NTRC

PAVEMENT FAILURE STUDY

(USING DEFLECTION DATA)

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PHASE-I

NATIONAL TRANSPORT RESEARCH CENTRE

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NTRC-223

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EXECUTIVE SUMMARY

The pace of highway construction has increased considerably during the last two decades & it now consumes a large proportion of national budget. Among the road components, pavement structure involves substantial costs.

The pavements are designed and constructed to last for a certain period of life. Unfortunately, most of the highways fail prematurely because of poor quality control, inadequate estimation of axle loads and poor material properties. The situation is so alarming that more than two thirds of national highway network requires re-construction/rehabilitation. Pre-mature pavement failures not only cause huge loss of investment but also inflate vehicle operational costs.

There are two methods to determine pavement structural failure; destructive testing (coring and pitting) and non-destructive testing (NDT). Deflection measurement is the main technique used in non-destructive testing methods.

A lot of deflection data had been collected by NHA using a Falling Weight Deflectograph during 1995-97, but no proper analysis was carried out. Research Advisory Committee of NTRC, while considering the proposal on pavement failures felt that data should be looked into by NTRC. Deflection data on three sections, all on National Highway (N-5) i.e. Karachi-Hyderabad, Gujranwala By-Pass and Rawalpindi-Hasanabdal were selected initially for analysis purposes.

The analysis of the deflection data provided by the NHA has revealed that the data is constrained by the following :

i) Deflection depends on the properties, including thicknesses of subgrade, subbase and asphaltic layer, it is, therefore, essential that the structural composition of the pavement is fully known. The deflection data of NHA does not provide information about pavement structure to which the deflection data is related.

ii) There are many factors that influence the measured pavement deflection These factors are load factors, pavement factors and climate factors and a complete knowledge of these factors for correct interpretation of the data is very essential. These factors have not been obtained by NHA while taking deflection measurements.

iii) The results of surface deflection data to predict the future traffic carrying capacity can only be empirically established by collecting the deflection and performance characteristics of a specific type of pavement in a particular environment over a period of several years.

iv) From the analysis of few sections of deflection data, it can be concluded that the properties of existing roads are extremely variable and hence any single testing method would not be sufficient to predict the failure or otherwise the life of pavement until and unless destructive testing is carried out side by side.

It is therefore imperative that in addition to the deflection measurements, destructive testing techniques (coring, pitting and collection of samples) are used to determine the causes of the pavement failures.

CHAPTER - I

INTRODUCTION

1.1 : General

Improved transportation system, predominantly highways, is crucial for the development of a country. Efficient movement of agricultural products, access to medical attention, and the ability to transport raw materials and finished products are all essential for the development of nations to raise their living standards.

Today, the motor vehicles have become the principle means for transporting goods and passengers all over the world. The situation is no different in our country. The overall importance of motor vehicles to intercity passengers and freight movement in our country can be judged from the fact that more than 90% of the country's passenger and freight traffic is carried by road mode of transport. According to the latest estimates (1998-99), about 90.6% of the country's passengers traffic and 95.3% of the country's freight traffic is carried by the roads.

The investments made on the highway system have been increasing rapidly. The budget allocation for the highways alone constitute about 20% of the country's total development outlay in our country these days. In view of the accelerated highway construction under taken specially during the last few decades, pavements now represent one of the most costly of all the public investments. These highway pavements are designed and constructed to last for a certain life period having several physical, structural & functional properties. Unfortunately, in our country, most of these highways fail prematurely either because of poor quality control, inadequate estimation of axle loads and poor analysis of material properties. As a result the investment made is wasted.

1.2 : The Problem

There is little doubt that socio-economic benefits rendered by the improved highway system are prodigious but it is the dilemma of this country that these gains are lost when the highway pavements fail prematurely. Highway sections of National Highway (N-5) such as Nowshera - Chablat, Mianchannu-Sahiwal and Kashmir Highway of CDA are some examples. These premature pavement failures not only result in wastage of investment made but also inflates operational costs of the

vehicles and causes considerable delays in freight movements. As a result billions of rupees are being lost daily. This situation calls for immediate remedial steps in this regard. There is an immediate need for identification of causes of pavement failures in the country and to suggest remedial measures to mitigate the prevailing problems.

