6.17	11.41	11.84	29.42
Standard Deviation	1.07	2.27	2.20	4.60
Variance	1.13	5.15	4.85	21.13
Maximum Value	9.30	17.28	17.02	41.68
Minimum Value	3.95	4.80	6.04	17.04

Table 6.8.4

AVERAGE AXLE LOADS (TONNES)
4-AXLE SINGLE TRUCK (LOADED)

St.No	Station's Name	Front	Rear1	Rear2	Rear3	Total
1.	Karachi-Gaddani	4.45	11.46	8.87	10.41	35.19
2.	Karachi-Hyderabad	4.64	10.64	11.88	10.65	37.81
3.	Karachi-Thatta	5.45	10.80	9.54	9.35	35.14
7.	Jaccobbabad-Sibbi	8.43	11.20	9.64	8.98	38.25
8.	R.Y.Khan-Sadiqabad	4.90	10.57	11.96	12.83	40.26
12.	D.G.Khan-Taunsa	7.82	12.85	9.41	8.53	38.61
18.	Jhelum-Rawalpindi	6.64	13.26	16.25	13.80	49.95
19.	Rawalpindi-Chablat	5.07	12.51	12.32	12.59	42.49
	Average	5.92	11.66	11.23	10.89	39.71
	Standard Deviation	1.42	0.99	2.28	1.84	4.49
	Variance	2.03	0.99	5.20	3.37	20.15
	Maximum Value	8.43	13.26	16.25	13.80	49.95
	Minimum Value	4.45	10.57	8.87	8.53	35.14

Table 6.8.4-A

AVERAGE AXLE LOADS (TONNES)
4-AXLE SINGLE TRUCK (EMPTY)

	Front	Rear1	Rear2	Rear3	Total
Average	4.43	4.42	4.23	4.11	17.19
Standard Deviation	0.66	0.15	0.54	0.88	1.08
Variance	0.44	0.02	0.29	0.78	1.17
Maximum	5.32	4.65	4.79	5.06	17.84
Minimum	3.60	4.25	3.35	2.75	15.32

Table 6.8.4

AGRICULATURE ITEMS

(Load in Tonnes)

	Front	Rear1	Rear2	Rear3	Total
Average	6.78	11.08	10.31	10.29	38.45
Standard Deviation	1.59	1.29	2.14	2.20	6.00
Variance	2.51	1.66	4.59	4.84	36.02
Maximum Value	8.55	13.04	14.55	13.78	49.52
Minimum Value	4.94	8.70	7.38	7.06	28.91

BASIC MANUFACTURE

	Front	Rear1	Rear2	Rear3	Total
Average	4.56	10.62	10.62	10.91	36.71
Standard Deviation	0.54	1.61	3.59	3.15	7.52
Variance	0.29	2.60	12.90	9.90	56.56
Maximum Value	5.73	13.65	16.80	15.98	50.52
Minimum Value	3.60	8.30	5.95	5.50	26.50

BULK MANUFACTURE

	Front	Rear1	Rear2	Rear3	Total
Average	6.09	13.09	11.52	11.51	42.22
Standard Deviation	1.27	2.00	2.11	2.11	4.38
Variance	1.62	3.98	4.44	4.44	19.18
Maximum Value	8.00	16.00	14.85	14.11	47.60
Minimum Value	4.40	9.54	7.84	7.76	34.45

FUEL AND LUBRICANTS

	Front	Rear1	Rear2	Rear3	Total
Average	5.40	13.21	11.84	13.22	43.67
Standard Deviation	0.30	1.72	1.77	0.97	3.15
Variance	0.09	2.97	3.12	0.75	9.93
Maximum Value	5.77	15.58	13.52	13.85	47.98
Minimum Value	5.03	11.54	9.40	12.00	40.53

MISCELLENOUS MANUFACTURE

	Front	Rear1	Rear2	Rear3	Total
Average	4.73	10.36	10.98	9.59	35.65
Standard Deviation	0.49	2.95	3.42	2.85	6.15
Variance	0.24	3.69	11.72	8.13	37.85
Maximum Value	5.45	13.48	17.95	13.82	50.38
Minimum Value	3.90	4.74	5.60	5.64	30.41

Table 6.8.5

AVERAGE AXLE LOADS (TONNES)
4-AXLE MID-TANDEM TRUCK (LOADED)

	Front	Rear1	Rear2	Rear3	Total
Average	5.69	10.42	9.64	9.40	35.14

Table 6.8.6

AVERAGE AXLE LOADS (TONNES)
4-AXLE REAR-TANDEM TRUCK (LOADED)

St.No	Station	Front	Rear1	Rear2	Rear3	Total
1.	Karachi-Gaddani	4.28	11.09	8.13	8.60	32.02
2.	Karachi-Hyderabad	4.67	12.05	11.88	11.56	40.16
3.	Karachi-Thatta	4.84	11.30	9.73	10.81	36.67
4.	Hyderabad-Larkana	5.32	11.57	10.68	9.36	36.94
5.	Sakrand-Kandiaro	4.95	12.01	12.10	11.86	40.91
6.	Khairpur-Rohri	5.31	13.53	10.80	11.16	40.80
8.	R.Y.Khan-Sadiqabad	4.89	11.53	9.28	9.64	35.35
9.	Chanigot-Bahawalpur	5.01	13.01	11.33	12.40	41.75
10.	Multan-D.G.Khan	5.39	12.72	11.13	11.43	40.68
11.	D.G.Khan-Kashmore	4.65	12.68	9.58	11.10	38.00
12.	D.G.Khan-Taunsa	4.55	13.94	12.07	12.37	42.93
13.	Sahiwal-Multan	5.58	13.83	12.49	10.76	42.66
14.	Okara-Lahore	5.13	10.75	9.36	9.76	34.99
15.	Lahore-Gujranwala	5.07	12.40	11.43	12.26	40.17
19.	Rawalpindi-Chablat	4.28	11.07	7.27	8.26	30.86
23.	Chablat-Nowshera	5.24	12.17	7.80	8.30	33.50
26.	Peshawar-Kohat	4.70	13.44	11.69	10.88	40.69
27.	Bannu-D.I.Khan	4.37	11.28	10.25	8.40	34.30
30.	Quetta-Nowshki	5.10	12.87	9.61	8.96	36.54
	Average	4.91	12.28	10.35	10.41	37.89
	Standard Deviation	0.37	0.97	1.49	1.41	3.57
	Variance	0.14	0.93	2.23	1.99	12.72
	Maximum Value	5.58	13.94	12.49	12.40	42.93
	Minimum	4.28	10.75	7.27	8.26	30.86

Table 6.8.6

STANDARD DEVIATION OF 4-AXLE REAR-TANDEM TRUCKS (LOADED)

St.No	Station	Front	Rear1	Rear2	Rear3	Total
2.	Karachi-Hyderabad	0.56	0.66	3.21	3.45	10.56
3.	Karachi-Thatta	0.79	3.31	2.99	4.01	43.53
4.	Hyderabad-Larkana	1.22	2.78	2.55	3.04	5.96
5.	Sakrand-Kandiaro	0.43	2.12	1.95	2.27	5.84
6.	Khairpur-Rohri	0.89	0.89	3.53	2.45	3.79
8.	R.Y.Khan-Sadiqabad	0.49	2.18	2.13	1.94	4.85
9.	Chanigot-Bahawalpur	0.47	2.33	3.93	2.52	7.81
10.	Multan-D.G.Khan	0.88	2.58	2.03	2.43	6.72
12.	D.G.Khan-Taunsa	0.66	1.51	1.95	1.94	4.95
13.	Sahiwal-Multan	1.30	2.20	3.25	2.92	7.83
14.	Okara-Lahore	1.00	2.35	2.01	2.02	6.03
15.	Lahore-Gujranwala	0.75	3.37	3.58	3.81	10.82
	Average	0.79	2.19	2.76	2.73	9.88
	Standard Deviation	0.27	0.80	0.71	0.69	10.32
	Variance	0.08	0.64	0.50	0.47	6.59
	Maximum Value	1.30	3.37	3.93	4.01	43.43
	Minimum	0.43	0.66	1.95	1.94	30.79

Table 6.8.6-A

AVERAGE AXLE LOADS (TONNES) 4-AXLE REAR-TANDEM TRUCK (EMPTY)

	Front	Rear1	Rear2	Rear3	Total
Average	4.07	5.11	5.32	5.06	19.56
Standard Deviation	0.57	0.92	1.01	0.48	1.79
Variance	0.33	0.85	1.01	0.23	3.19
Maximum Value	5.30	6.77	6.43	5.70	22.43
Minimum	3.35	3.90	3.60	4.14	16.77

Table 6.8.6.3

FOOD ITEMS

	Front	Rear1	Rear2	Rear3	Total
Average	5.24	13.04	12.21	11.75	42.25
Standard Deviation	0.58	3.13	1.59	1.31	4.96
Variance	0.34	9.81	2.54	1.72	24.56
Maximum Value	6.06	16.82	15.73	14.50	52.32
Minimum Value	4.47	8.64	10.75	10.13	35.74

BULK MANUFACTURE ITEMS

	Front	Rear1	Rear2	Rear3	Total
Average	5.25	13.46	11.59	11.53	41.82
Standard Deviation	0.79	1.85	2.14	2.19	4.84
Variance	0.62	3.41	4.57	4.79	23.40
Maximum Value	7.75	16.90	16.54	15.54	52.09
Minimum Value	3.56	7.45	6.67	7.33	31.47

FUEL AND LUBRICANTS

	Front	Rear1	Rear2	Rear3	Total
Average	5.18	12.66	10.60	11.01	39.46
Standard Deviation	0.60	1.65	1.96	2.28	5.39
Variance	0.36	2.72	3.83	5.18	29.06
Maximum Value	7.29	15.80	14.75	16.04	52.21
Minimum Value	4.30	9.30	6.90	5.05	26.75

RAW MATERIALS

	Front	Rear1	Rear2	Rear3	Total
Average	4.66	14.08	11.84	10.47	41.05
Standard Deviation	0.27	1.27	2.73	3.01	6.00
Variance	0.07	1.61	7.45	9.05	36.03
Maximum Value	5.10	15.70	16.60	15.40	52.20
Minimum Value	4.35	12.01	8.25	6.40	34.05

AGRICULTURE ITEMS

	Front	Rear1	Rear2	Rear3	Total
Average	4.94	12.22	10.89	10.86	38.90
Standard Deviation	0.48	1.82	1.94	1.85	3.89
Variance	0.23	3.31	3.75	3.42	15.11
Maximum Value	5.93	14.70	14.03	14.22	46.14
Minimum Value	4.46	8.59	7.50	8.50	34.85

Table 6.8.6.3

BASIC MANUFACTURE

	Front	Rear1	Rear2	Rear3	Total
Average	4.94	11.05	10.32	10.33	36.63
Standard Deviation	0.81	2.41	2.51	2.78	7.21
Variance	0.65	5.82	6.29	7.73	51.92
Maximum Value	7.71	21.90	17.32	18.00	62.90
Minimum Value	3.72	4.43	5.70	4.30	25.53

MISCELLANEOUS MANUFACTURE

	Front	Rear1	Rear2	Rear3	Total
Average	5.16	11.54	10.18	9.83	36.71
Standard Deviation	1.14	3.69	3.46	3.68	10.61
Variance	1.31	13.59	11.98	13.55	112.56
Maximum Value	9.35	21.10	19.65	18.91	64.35
Minimum Value	3.57	5.63	2.50	2.50	16.09

Table 6.8.7

AVERAGE AXLE LOADS (TONNES)
5-AXLE TRUCK TANDEM (LOADED)

	Front	Rear1	Rear2	Rear3	Rear4	Total
Average	5.74	9.77	9.52	10.56	11.59	47.17
Standard Deviation	1.00	1.40	3.91	3.41	2.25	10.40
Variance	1.00	1.95	15.28	11.62	5.06	108.14
Maximum Value	8.15	11.93	13.50	14.50	16.51	60.74
Minimum Value	4.82	8.09	3.29	5.18	8.99	32.92

Table 6.8.7-A

AVERAGE AXLE LOADS (TONNES)
5-AXLE TRUCK TANDEM (EMPTY)

	Front	Rear1	Rear2	Rear3	Rear4	Total
Average	6.32	3.29	4.56	4.58	4.69	23.44

Table 6.8.8

AVERAGE AXLE LOADS (TONNES)
6-AXLE TRUCK TANDEM TRIANDEM (LOADED)

St. No.	Station Name	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
3.	Karachi-Thatta	6.32	8.91	9.25	7.97	9.01	9.77	51.23
4.	Hyderabad-Larkana	6.35	7.47	8.36	8.44	7.38	7.40	45.39
5.	Sakrand-Kandiaro	6.10	11.18	10.90	12.76	11.45	13.05	65.44
6.	Khairpur-Rohri	5.94	8.81	9.13	9.98	10.04	10.68	54.57
8.	R.Y.Khan-Sadiqabad	5.85	10.52	10.43	12.17	10.50	10.93	60.38
9.	Chanigoth-Bhawalpur	5.65	8.85	10.50	10.03	12.16	8.33	55.22
10.	Multan-D.G.Khan	6.38	9.68	10.05	8.55	8.27	7.77	50.70
13.	Sahiwal-Multan	5.69	13.05	12.32	11.29	14.01	12.11	68.46
16.	Wazirabad-Gujrat	6.48	14.52	12.88	13.27	15.52	16.11	78.78
25.	Peshawar-Tourkham	6.34	10.44	11.77	11.14	9.35	7.61	56.65
	Average	6.11	10.34	10.56	10.56	10.77	10.38	58.68
	Standard Deviation	0.29	2.02	1.38	1.77	2.43	2.67	9.37
	Variance	0.08	4.08	1.89	3.15	5.89	7.13	87.70
	Maximum Value	6.48	14.52	12.88	13.27	15.52	16.11	78.78
	Minimum Value	5.65	7.47	8.36	7.97	7.38	7.40	45.39

Table 6.8.8-A

AVERAGE AXLE LOADS (TONNES)
6-AXLE TRUCK TANDEM TRIANDEM (EMPTY)

	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
Average	5.29	3.71	3.49	3.72	3.11	4.03	23.35

Table 6.8.8.3

AGRIGULTURE ITEMS

(Load in Tonnes)

	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
Average	6.36	11.89	11.44	11.76	12.76	12.36	66.57
St. Deviation	0.71	2.65	1.96	2.45	3.19	3.53	12.77
Variance	0.60	7.03	3.86	5.98	10.18	12.45	163.12
Maximum Value	7.45	16.10	13.90	14.88	17.56	18.96	87.17
Minimum Value	5.50	5.70	6.55	6.95	7.05	7.60	40.30

BULK MANUFACTURES

	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
Average	6.54	10.40	10.99	11.33	11.35	10.62	61.23
St. Deviation	1.07	2.01	1.74	1.88	2.04	2.36	8.43
Variance	1.15	4.04	3.01	3.52	4.15	5.59	70.98
Maximum Value	8.02	14.30	13.83	13.92	14.74	15.14	75.15
Minimum Value	4.24	7.47	7.35	7.75	7.10	6.85	44.10

FOOD ITEMS

	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
Average	6.95	9.87	10.20	7.45	9.28	9.86	53.62
St. Deviation	0.51	0.68	0.90	0.52	0.42	1.34	3.63
Variance	0.26	0.47	0.81	0.27	0.18	1.79	13.21
Maximum Value	7.56	10.82	11.47	9.70	9.70	11.28	58.68
Minimum Value	6.32	9.24	9.55	8.70	8.70	8.07	50.32

TYRE PRESSURE (psi) FOR 2-AXLE SINGLE (1.2)

St. NO.	Station Name	Axle Config.	Average*	Minimum Value	Maximum Value
	Wazirabad	Front Axle	108.79	97.50	145
16.	Gujrat	Rear Axle	126.51	110	156.25
	Gujrat	Front Axle	108.24	65	122.50
17.	Jhelum	Rear Axle	124.80	65	145
	Jhelum	Front Axle	107.43	97.50	145
18.	Rawalpindi	Rear Axle	124.74	105	145
	Rawalpindi	Front Axle	109.50	60	140
19.	Chablat	Rear Axle	127.71	72.50	150
	Hasanabdal	Front Axle	108.76	90	140
20.	Haripur	Rear Axle	128.59	110	150
	Haripur	Front Axle	107.07	100	140
21.	Abbottabad	Rear Axle	127.35	110	145
	Abbottabad	Front Axle	107.19	80	145
22.	Manshera	Rear Axle	124.31	80	145
	Chablat	Front Axle	109.51	100	145
23.	Nowshera	Rear Axle	127.38	100	145
	Nowshera	Front Axle	109.16	100	145
24.	Peshawar	Rear Axle	127.78	100	145
	Peshawar	Front Axle	108.28	97.50	125
25.	Tourkham	Rear Axle	128.54	110	145
	Peshawar	Front Axle	109.37	100	125
26.	Kohat	Rear Axle	128.92	100	150
	Bannu	Front Axle	113.86	105	145
27.	D.I.Khan	Rear Axle	134.33	120	150
	Fortminro	Front Axle	112.72	100	145
28.	Q.Saifullah	Rear Axle	130.28	100	150
	Quetta	Front Axle	107.07	65	145
29.	Chamman	Rear Axle	127.26	80	160
	Quetta	Front Axle	109.31	85	140
30.	Nowshki	Rear Axle	126.41	95	145

* In case of front axles, the figures represent average of two front wheels & for rear axles, the figures represent average of all tyre pressure in that particular axle.

Table 6.10.2

TYRE PRESSURE (psi) FOR 3-AXLE SINGLE (1.2-2)

St. No.	Station Name	Axle Config.	Average*	Minimum Value	Maximum Value
16.	Wazirabad Gujrat	Front Axle	115.89	105	140
		Rear Axle 1	134.39	125	147.50
		Rear Axle 2	133.18	125	150
17.	Gujrat Jhelum	Front Axle	111.88	110	120
		Rear Axle 1	136.25	125	150
		Rear Axle 2	136.67	125	150
18.	Jhelum Rawalpindi	Front Axle	111.00	105	125
		Rear Axle 1	136.33	125	145
		Rear Axle 2	138.17	125	145
19.	Rawalpindi Chablat	Front Axle	118.50	110	150
		Rear Axle 1	138.25	120	150
		Rear Axle 2	138.73	120	150
20.	Hasanabdal Haripur	Front Axle	107.50	105	110
		Rear Axle 1	135.00	130	140
		Rear Axle 2	135.00	130	140
23.	Chablat Nowshera	Front Axle	110.00	110	110
		Rear Axle 1	140.00	135	145
		Rear Axle 2	140.00	135	145
25.	Peshawar Tourkham	Front Axle	120.45	100	135
		Rear Axle 1	145.00	135	150
		Rear Axle 2	145.00	135	150
26.	Peshawar Kohat	Front Axle	121.32	115	132.50
		Rear Axle 1	140.88	120	150
		Rear Axle 2	140.88	120	150
27.	Bannu D.I.Khan	Front Axle	122.50	120	130
		Rear Axle 1	143.96	135	150
		Rear Axle 2	143.96	135	150

* In case of front axles, the figures represent average of two front wheels and for rear axles, the figures represent average of all tyre pressure in that particular axle.