Some of the main causes identified for the premature failure of pavements include defective pavement designing, defective mix design and poor quality control practices during construction.

1.3 : Approach Adopted for the Study

In order to address this issue, Road Research Wing in National Transport Research Centre, had carried out some isolated studies to identify the failure causes. However, due to financial constraints, a comprehensive countrywide study have not been done.

Keeping this in view, a study proposal costing Rs. 3.8 million was prepared and put up to the Research Advisory Committee of NTRC for approval. The study aimed at taking cores of asphaltic wearing course and collecting samples of base, subbase and subgrade materials from the sections where failures had occurred and from adjacent sections having similar environmental and loading conditions where pavements are intact and then analyzing the results of the tests. Brig. Aftab Siddiqui, a member of RAC, expressed in the meeting that a lot of pavement data had already been collected by NHA during the period 1994-97 using Falling Weight Deflectograph (FWD) machine over most of the National Highways and that the analysis of this data could help determine the causes of premature pavement failures. It was decided that the data already available with the NHA would be used for analysis purposes and a status report be prepared for submission to the RAC.

As per decision of the RAC, NHA was contacted to provide the data. The deflection data was obtained from NHA and have been analysed for the preparation of this report.

CHAPTER - II

Literature Review

2 : General

A knowledge of the structural conditions along the length of a pavement and across its lanes is essential to get information about the structural adequacy of the pavement section. This information is necessary to know the rate of deterioration of the pavement and to select and design the proper rehabilitation alternative.

The volume of road traffic in developing countries is increasing each year, usually with marked increases in the loads carried by each commercial vehicle. Thus the frequency and magnitude of the axle loads being applied to the pavement are increasing and the highway authorities are faced with the problem of strengthening their existing roads, together with designing future roads to meet much higher traffic loadings.

The easiest and most convenient way to strengthen a flexible pavement is to apply an overlay of bituminous material to the existing surface, thereby increasing the thickness of the pavement and also improving the riding quality of the surface. Since overlays of bituminous surfacing can be relatively expensive, it is essential to take account of the residual strength of the existing pavement in determining the most economical thicknesses that will give the desired increase in life. If the existing pavement has very weak sections, it is better to completely reconstruct these areas rather than to overlay them with a very thick surfacing of bituminous material.

The structural evaluation of a pavement section can be developed by considering the structural components of the pavements using destructive testing (coring and sampling) and Non Destructive Testing (NDT)

2.1 : Destructive Testing

Destructive testing of a pavement section typically involves the coring, drilling and sampling of the pavement layers for laboratory testing to obtain the type, thickness and condition of the various pavement layers. This information can be used to conduct a component analysis in which structural coefficients are assigned to each layer based on the structural adequacy of each layer.

The pavement may be evaluated using the structural coefficients to determine the remaining life of the pavement in terms of the number of remaining traffic loadings available. If the pavement materials have not deteriorated due to the effects of moisture, traffic and environment the structural adequacy of the pavement may be determined using this method in conjunction with the distress survey. If the materials have deteriorated considerably, this procedure becomes unreliable.

2.2 : Non-Destructive Deflection Testing

Non-destructive test procedures for evaluating pavements have been developed through many years of research sponsored by the Department of Army, Department of Air Force and the Federal Aviation Administration (FAA) of USA. NDT when used in conjunction with the distress survey, is the most reliable method for determining the structural adequacy of the pavement. NDT can provide the following:-

a) Assistance in overlay design

b) Deflection variability along the project for use in selecting distinct design sections

c) Detailed deflective studies at localized areas to ascertain causes of distress, and to locate inadequate support or voids

d) Critical periods for pavement deterioration based on seasonal variation in deflections. This will assist in determining the climatic effects on the pavement.

e) An indication of the pavement structural capacity and its ability to support present and future traffic

f) Elastic stiffness of each layer

The information obtained from the NDT survey must be used in conjunction with the information from the distress survey NDT testing should generally be completed prior to or concurrently with destructive testing to assist in locating areas where cores, subgrade samples, and subgrade tests will be conducted.