Table 6.10.6

TYRE PRESSURE (psi) FOR 5-AXLE TANDEM (1.22-22)

St No	Station Name	Axle Config.	Average*	Minimum Value	Maximum Value
16	Wazirabad Gujrat	Front Axle	128.33	110	150
		Rear Axle 1	146.08	140	150
		Rear Axle 2	145.17	140	148.50
		Rear Axle 3	140.42	131.25	153.75
		Rear Axle 4	140.92	135	146.25

* In case of front axles, the figures represent average of two front wheels and for rear axles, the figures represent average of all tyre pressure in that particular axle.

Table 6.10.7

TYRE PRESSURE (psi) FOR 6-AXLE TANDEM (1.2-222)

St No	Station Name	Axle Config.	Average*	Minimum Value	Maximum Value
16	Wazirabad Gujrat	Front Axle	125	110	140
		Rear Axle 1	138	136	140
		Rear Axle 2	139.88	139.75	140
		Rear Axle 3	140	140	140
		Rear Axle 4	140	140	140
		Rear Axle 5	138.75	137.50	140
17	Jhelum Rawalpindi	Front Axle	133.33	125	150
		Rear Axle 1	126.67	125	130
		Rear Axle 2	126.25	123.75	130
		Rear Axle 3	125.83	122.50	130
		Rear Axle 4	126.67	125	130
		Rear Axle 5	127.08	125	130

* In case of front axles, the figures represent average of two front wheels and for rear axles, the figures represent average of all tyre pressure in that particular axle.

Table 7.2-A

EQUIVALENT STANDARD AXLES FOR 2-AXLE TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear	Total
1	Karachi-Gaddani	0.25	23.34	23.59
2	Karachi-Hyderabad	0.14	6.80	6.94
3	Karachi-Thatta	0.15	6.00	6.15
4	Hyderabad-Larkana	0.12	5.68	5.80
5	Sakrand-Kandiaro	0.13	5.37	5.49
6	Khairpur-Rohri	0.13	8.53	8.66
7	Jacobabad-Sibi	0.16	7.42	7.58
8	R.Y.Khan-Sadiqabad	0.14	5.67	5.81
9	Chunikot-Bahawalpur	0.13	7.19	7.31
10	Multan-D.G. Khan	0.25	10.61	10.86
11	D.G. Khan-Kashmore	0.11	5.00	5.11
12	D.G.Khan-Taunsa	0.11	4.22	4.33
13	Sahiwal-Multan	0.16	5.56	5.73
14	Okara-Lahore	0.12	3.20	3.32
15	Lahore-Gujranwala	0.11	4.93	5.04
16	Wazirabad-Gujrat	0.21	4.80	5.00
17	Gujrat-Jhelum	0.26	5.87	6.12
18	Jhelum-Rawalpindi	0.15	6.12	6.27
19	Rawalpindi-Chablat	0.15	4.74	4.89
20	Hasanabdal-Haripur	0.12	4.35	4.47
21	Haripur-Abbotabad	0.12	3.86	3.98
22	Abbotabad-Manshera	0.13	4.79	4.92
23	Chablat-Nowshera	0.13	5.92	6.06
24	Nowshera-Peshawar	0.14	5.68	5.82
25	Peshawar-Tourkhum	0.12	6.39	6.51
26	Peshawar-Kohat	0.11	4.62	4.73
27	Bannu-D.I.Khan	0.21	7.12	7.33
28	Fortminro-Q.Saifullah	0.15	5.64	5.79
29	Quetta-Chamman	0.11	4.09	4.20
30	Quetta-Noshki	0.13	6.81	6.94
	Average	0.15	6.34	6.49
	Standard Deviation	0.04	3.48	3.50
	Variance	0.00	12.09	12.26
	Maximum Value	0.26	23.34	23.59
	Minimum Value	0.11	3.20	3.32

EQUIVALENT STANDARD AXLES FOR 3-AXLE SINGLE TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Rear2	Total
1	Karachi-Gaddani	0.57	10.32	10.39	23.37
2	Karachi-Hyderabad	0.57	13.84	11.72	26.13
4	Hyderabad-Larkana	0.62	4.66	5.21	10.49
5	Sakrand-Kandiaro	1.40	8.20	18.47	36.08
9	Chunikot-Bahwawalpur	0.09	4.85	9.51	14.45
16	Wazirabad-Gujrat	0.63	7.99	9.29	17.91
17	Gujrat-Jhelum	0.92	5.74	6.12	12.78
18	Jhelum-Rawalpindi	0.60	15.50	10.04	26.14
19	Rawalpindi-Chablat	0.34	4.57	4.68	9.59
20	Hasanabdal-Haripur	0.18	3.10	1.90	5.19
21	Haripur-Abbotabad	0.54	9.16	6.53	16.23
23	Chablat-Nowshera	0.42	7.44	4.00	11.86
25	Peshawar-Tourkham	0.50	8.40	4.14	13.05
26	Peshawar-Kohat	0.20	6.59	4.09	10.88
27	Bannu-D.I.Khan	0.65	9.61	4.96	15.22
	Average	0.55	8.66	7.54	16.62
	Standard Deviation	0.31	4.18	4.20	7.80
	Variance	0.09	17.43	17.65	60.88
	Maximum Value	1.40	15.20	18.47	36.08
	Minimum Value	0.09	3.10	3.10	5.19

Table 7.2-C

EQIVALENT STANDARD AXLES LOADS FOR 3-AXLE REAR-TANDEM TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Rear2	Total
1	Karachi-Gaddani	1.61	20.04	24.89	46.54
2	Karachi-Hyderabad	0.40	11.72	9.94	22.05
3	Karachi-Thatta	0.87	10.49	10.93	22.29
4	Hyderabad-Larkana	0.33	5.85	5.00	11.18
5	Sakrand-Kandiaro	0.69	11.80	12.30	24.79
6	Khairpur-Rohri	0.65	10.93	13.52	25.10
7	Jacobabad-Sibi	0.36	4.01	4.67	9.05
8	RY Khan-Sadiqabad	0.58	5.52	11.78	13.13
9	Chunikot-Bhawalpur	0.44	5.80	8.83	15.08
10	Multan-D.G. Khan	0.27	3.89	3.87	8.03
11	DG Khan-Kashmore	0.48	5.82	9.12	15.42
12	D.G.Khan-Taunsa	0.35	4.69	5.09	10.13
13	Sahiwal-Multan	0.75	9.32	10.05	20.13
14	Okara-Lahore	0.30	5.08	5.17	10.55
15	Lahore-Gujranwala	0.72	11.57	9.25	21.54
16	Wazirabad-Gujrat	0.67	11.34	15.01	27.10
17	Gujrat-Jhelum	0.66	7.83	8.93	17.41
18	Jhelum-Rawalpindi	0.67	17.17	16.53	34.37
19	Rawalpindi-Chablat	0.30	6.52	5.09	11.91
20	Hasanabdal-Haripur	0.42	7.71	7.42	15.55
21	Haripur-Abbotabad	1.00	8.85	9.46	19.31
23	Chablat-Nowshera	0.60	10.29	10.60	21.49
24	Nowshera-Peshawar	0.59	8.47	5.60	14.66
25	Peshawar-Tourkhum	1.53	10.35	11.88	23.76
26	Peshawar-Kohat	0.30	6.82	6.78	13.90
27	Bannu-D.I.Khan	0.54	7.93	7.80	16.26
29	Quetta-Chamman	0.31	2.98	3.64	6.94
30	Quetta-Noshki	0.32	9.33	10.00	19.65
	Average	0.60	8.65	9.40	18.48
	Standard Deviation	0.33	3.78	4.45	8.32
	Variance	0.11	14.32	19.79	69.16
	Maximum Value	1.61	20.04	24.89	46.54
	Minimum Value	0.27	2.98	3.64	6.94

Table 7.2-D

EQIVALENT STANDARD AXLES FOR 4-AXLE SINGLE TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Rear2	Rear3	Total
1	Karachi-Gaddani	0.07	4.60	1.46	3.00	9.13
2	Karachi-Hyderabad	0.08	4.35	7.03	5.03	16.49
3	Karachi-Thatta	0.23	3.72	2.16	3.51	9.61
4	Hyderabad-Larkana	0.13	5.36	3.34	4.14	12.83
5	Sakrand-Kandiaro	0.13	14.29	7.86	6.51	28.79
7	Jaccobbabad-Sibbi	1.16	4.16	2.12	1.56	7.43
9	R.Y.Khan-Sadiqabad	0.10	3.44	6.32	8.27	18.13
13	Sahiwal-Multan	0.83	7.84	1.91	1.30	11.87
18	Jhelum-Rawalpindi	0.56	8.91	24.11	10.64	44.22
19	Rawalpindi-Chablat	0.13	6.93	13.31	11.15	31.52
	Average	0.34	6.36	6.96	5.51	19.00
	Standard Deviation	0.36	3.17	6.72	3.35	11.42
	Variance	0.13	10.04	45.10	11.25	130.41
	Maximum Value	1.16	14.29	24.11	11.15	44.72
	Minimum Value	0.07	3.44	1.46	1.30	7.43

Table 7.2-E

EQUIVALENT STANDARD AXLES FOR 4-AXLE MID-TANDEM TRUCK (LOADED IN BOTH DIRECTIONS)

	Front	Rear1	Rear2	Rear3	Total
Average	0.38	5.69	3.67	4.50	14.20

Table 7.2-F

EQUIVALENT STANDARD AXLE FOR 4-AXLE REAR-TANDEM TRUCKS LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Rear2	Rear3	Total
1	Karachi-Gaddani	0.05	3.85	0.98	1.27	6.15
2	Karachi-Hyderabad	0.09	9.66	8.11	7.68	25.53
3	Karachi-Thatta	0.11	5.97	3.01	5.65	14.74
4	Hyderabad-Larkana	0.22	6.76	5.03	3.55	15.55
5	Sakrand-Kandiaro	0.11	7.02	7.01	6.83	20.97
6	Khairpur-Rohri	0.18	15.78	5.00	7.94	28.90
8	R.Y.Khan-Sadiqabad	0.11	5.93	2.61	2.83	11.48
9	Chanigot-Bahawalpur	0.12	9.85	7.35	8.06	25.38
10	Multan-D.G.Khan	0.19	9.41	4.89	5.75	20.24
11	D.G.Khan-Kashmore	0.08	7.67	2.44	4.25	14.44
12	D.G.Khan-Taunsa	0.08	11.84	6.54	7.35	25.81
13	Sahiwal-Multan	0.28	12.55	10.55	6.20	29.58
14	Okara-Lahore	0.17	4.74	2.47	2.87	10.24
15	Lahore-Gujranwala	0.14	9.82	7.82	7.81	25.59
19	Rawalpindi-Chablat	0.05	3.95	0.81	1.28	6.10
23	Chablat-Nowshera	0.15	7.06	0.83	1.09	9.13
26	Peshawar-Kohat	0.08	9.50	5.66	3.90	19.14
27	Bannu-D.I.Khan	0.06	4.29	2.79	1.14	8.28
30	Quetta-Nowshki	0.12	7.77	2.09	1.52	11.50
	Average	0.13	8.07	4.53	4.58	17.30
	Standard Deviation	0.06	3.07	2.75	2.56	7.67
	Variance	0.00	9.45	7.56	6.53	58.85
	Maximum Value	0.28	15.78	10.55	8.06	29.56
	Minimum Value	0.03	3.85	0.81	1.09	6.09

Table 7.2-G

EQUIVALENT STANDARD AXLE FOR 5-AXLE TANDEM TRUCK (LOADED IN BOTH DIRECTIONS)

	Front	Rear1	Rear2	Rear3	Rear4	Total
Average	0.27	2.62	4.45	5.66	6.58	19.59
St. Deviation	0.28	1.66	3.97	4.89	6.83	15.64
Variance	0.08	2.77	15.80	23.94	46.66	244.52
Maximum Value	0.99	5.52	9.64	13.29	23.84	50.96
Minimum Value	0.09	0.96	0.02	0.13	1.55	3.80

EQUIVALENT STANDARD AXLE LOADS FOR 6-AXLE TANDEM TRIDEM TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
3	Karachi-Thatta	0.32	1.49	1.76	0.90	1.56	2.25	8.27
4	Hyderabad-Larkana	0.32	0.67	1.12	1.16	0.64	0.64	4.55
5	Sakrand-Kandiaro	0.27	4.12	3.68	7.48	4.59	8.27	28.42
6	Khairpur-Rohri	0.24	1.41	1.66	2.47	2.54	3.36	11.68
8	R.Y.Khan-Sadiqabad	0.22	3.02	6.04	3.11	3.73	3.73	19.84
9	Chanigot-Bahawalpur	0.19	1.44	3.11	2.53	6.02	1.10	14.39
10	Multan-D.G.Khan	0.33	2.16	2.16	2.55	1.23	1.06	9.49
13	Sahiwal-Multan	0.20	8.27	6.38	4.31	11.39	5.91	36.46
16	Wazirabad-Gujrat	0.35	13.37	7.80	8.92	18.05	21.35	69.84
25	Peshawar-Tourkham	0.32	3.03	5.20	4.06	1.85	0.73	15.18
	Average	0.57	3.90	3.89	3.75	5.16	4.84	21.81
	Standard Deviation	0.86	3.77	2.21	2.47	5.24	5.99	18.45
	Variance	0.74	14.20	4.87	6.08	27.46	35.83	340.3
	Maximum Value	3.14	13.37	7.80	8.92	18.05	21.35	69.84
	Minimum Value	0.19	0.67	1.12	0.90	0.64	0.64	4.55

Table 7.2-a

EQ.ST.AXLES,2-AXLE TRUCK (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear	Total
1	Karachi-Gaddani	0.33	11.16	11.49
	Gaddani-Karachi	0.18	32.60	32.77
2	Karachi-Hyderabad	0.11	6.23	6.34
	Hyderabad-Karachi	0.16	7.36	7.52
3	Karachi-Thatta	0.06	3.28	3.34
	Thatta-Karachi	0.22	8.16	8.38
4	Hyderabad-Larkana	0.15	6.78	6.93
	Larkana-Hyderabad	0.03	2.92	2.94
5	Kandiaro-Sakrand	0.09	3.95	4.03
	Sakrand-Kandiaro	0.16	6.64	6.80
6	Khairpur-Rohri	0.14	11.04	11.19
	Rohri-Khairpur	0.12	4.33	4.45
7	Jacobabad-Sibbi	0.18	6.21	6.38
	Sibbi-Jaccobabad	0.12	4.98	5.10
8	R.Y.Khan-Sadiqabad	0.15	5.89	6.04
	Sadiqabad-R.Y.Khan	0.13	5.41	5.54
9	Chunigot-Bahawalpur	0.12	6.90	7.02
	Bahawalpur-Chunigot	0.13	7.45	4.59
10	Multan-D.G.Khan	0.08	2.88	2.95
	D.G.Khan-Multan	0.36	15.68	16.04
11	D.G.Khan-Kashmore	0.10	4.72	4.82
	Kashmore-D.G.Khan	0.13	5.19	5.32
12	D.G.Khan-Taunsa	0.14	5.92	6.06
	Taunsa-D.G.Khan	0.08	2.51	2.59
13	Sahiwal-Multan	0.19	6.10	6.29
	Multan-Sahiwal	0.13	4.89	5.02
14	Okara-Lahore	0.09	3.18	3.17
	Lahore-Okara	0.14	3.21	3.35
15	Lahore-Gujranwala	0.15	5.38	5.53
	Gujranwala-Lahore	0.08	4.52	4.60
16	Wazirabad-Gujrat	0.18	4.73	4.91
	Gujrat-Wazirabad	0.23	4.85	5.08
17	Gujrat-Jhelum	N.A.	N.A.	N.A.
	Jhelum-Gujrat	0.26	5.87	6.13
18	Jhelum-Rawalpindi	0.12	5.35	5.47
	Rawalpindi-Jhelum	0.19	7.59	7.78
19	Rawalpindi-Chablat	0.08	2.56	2.64
	Chablat-Rawalpindi	0.19	5.83	6.02
20	Haripur-Hasanabdal	0.14	3.97	4.11
	Hasanabdal-Haripur	0.11	4.67	4.78
21	Haripur-Abbottabad	0.12	3.72	3.84
	Abbottabad-Haripur	0.14	4.23	4.37
22	Abbottabad-Manshera	0.15	5.03	5.18
	Manshera-Abbottabad	0.06	3.82	3.89
23	Chablat-Nowshera	0.13	6.16	6.29
	Nowshera-Chablat	0.13	5.74	5.87
24	Nowshera-Peshawar	0.15	6.71	6.86
	Peshawar-Nowshera	0.13	4.72	4.85
25	Peshawar-Tourkham	0.13	5.27	5.39
	Tourkham-Peshawar	0.12	6.82	6.95
26	Peshawar-Kohat	0.11	4.10	4.21
	Kohat-Peshawar	0.11	4.98	5.10
27	Bannu-D.I.Khan	0.17	7.27	7.44
	D.I.Khan-Bannu	0.23	7.00	7.23
28	Fortminro-Q.Saifullah	0.13	4.78	4.91
	Q.Saifullah-Fortminro	0.18	6.66	6.83
29	Quetta-Chamman	0.11	4.20	4.31
	Chamman-Quetta	0.11	4.01	4.12
30	Quetta-Noshki	0.12	3.69	3.81
	Noshki-Quetta	0.13	9.40	9.53

EQIVALENT STANDARD AXLES FOR 3-AXLE SINGLE TRUCKS (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear1	Rear2	Total
1	Karachi-Gaddani	0.94	15.43	12.68	29.06
	Gaddani-Karachi	1.83	22.54	28.56	52.93
2	Karachi-Hyderabad	0.85	20.94	16.06	37.04
	Hyderabad-Karachi	0.16	4.35	5.18	9.69
4	Hyderabad-Larkana	0.62	4.66	5.20	10.48
	Larkana-Hyderabad	N.A.	N.A.	N.A.	N.A.
5	Sakrand-Kandiaro	1.40	18.20	18.47	38.08
	Kandiaro-Sakrand	N.A.	N.A.	N.A.	N.A.
9	Chunikot-Bahawalpur	0.09	4.85	9.51	14.45
	Bahawalpur-Chunigot	N.A.	N.A.	N.A.	N.A.
16	Wazirabad-Gujrat	0.63	4.02	8.79	13.43
	Gujrat-Wazirabad	0.63	13.26	9.94	23.84
17	Jhelum-Gujrat	0.92	5.74	6.12	12.78
	Gujrat-Jhelum	N.A.	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.72	16.48	6.52	23.72
	Rawalpindi-Jhelum	0.50	14.61	13.10	28.21
19	Rawalpindi-Chablat	0.29	1.59	2.05	3.92
	Chablat-Rawalpindi	0.40	8.28	7.96	16.64
20	Hasanabdal-Haripur	0.18	3.10	1.90	5.18
	Haripur-Hasanabdal	N.A.	N.A.	N.A.	N.A.
21	Abbottabad-Haripur	0.54	9.16	6.53	16.23
	Haripur-Abbottabad	N.A.	N.A.	N.A.	N.A.
23	Chablat-Nowshera	0.47	8.42	4.19	13.08
	Nowshera-Chablat	0.28	4.95	3.51	8.74
25	Peshawar-Tourkham	0.67	8.75	4.80	14.22
	Tourkham-Peshawar	0.39	8.16	3.69	12.24
26	Kohat-Peshawar	0.20	6.58	4.08	10.87
	Peshawar-Kohat	N.A.	N.A.	N.A.	N.A.
27	Bannu-D.I.Khan	0.66	9.20	5.54	15.40
	D.I.Khan-Bannu	0.65	9.74	4.75	15.14

Table 7.2-c

EQUIVALENT STANDARD AXLE LOADS, 3-AXLE R-TANDEM TRUCK
(LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear1	Rear2	Total
1	Karachi-Gaddani	0.49	7.42	6.35	14.26
	Gaddani-Karachi	1.21	15.01	21.31	37.53
2	Karachi-Hyderabad	0.52	19.45	15.60	35.58
	Hyderabad-Karachi	0.27	4.34	4.54	9.16
3	Karachi-Thatta	1.54	11.88	15.47	28.49
	Thatta-Karachi	0.20	9.09	6.37	15.65
4	Hyderabad-Larkana	0.36	6.54	5.47	12.37
	Larkana-Hyderabad	0.30	5.16	4.54	10.00
5	Sakrand-Kandiaro	0.74	12.87	14.12	27.73
	Kandiaro-Sakrand	0.52	7.98	5.88	14.37
6	Khairpur-Rohri	0.74	12.80	16.67	30.20
	Rohri-Khairpur	0.40	5.39	4.23	10.02
7	Jaccobabad-Sibbi	0.43	3.88	4.18	8.49
	Sibbi-Jaccobabad	0.32	7.38	5.05	12.76
8	R.Y.Khan-Sadiqabad	0.34	4.86	4.34	9.54
	Sadiqabad-R.Y.Khan	0.72	5.91	6.49	13.12
9	Chunigot-Bahawalpur	0.47	6.08	10.94	17.47
	Bahawalpur-Chunigot	0.42	5.53	6.84	12.80
10	Multan-D.G.Khan	0.20	2.88	3.43	6.51
	D.G.Khan-Multan	0.41	6.04	4.77	11.23
11	D.G.Khan-Kashmore	0.32	3.65	5.92	9.88
	Kashmore-D.G.Khan	0.57	7.07	10.96	18.59
12	D.G.Khan-Taunsa	0.35	4.68	5.08	10.12
	Taunsa-D.G.Khan	N.A.	N.A.	N.A.	N.A.
13	Sahiwal-Multan	0.73	10.47	9.62	20.83
	Multan-Sahiwal	0.77	7.88	10.56	19.21
14	Okara-Lahore	0.30	6.41	6.20	12.92
	Lahore-Okara	0.29	2.46	3.15	5.90
15	Gujranwala-Lahore	0.59	5.81	5.07	11.47
	Lahore-Gujranwala	0.86	18.13	14.00	33.00
16	Wazirabad-Gujrat	0.56	8.49	11.48	20.53
	Gujrat-Wazirabad	0.74	13.30	17.61	31.65
17	Jhelum-Gujrat	0.66	7.83	8.93	17.41
	Gujrat-Jhelum	N.A.	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.72	15.94	15.12	31.78
	Rawalpindi-Jhelum	0.44	22.56	22.80	45.80
19	Rawalpindi-Chablat	0.16	1.64	1.96	3.75
	Chablat-Rawalpindi	0.35	8.03	6.06	14.44
20	Hasanabdal-Haripur	0.28	7.78	7.25	15.30
	Haripur-Hasanabdal	0.69	7.54	7.75	15.98
21	Haripur-Abbottabad	1.17	9.33	11.16	21.66
	Abbottabad-Haripur	0.33	6.91	2.61	9.84
23	Chablat-Nowshera	0.60	10.28	10.62	21.50
	Nowshera-Chablat	0.58	10.25	10.44	21.27
24	Nowshera-Peshawar	0.39	7.30	4.90	12.59
	Peshawar-Nowshera	0.86	10.01	6.52	17.39
25	Peshawar-Tourkham	1.53	10.34	11.87	23.74
	Tourkham-Peshawar	N.A.	N.A.	N.A.	N.A.
26	Peshawar-Kohat	0.16	2.97	4.93	8.07
	Kohat-Peshawar	0.31	7.05	6.89	14.25
27	Bannu-D.I.Khan	0.73	7.66	9.65	18.04
	D.I.Khan-Bannu	0.45	8.03	6.95	15.44
29	Quetta-Chamman	0.46	4.71	5.37	10.54
	Chamman-Quetta	0.26	2.40	3.06	5.73
30	Noshki-Quetta	0.40	11.23	12.94	24.57
	Quetta-Noshki	0.12	4.21	2.10	6.43

Table 7.2-d

EQUIVALENT STANDARD AXLES FOR 4-AXLE SINGLE TRUCKS (LOADED IN EACH DIRECTION)

S.NO	Station Name	Front	Rear1	Rear2	Rear3	Total
1	Karachi-Gaddani	0.09	4.09	1.51	2.18	7.87
	Gaddani-Karachi	N.A.	N.A.	N.A.	N.A.	N.A.
2	Karachi-Hyderabad	0.07	5.01	10.38	8.80	26.69
	Hyderabad-Karachi	0.07	4.40	9.51	8.62	22.60
3	Karachi-Thatta	0.28	4.04	2.71	2.41	9.16
	Thatta-Karachi	0.15	3.24	1.34	5.55	10.28
4	Hyderabad-Larkana	0.15	7.15	5.11	5.86	18.27
	Larkana-Hyderabad	0.10	2.34	0.38	1.25	4.07
5	Sakrand-Kandiaro	0.10	13.46	5.06	5.48	24.10
	Kandiaro-Sakrand	0.18	15.49	12.04	8.05	35.76
7	Sibbi-Jaccobabad	1.16	4.16	2.11	1.56	8.98
	Jaccobabad-Sibbi	N.A.	N.A.	N.A.	N.A.	N.A.
8	R.Y.Khan-Sadiqabad	0.11	4.86	2.98	4.77	12.71
	Sadiqabad-R.Y.Khan	0.10	2.02	9.66	11.74	33.51
13	Sahiwal-Multan	0.83	7.83	1.91	1.30	11.86
	Multan-Sahiwal	N.A.	N.A.	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.56	8.90	24.09	10.63	44.17
	Rawalpindi-Jhelum	N.A.	N.A.	N.A.	N.A.	N.A.
19	Rawalpindi-Chablat	0.13	6.93	13.31	11.15	31.52
	Chablat-Rawalpindi	N.A.	N.A.	N.A.	N.A.	N.A.

Table 7.2-f

EQUIVALENT STANDARD AXLES FOR 4-AXLE REAR-TANDEM TRUCK (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear1	Rear2	Rear3	Total
1	Karachi-Gaddani	0.05	3.85	0.98	1.27	6.16
	Gaddani-Karachi	N.A.	N.A.	N.A.	N.A.	N.A.
2	Karachi-Hyderabad	0.10	12.31	9.61	9.07	31.09
	Hyderabad-Karachi	0.06	4.05	4.92	4.70	13.74
3	Karachi-Thatta	0.11	6.77	2.90	6.39	16.18
	Thatta-Karachi	N.A.	N.A.	N.A.	N.A.	N.A.
4	Hyderabad-Larkana	0.37	6.55	4.27	2.64	13.83
	Larkana-Hyderabad	0.08	6.94	5.72	4.38	17.11
5	Sakrand-Kandiaro	0.09	6.32	6.62	7.02	20.05
	Kandiaro-Sakrand	0.13	7.88	7.49	6.59	22.10
6	Khairpur-Rohri	0.26	22.29	7.57	13.52	43.63
	Rohri-Khairpur	0.09	8.05	1.96	1.33	11.42
8	R.Y.Khan-Sadiqabad	0.08	5.26	1.79	1.96	9.10
	Sadiqabad-R.Y.Khan	0.13	6.58	3.43	3.69	13.83
9	Chunigot-Bahawalpur	0.14	7.69	4.15	9.69	21.67
	Bahawalpur-Chunigot	0.10	11.45	9.74	6.83	28.11
10	Multan-D.G.Khan	0.10	6.43	3.00	2.37	11.90
	D.G.Khan-Multan	0.21	10.32	5.46	6.78	22.77
11	D.G.Khan-Kashmore	0.08	7.66	2.44	4.24	14.42
	Kashmore-D.G.Khan	N.A.	N.A.	N.A.	N.A.	N.A.
12	D.G.Khan-Taunsa	0.08	11.83	6.53	7.35	25.78
	Taunsa-D.G.Khan	N.A.	N.A.	N.A.	N.A.	N.A.
13	Multan-Sahiwal	0.32	13.76	12.29	7.07	33.44
	Sahiwal-Multan	0.08	6.42	1.79	1.81	10.10
14	Okara-Lahore	0.10	7.87	3.20	3.88	15.05
	Lahore-Okara	0.22	2.09	1.84	2.01	6.16
15	Lahore-Gujranwala	0.16	13.02	10.88	10.95	35.01
	Gujranwala-LohreE	0.07	2.59	0.92	0.73	4.31
19	Rawalpindi-Chablat	N.A.	N.A.	N.A.	N.A.	N.A.
	Chablat-Rawalpindi	0.05	3.95	0.81	1.20	6.09
23	Chablat-Nowshera	0.15	7.05	0.82	1.09	9.12
	Nowshera-Chablat	N.A.	N.A.	N.A.	N.A.	N.A.
26	Peshawar-Kohat	0.08	9.50	5.66	3.90	19.14
	Kohat-Peshawar	N.A.	N.A.	N.A.	N.A.	N.A.
27	Bannu-D.I.Khan	0.06	4.29	2.79	1.14	8.27
	D.I.Khan-Bannu	N.A.	N.A.	N.A.	N.A.	N.A.
30	Quetta-Nowshki	0.12	7.77	2.09	1.52	11.50
	Nowshki-Quetta	N.A.	N.A.	N.A.	N.A.	N.A.

EQUIVALENT STANDARD AXLES FOR 6-AXLE TANDEM TRIDEM (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear1	Rear2	Rear3	Rear4	Rear5	Total
3	Karachi-Thatta	0.31	2.76	2.52	3.29	3.50	4.22	16.61
	Thatta-Karachi	0.40	1.77	2.35	0.47	1.46	2.98	9.43
4	Hyderabad-Larkana	0.34	1.75	2.69	2.42	1.33	0.50	9.03
	Larkana-Hyderabad	0.30	0.20	0.37	0.49	0.26	0.82	2.43
5	Kandiaro-Sakrand	0.27	4.12	3.68	7.47	4.59	8.26	28.39
	Sakrand-Kandiaro	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
6	Khairpur-Rohri	0.24	0.77	1.42	3.44	3.99	16.12	25.97
	Rohri-Khairpur	0.25	2.20	2.20	2.42	2.18	1.78	11.03
8	R.Y.Khan-Sadiqabad	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Sadiqabad-R.Y.Khan	0.36	3.33	3.16	6.60	3.26	6.51	23.22
9	Chunigot-Bahawalpur	0.19	1.44	3.11	2.53	6.01	1.10	14.37
	Bahawalpur-Chunigot	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
10	Multan-D.G.Khan	0.40	2.27	2.68	1.37	1.16	0.84	8.73
	D.G.Khan-Multan	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
13	Multan-Sahiwal	0.78	7.07	9.83	10.37	7.95	5.60	41.61
	Sahiwal-Multan	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
15	Lahore-Gujranwala	0.18	7.29	6.90	5.97	17.45	9.08	46.86
	Gujranwala-Lahore	0.24	10.49	5.41	2.10	4.59	2.22	25.05
16	Wazirabad-Gujrat	0.77	4.51	6.45	11.48	11.00	4.45	38.66
	Gujrat-Wazirabad	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.38	14.06	7.99	9.52	19.36	25.30	76.60
	Rawalpindi-Jhelum	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
25	Peshawar-Tourkham	0.32	3.03	5.19	4.05	1.84	0.73	15.17
	Tourkham-Peshawar	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Table 7.3-A

EQUIVALENT STANDARD AXLES FOR 2-AXLE TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear	Total
1	Karachi-Gaddani	0.26	12.83	13.09
2	Karachi-Hyderabad	0.16	4.78	4.94
3	Karachi-Thatta	0.17	4.23	4.40
4	Hyderabad-Larkana	0.14	4.46	4.60
5	Sakrand-Kandiaro	0.14	4.03	4.17
6	Khairpur-Rohri	0.16	5.74	5.90
7	Jaccobabad-Sibbi	0.18	4.07	4.25
8	R.Y.Khan-Sadiqabad	0.17	4.21	4.37
9	Chunigot-Bahawalpur	0.15	5.07	5.22
10	Multan-D.G.Khan	0.28	7.09	7.37
11	D.G.Khan-Kashmore	0.13	3.70	3.84
12	D.G.Khan-Taunsa	0.14	3.20	3.33
13	Sahiwal-Multan	0.18	4.08	4.26
14	Okara-Lahore	0.13	2.52	2.65
15	Lahore-Gujranwala	0.14	3.72	3.86
16	Wazirabad-Gujrat	0.24	3.63	3.87
17	Gujrat-Jhelum	0.28	4.44	4.72
18	Jhelum-Rawalpindi	0.17	4.40	4.58
19	Rawalpindi-Chablat	0.17	3.55	3.72
20	Hasanabdal-Haripur	0.14	3.37	3.51
21	Haripur-Abbottabad	0.15	3.07	3.21
22	Abbottabad-Manshera	0.15	3.66	3.82
23	Chablat-Nowshera	0.16	4.30	4.45
24	Nowshera-Peshawar	0.17	4.25	4.42
25	Peshawar-Tourkham	0.14	4.80	4.94
26	Peshawar-Kohat	0.14	3.52	3.66
27	Bannu-D.I.Khan	0.23	5.24	5.47
28	Fortminro-Q.Saifullah	0.18	4.14	4.32
29	Quetta-Chamman	0.13	3.14	3.27
30	Quetta-Noshki	0.15	4.80	4.97
	Average	0.17	4.50	4.67
	Standard Deviation	0.04	1.79	1.81
	Variance	0.00	0.02	0.02
	Maximum Value	0.28	12.83	13.09
	Minimum Value	0.13	2.52	2.65

EQUIVALENT STANDARD AXLES FOR 3-AXLE SINGLE TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Rear2	Total
1	Karachi-Gaddani	0.62	7.36	8.46	16.4
2	Karachi-Hyderabad	0.57	8.71	1.93	11.22
4	Hyderabad-Larkana	0.57	3.85	4.07	8.49
5	Sakrand-Kandiaro	1.51	11.20	11.02	23.91
9	Chunigot-Bahawalpur	0.09	4.09	7.00	11.18
16	Wazirabad-Gujrat	0.66	4.82	6.76	12.24
17	Gujrat-Jhelum	0.92	4.46	4.75	10.13
18	Jhelum-Rawalpindi	0.46	10.00	6.07	16.53
19	Rawalpindi-Chablat	0.35	3.56	3.37	7.28
20	Hasanabdal-Haripur	0.19	2.61	1.85	4.64
21	Haripur-Abbottabad	0.62	7.00	5.39	13.01
23	Chablat-Nowshera	0.39	5.44	3.06	8.88
25	Peshawar-Tourkham	0.52	6.06	3.25	9.83
26	Peshawar-Kohat	0.24	4.05	3.11	7.40
27	Bannu-D.I.Khan	0.66	6.68	3.90	11.24
	Average	0.56	5.96	4.90	11.44
	Standard Deviation	0.33	2.43	2.48	4.53
	Variance	0.11	5.91	6.15	20.54
	Maximum Value	1.51	11.20	11.02	23.91
	Minimum Value	0.09	2.61	1.85	4.61

Table 7.3-C

EQUIVALENT STANDARD AXLES FOR 3-AXLE REAR TANDEM TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Tandem	Total
1	Karachi-Gaddani	1.70	18.57	20.27
2	Karachi-Hyderabad	0.41	9.56	9.98
3	Karachi-Thatta	0.85	9.70	10.55
4	Hyderabad-Larkana	0.35	5.30	5.66
5	Sakrand-Kandiaro	0.68	10.69	11.37
6	Khairpur-Rohri	0.68	10.76	11.44
7	Jaccobabad-Sibbi	0.42	4.42	4.85
8	R.Y.Khan-Sadiqabad	0.57	5.74	6.31
9	Chunigot-Bahawalpur	0.48	6.86	7.34
10	Multan-D.G.Khan	0.29	4.25	4.55
11	D.G.Khan-Kashmore	0.49	7.08	7.58
12	D.G.Khan-Taunsa	0.36	4.90	5.26
13	Sahiwal-Multan	0.73	8.82	9.55
14	Okara-Lahore	0.22	5.19	5.42
15	Lahore-Gujranwala	0.75	9.49	10.24
16	Wazirabad-Gujrat	0.71	11.70	12.41
17	Gujrat-Jhelum	0.71	8.08	8.79
18	Jhelum-Rawalpindi	0.66	14.32	14.98
19	Rawalpindi-Chablat	0.35	5.89	6.24
20	Hasanabdal-Haripur	0.50	7.41	7.90
21	Haripur-Abbottabad	1.05	8.55	9.60
23	Chablat-Nowshera	0.62	9.72	10.33
24	Nowshera-Peshawar	0.65	6.70	7.35
25	Peshawar-Tourkham	1.27	10.03	11.30
26	Peshawar-Kohat	0.34	6.63	6.96
27	Bannu-D.I.Khan	0.56	7.72	8.28
29	Quetta-Chamman	0.32	3.67	3.99
30	Quetta-Noshki	0.37	8.79	9.16
	Average	0.61	8.23	8.84
	Standard Deviation	0.31	3.17	3.42
	Variance	0.10	10.04	11.66
	Maximum Value	1.70	18.57	20.27
	Minimum Value	0.22	3.67	3.99

EQUIVALENT STANDARD AXLES FOR 4-AXLE SINGLE TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Rear2	Rear3	Total
1	Karachi-Gaddani	0.09	4.09	1.51	2.18	7.87
2	Karachi-Hyderabad	0.12	3.36	5.10	3.75	12.32
3	Karachi-Thatta	0.22	3.19	1.81	2.54	7.76
4	Hyderabad-Larkana	0.16	3.78	2.63	2.52	9.09
5	Sakrand-Kandiaro	0.18	9.34	5.60	4.41	19.53
7	Jaccobabad-Sibbi	1.00	3.03	3.03	1.51	8.57
9	R.Y.Khan-Sadiqabad	0.09	4.09	2.18	4.09	10.45
13	Sahiwal-Multan	0.81	5.39	1.85	1.26	9.30
18	Jhelum-Rawalpindi	0.19	7.00	8.90	7.00	23.09
19	Rawalpindi-Chablat	0.14	4.74	9.36	7.71	21.94
	Average	0.13	4.80	4.20	3.70	12.99
	Standard Deviation	0.31	1.89	2.79	2.08	5.98
	Variance	0.09	3.57	7.79	4.34	33.36
	Maximum Value	1.00	9.34	9.36	7.71	23.09
	Minimum Value	0.09	3.03	1.51	1.26	7.76

Table 7.3-F

EQUIVALENT STANDARD AXLES FOR 4-AXLE REAR-TANDEM TRUCKS (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Rear1	Tandem	Total
1	Karachi-Gaddani	0.09	3.03	1.38	4.50
2	Karachi-Hyderabad	0.11	6.34	7.25	13.70
3	Karachi-Thatta	0.10	4.39	4.35	8.84
4	Hyderabad-Larkana	0.24	4.90	4.13	9.28
5	Sakrand-Kandiaro	0.14	4.64	6.18	10.96
6	Khairpur-Rohri	0.21	9.51	5.97	15.69
8	R.Y.Khan-Sadiqabad	0.14	4.17	2.94	7.24
9	Chunigot-Bahawalpur	0.12	7.37	7.04	14.53
10	Multan-D.G.Khan	0.21	6.38	5.41	12.01
11	D.G.Khan-Kashmore	0.09	5.55	3.86	9.49
12	D.G.Khan-Taunsa	0.10	8.12	6.72	14.93
13	Sahiwal-Multan	0.27	8.55	7.39	16.21
14	Okara-Lahore	0.20	3.55	3.00	6.75
15	Lahore-Gujranwala	0.16	6.44	7.26	13.86
19	Rawalpindi-Chablat	0.09	3.03	2.08	5.20
23	Chablat-Nowshera	0.36	7.00	1.38	8.74
26	Peshawar-Kohat	0.09	6.20	5.20	11.50
27	Bannu-D.I.Khan	0.09	3.03	2.51	5.60
30	Quetta-Nowshki	0.19	5.39	2.08	7.66
	Average	0.16	5.66	4.53	10.35
	Standard Deviation	0.07	1.87	2.87	3.62
	Variance	0.01	3.50	4.29	13.10
	Maximum Value	0.36	9.51	7.39	16.21
	Minimum	0.09	3.03	1.38	4.50

Table 7.3-H

EQUIVALENT STANDARD AXLES FOR 6-AXLE TANDEM TRIDEM (LOADED IN BOTH DIRECTIONS)

S.No	Station Name	Front	Tandem	Tridem	Total
3	Karachi-Thatta	0.38	2.73	3.46	6.57
4	Hyderabad-Larkana	0.36	1.50	1.39	3.25
5	Sakrand-Kandiaro	0.14	4.97	4.73	11.84
6	Khairpur-Rohri	0.27	2.20	4.34	6.81
8	R.Y.Khan-Sadiqabad	0.36	3.69	6.33	10.37
9	Chunigot-Bahawalpur	0.19	2.51	4.05	6.75
10	Multan-D.G.Khan	0.44	2.93	1.72	5.10
13	Sahiwal-Multan	0.81	7.83	9.35	17.99
15	Lahore-Gujranwala	0.25	7.40	8.48	16.13
16	Wazirabad-Gujrat	0.81	6.05	9.75	16.61
18	Jhelum-Rawalpindi	0.45	10.40	11.60	22.45
25	Peshawar-Tourkham	0.36	3.00	2.85	6.21
	Average	0.40	4.60	5.84	10.84
	Standard Deviation	0.20	2.64	3.24	5.86
	Variance	0.04	6.97	10.47	34.31
	Maximum Value	0.81	10.40	11.60	22.45
	Minimum Value	0.14	1.50	1.39	3.25

Table 7.3-a

EQ.ST.AXLES, 2-AXLE TRUCK (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear	Total
1	Karachi-Gaddani	0.35	7.22	7.58
	Gaddani-Karachi	0.20	17.16	17.36
2	Karachi-Hyderabad	0.14	4.44	4.58
	Hyderabad-Karachi	0.18	5.10	5.29
3	Karachi-Thatta	0.08	2.61	2.69
	Thatta-Karachi	0.06	3.28	3.34
4	Hyderabad-Larakana	0.13	4.32	4.46
	Larkana-Hyderabad	0.04	2.68	2.72
5	Kandiaro-Sakrand	0.10	3.08	3.19
	Sakrand-Kandiaro	0.18	4.89	5.07
6	Khairpur-Rohri	0.17	7.22	7.39
	Rohri-Khairpur	0.14	3.28	3.42
7	Jaccobabad-Sibbi	0.21	4.36	4.57
	Sibbi-Jaccobabad	0.14	3.59	3.73
8	R.Y.Khan-Sadiqabad	0.18	4.27	4.45
	Sadiqabad-R.Y.Khan	0.15	4.14	4.29
9	Chunigot-Bahawalpur	0.14	5.00	5.14
	Bahawalpur-Chunigot	0.16	5.15	5.30
10	Multan-D.G.Khan	0.09	2.38	2.47
	D.G.Khan-Multan	0.40	10.20	10.60
11	D.G. Khan-Kashmore	0.12	3.60	3.72
	Kashmore-D.G.Khan	0.14	3.78	3.92
12	D.G.Khan-Taunsa	0.17	4.30	4.47
	Taunsa-D.G.Khan	0.10	2.09	2.20
13	Sahiwal-Multan	0.21	4.43	4.63
	Multan-Sahiwal	0.15	3.66	3.82
14	Okara-Lahore	0.11	2.56	2.66
	Lahore-Okara	0.16	2.49	2.65
15	Lahore-Gujranwala	0.10	3.13	3.63
	Gujranwala-Lahore	0.18	3.94	4.12
16	Wazirabad-Gujrat	0.22	3.62	3.83
	Gujrat-Wazirabad	0.26	3.65	3.91
17	Gujrat-Jhelum	N.A.	N.A.	N.A.
	Jhelum-Gujrat	0.28	4.44	4.72
18	Jhelum-Rawalpindi	0.15	3.94	4.09
	Rawalpindi-Jhelum	0.22	5.29	5.51
19	Rawalpindi-Chablat	0.10	2.12	2.22
	Chablat-Rawalpindi	0.21	4.27	4.48
20	Haripur-Hasanabdal	0.17	3.07	3.24
	Hasanabdal-Haripur	0.13	3.63	3.75
21	Haripur-Abbottabad	0.14	2.97	3.11
	Abbottabad-Haripur	0.17	3.34	3.51
22	Abbottabad-Manshera	0.17	3.81	3.98
	Manshera-Abbottabad	0.08	3.07	3.17
23	Chablat-Nowshera	0.16	4.47	4.64
	Nowshera-Chablat	0.15	4.17	4.32
24	Nowshera-Peshawar	0.18	4.91	5.09
	Peshawar-Nowshera	0.16	3.66	3.82
25	Peshawar-Tourkham	0.13	4.08	4.22
	Tourkham-Peshawar	0.14	5.08	5.23
26	Peshawar-Kohat	0.14	3.25	3.38
	Kohat-Peshawar	0.14	3.72	3.86
27	Bannu-D.I.Khan	0.18	5.36	5.55
	D.I.Khan-Bannu	0.27	5.16	5.43
28	Fortminro-Q.Saifullah	0.16	3.56	3.72
	Q.Saifullah-Fortminro	0.21	4.83	5.04
29	Quetta-Chamman	0.13	3.20	3.33
	Chamman-Quetta	0.13	3.11	3.24
30	Quetta-Noshki	0.13	2.89	3.02
	Noshki-Quetta	0.16	6.39	6.55

EQUIVALENT STANDARD AXLES FOR 3-AXLE SINGLE TRUCKS (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear1	Rear2	Total
1	Karachi-Gaddani	1.00	11.20	8.90	21.10
	Gaddani-Karachi	0.56	6.81	8.40	15.77
2	Karachi-Hyderabad	0.83	12.43	0.41	13.67
	Hyderabad-Karachi	0.19	3.14	4.21	7.53
4	Hyderabad-Larkana	0.57	3.85	4.07	8.49
	Larkana-Hyderabad	N.A.	N.A.	N.A.	N.A.
5	Sakrand-Kandiaro	1.40	18.20	18.41	38.08
	Kandiaro-Sakrand	N.A.	N.A.	N.A.	N.A.
9	Chunigot-Bahawalpur	0.09	4.85	9.51	14.45
	Bahawalpur-Chunigot	N.A.	N.A.	N.A.	N.A.
16	Wazirabad-Gujrat	0.70	3.19	6.41	10.30
	Gujrat-Wazirabad	0.62	7.00	7.21	14.82
17	Jhelum-Gujrat	0.92	4.46	4.75	10.13
	Gujrat-Jhelum	N.A.	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.67	10.51	5.14	16.32
	Rawalpindi-Jhelum	0.50	9.42	8.76	18.68
19	Rawalpindi-Chablat	0.28	1.54	1.69	3.52
	Chablat-Rawalpindi	0.45	6.08	5.47	11.99
20	Hasanabdal-Haripur	0.19	2.61	1.85	4.64
	Haripur-Hasanabdal	N.A.	N.A.	N.A.	N.A.
21	Abbottabad-Haripur	0.54	9.16	6.53	16.23
	Haripur-Abbottabad	N.A.	N.A.	N.A.	N.A.
23	Chablat-Nowshera	0.43	6.23	3.24	9.90
	Nowshera-Chablat	0.27	3.45	2.61	6.33
25	Peshawar-Tourkham	0.65	6.27	3.89	10.81
	Tourkham-Peshawar	0.44	5.93	2.82	9.18
26	Kohat-Peshawar	0.24	4.05	3.11	7.40
	Peshawar-Kohat	N.A.	N.A.	N.A.	N.A.
27	Bannu-D.I.Khan	0.59	6.66	4.16	11.41
	D.I.Khan-Bannu	0.69	6.69	3.81	11.18

Table 7.3-c

EQUIVALENT STANDARD AXLES FOR 3-AXLE REAR TANDEM TRUCKS (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Tandem	Total
1	Karachi-Gaddani	0.62	7.40	8.02
	Gaddani-Karachi	1.91	20.80	22.71
2	Karachi-Hyderabad	0.52	14.92	15.44
	Hyderabad-Karachi	0.31	4.47	4.78
3	Karachi-Thatta	2.94	15.12	17.86
	Thatta-Karachi	1.45	11.76	13.21
4	Hyderabad-Larkana	0.37	5.82	6.19
	Larkana-Hyderabad	0.34	4.80	5.14
5	Sakrand-Kandiaro	0.73	11.90	12.63
	Kandiaro-Sakrand	0.52	6.43	6.95
6	Khairpur-Rohri	0.76	12.82	13.58
	Rohri-Khairpur	0.45	4.71	5.16
7	Jaccobabad-Sibbi	0.47	4.27	4.74
	Sibbi-Jaccobabad	0.34	4.68	5.02
8	R.Y.Khan-Sadiqabad	0.34	4.90	5.24
	Sadiqabad-R.Y.Khan	0.72	6.25	6.96
9	Chunigot-Bahawalpur	0.49	7.96	8.45
	Bahawalpur-Chunigot	0.47	5.83	6.30
10	Multan-D.G.Khan	0.23	3.60	3.83
	D.G.Khan-Multan	0.43	5.64	6.07
11	D.G.Khan-Kashmore	0.31	4.72	5.03
	Kashmore-D.G.Khan	0.60	8.45	9.05
12	D.G.Khan-Taunsa	0.36	4.90	5.26
	Taunsa-D.G.Khan	N.A.	N.A.	N.A.
13	Sahiwal-Multan	0.76	8.49	9.25
	Multan-Sahiwal	0.71	9.08	9.79
14	Okara-Lahore	0.23	6.31	6.54
	Lahore-Okara	0.21	3.03	3.24
15	Gujranwala-Lahore	0.62	5.46	6.08
	Lahore-Gujranwala	0.88	13.78	14.66
16	Wazirabad-Gujrat	0.59	9.16	9.75
	Gujrat-Wazirabad	0.80	13.48	14.28
17	Jhelum-Gujrat	0.71	8.08	8.79
	Gujrat-Jhelum	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.71	13.37	14.08
	Rawalpindi-Jhelum	0.41	18.63	19.03
19	Rawalpindi-Chablat	0.17	2.30	2.47
	Chablat-Rawalpindi	0.40	7.02	7.42
20	Haripur-Hasababdal	0.81	6.90	7.71
	Hasanabdal-Haripur	0.34	7.66	8.00
21	Haripur-Abbottabad	1.23	9.47	10.69
	Abbottabad-haripur	0.36	4.86	5.22
23	Chablat-Nowshera	0.61	9.74	10.35
	Nowshera-Chablat	0.62	9.60	10.22
24	Nowshera-Peshawar	0.42	6.08	6.50
	Peshawar-Nowshera	0.95	7.52	8.47
25	Peshawar-Tourkham	1.27	10.03	11.30
	Tourkham-Peshawar	N.A.	N.A.	N.A.
26	Peshawar-Kohat	0.22	4.17	4.39
	Kohat-Peshawar	0.34	6.78	7.12
27	Bannu-D.I.Khan	0.71	8.42	9.12
	D.I.Khan-Bannu	0.49	7.41	7.90
29	Quetta-Chamman	0.43	5.30	5.74
	Chamman-Quetta	0.29	3.13	3.41
30	Noshki-Quetta	0.46	10.84	11.30
	Quetta-Noshki	0.12	3.33	3.45

EQUIVALENT STANDARD AXLES FOR 4-AXLE SINGLE TRUCKS (LOADED IN EACH DIRECTION)

S.No	Station	Front	Rear1	Rear2	Rear3	Total
1	Karachi-Gaddani	0.09	4.09	1.51	2.18	7.87
	Gaddani-Karachi	N.A.	N.A.	N.A.	N.A.	N.A.
2	Karachi-Hyderabad	0.13	3.30	4.03	1.90	9.36
	Hyderabad-Karachi	0.11	3.43	6.43	6.06	16.03
3	Karachi-Thatta	0.21	2.93	1.76	1.88	7.67
	Thatta-Karachi	0.14	2.80	1.26	3.68	7.87
4	Hyderabad-Larkana	0.19	4.87	3.94	3.77	12.77
	Larkana-Hyderabad	0.10	1.96	0.45	0.45	2.96
5	Sakrand-Kandiaro	0.16	8.87	4.03	3.76	16.81
	Kandiaro-Sakrand	0.22	10.05	7.95	5.39	23.61
7	Sibbi-Jaccobabad	1.00	3.03	1.85	0.70	6.64
	Jaccobabad-Sibbi	N.A.	N.A.	N.A.	N.A.	N.A.
8	R.Y.Khan-Sadiqabad	0.09	4.09	2.18	4.09	10.45
	Sadiqabad-R.Y.Khan	0.09	2.18	7.00	8.90	18.17
13	Multan-Sahiwal	0.81	5.39	1.85	1.26	9.30
	Sahiwal-Multan	N.A.	N.A.	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.19	7.00	8.90	7.00	23.09
	Rawalpindi-Jhelum	N.A.	N.A.	N.A.	N.A.	N.A.
19	Rawalpindi-Chablat	0.13	6.93	13.31	11.15	31.52
	Chablat-Rawalpindi	N.A.	N.A.	N.A.	N.A.	N.A.

Table 7.3-f

EQUIVALENT STANDARD AXLES FOR 4-AXLE REAR-TANDEM TRUCK (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Rear1	Tandem	Total
1	Karachi-Gaddani	0.09	3.03	1.38	4.50
	Gaddani-Karachi	N.A.	N.A.	N.A.	N.A.
2	Karachi-Hyderabad	0.13	7.83	8.35	16.30
	Hyderabad-Karachi	0.08	3.22	4.93	8.23
3	Karachi-Thatta	0.10	4.39	4.35	8.84
	Thatta-Karachi	N.A.	N.A.	N.A.	N.A.
4	Hyderabad-Larkana	0.39	4.93	3.36	8.69
	Larkana-Hyderabad	0.10	4.88	4.85	9.83
5	Sakrand-Kandiaro	0.17	5.35	6.79	12.31
	Kandiaro-Sakrand	0.12	4.66	6.69	11.46
6	Khairpur-Rohri	0.30	12.86	9.38	22.54
	Rohri-Khairpur	0.10	5.56	1.94	7.60
8	R.Y.Khan-Sadiqabad	0.10	3.72	2.16	5.99
	Sadiqabad-R.Y.Khan	0.17	4.61	3.71	8.49
9	Chunigot-Bahawalpur	0.12	6.13	6.40	12.65
	Bahawalpur-Chunigot	0.11	8.31	7.52	15.94
10	Multan-D.G.Khan	0.09	4.85	2.95	7.89
	D.G.Khan-Multan	0.25	6.86	6.17	13.28
11	D.G.Khan-Kashmore	0.09	5.55	3.86	9.49
	Kashmore-D.G.Khan	N.A.	N.A.	N.A.	N.A.
12	D.G.Khan-Taunsa	0.10	8.12	6.72	14.93
	Taunsa-D.G.Khan	N.A.	N.A.	N.A.	N.A.
13	Sahiwal-Multan	0.09	5.02	2.11	7.21
	Multan-Sahiwal	0.30	9.26	8.44	18.01
14	Okara-Lahore	0.12	5.58	3.79	9.49
	Lahore-Okara	0.27	1.84	2.34	4.45
15	Gujranwala-Lahore	0.09	2.09	1.10	3.20
	Lahore-Gujranwala	0.19	8.37	10.00	18.57
19	Rawalpindi-Chablat	0.09	3.03	2.08	5.20
	Chablat-Rawalpindi	0.09	3.03	1.29	4.41
23	Chablat-Nowshera	0.22	4.59	13.90	18.74
	Nowshera-Chablat	N.A.	N.A.	N.A.	N.A.
26	Peshawar-Kohat	0.09	6.20	5.20	11.50
	Kohat-Peshawar	N.A.	N.A.	N.A.	N.A.
27	D.I.Khan-Bannu	0.09	3.03	2.51	5.60
	Bannu-D.I.Khan	N.A.	N.A.	N.A.	N.A.
30	Quetta-Nowshki	0.19	5.39	2.08	7.66
	Nowshki-Quetta	N.A.	N.A.	N.A.	N.A.

EQUIVALENT STANDARD AXLES FOR 6-AXLE TANDEM TRIDEM (LOADED IN EACH DIRECTION)

S.No	Station Name	Front	Tandem	Tridem	Total
3	Karachi-Thatta	0.33	2.85	4.66	7.85
	Thatta-Karachi	0.43	2.52	2.03	5.03
4	Hyderabad-Larkana	0.36	2.51	1.91	4.78
	Larkana-Hyderabad	0.36	0.50	0.87	1.72
5	Kandiaro-Sakrand	0.36	4.17	8.20	12.72
	Sakrand-Kandiaro	N.A.	N.A.	N.A.	N.A.
6	Khairpur-Rohri	0.36	1.38	8.20	9.94
	Rohri-Khairpur	0.25	2.47	3.05	3.75
8	R.Y.Khan-Sadiqabad	N.A.	N.A.	N.A.	N.A.
	Sadiqabad-R.Y.Khan	0.36	3.69	6.33	10.37
9	Chunigot-Bahawalpur	0.19	2.51	4.05	6.75
	Bahawalpur-Chunigot	N.A.	N.A.	N.A.	N.A.
10	Multan-D.G.Khan	0.44	2.93	1.72	5.10
	D.G.Khan-Multan	N.A.	N.A.	N.A.	N.A.
13	Multan-Sahiwal	0.81	7.83	9.35	17.99
	Sahiwal-Multan	N.A.	N.A.	N.A.	N.A.
15	Lahore-Gujranwala	0.19	7.40	10.40	18.29
	Gujranwala-Lahore	0.36	7.40	4.05	11.81
16	Wazirabad-Gujrat	0.81	6.05	9.75	16.61
	Gujrat-Wazirabad	N.A.	N.A.	N.A.	N.A.
18	Jhelum-Rawalpindi	0.45	10.40	11.60	22.45
	Rawalpindi-Jhelum	N.A.	N.A.	N.A.	N.A.
25	Peshawar-Tourkham	0.36	2.18	5.39	7.93
	Tourkham-Peshawar	N.A.	N.A.	N.A.	N.A.