2.3 : Principle of Deflection Measurements

When a loaded wheel passes over a pavement a small transient vertical depression of the surface of the pavement occurs. The magnitude of the temporary depressions under a wheel load of say 4,000 kg (4 tonnes) ranges from about 0.25 mm

(10^{-2}in) for a stiff 'flexible' pavement in good condition to ten times this figure for a weak pavement in danger of early failure.

The magnitude of the surface depression or 'deflection' is a function of the wheel load, the area of contact between the tyre and the road, the speed of the wheel, and the stress-strain characteristics and thicknesses of the various pavement layers and the subgrade. Thus if a standard wheel load, tyre size, and method of measurement are adopted, the magnitude of the surface deflection that occurs under the wheel enables comparisons to be made between the effective 'stiffness' of different pavements and changes in stiffness over a period of time for a particular pavement.

The deflection of a road pavement is related to the stresses and strains induced in the pavement by the applied loads. The long term structural behavior of a pavement is also related to the stresses and strains experienced by various pavement layers and the subgrade. It might therefore be expected that the performance of a road would be related to the deflection. It has been confirmed from various experimental studies extending over many years that there is a relationship between deflection and long term performance for each type of pavement structure used. It should be noted that there are various ways in which a pavement can deteriorate and 'fail'. The stresses or strains which are most clearly related to deflection may not be the same stresses or strains which are responsible for the primary mode of deterioration and in such a case deflection alone is not expected to correlate very well with long term pavement performance.

Every vehicle that passes over a pavement induces transient strains in the pavement layers and the subgrade. The magnitude of these transient strains will vary greatly according to the magnitude of the wheel load and the effect of the temperature and moisture conditions on the stress-strain properties of the pavement materials and subgrade at the time of the application of the road.

When a transient strain due to a wheel load exceeds a certain critical value in one or more of the pavement layers or the subgrade it can be assumed that a small non-recoverable strain remains in that layer after the vehicle has passed. Throughout the 'life' of the pavement these minute permanent strains accumulate and appear as deformation and eventually cracking of the road surfacing.

The proportion of these transient strains that are large enough to produce permanent strains thus affects the length of time that the pavement can carry the applied traffic loading before 'failing'.

It is therefore reasonable to expect that the magnitude of the transient vertical strain of a pavement under a 'standard' wheel load should be an indicator of the magnitude of the whole range of strains that the pavement experiences under traffic loading, and that this in turn is related to the number of repetitions of the traffic loads that the pavement can sustain before accumulating an unacceptable amount of permanent strain.

Thus it is not surprising that the magnitude of the deflection of a pavement under a 'standard' wheel load correlated well with the subsequent performance of that pavement under traffic.

2.4 : Deflection criteria curves

If the stress-strain properties of pavement materials and soils were better known, it would be possible to calculate the surface deflection of a pavement system under a given load and predict the amount of traffic-loading that a pavement could carry before 'failing'. Calculations of this nature can be performed on the basis of present knowledge but there is still uncertainty about the behavior of pavement materials when they are subjected to the wide range of loads imposed by traffic. For example, bituminous surfacing are capable of carry up to three orders of magnitude more traffic than would be expected on the basis of laboratory fatigue studies. This is caused partly by self healing of the material during the rest periods between loads and there is some laboratory evidence to indicate the magnitude of this effect. However it has proved impossible to simulate cane field conditions in the laboratory and therefore the long term effects of the environmental factors on the behavior of the materials is not well understood.

The relation between the surface deflection of a pavement under a 'standard' load and its future traffic-carrying capacity must therefore be established empirically by studying the deflection and performance characteristics of a specific type of pavement in a particular environment over a period of several years. This relationship can be conveniently expressed in terms of a 'deflection criterion curve' derived by plotting the deflection of a pavement against the cumulative traffic it has carried, the

condition of the pavement in the vicinity of the deflection measurement point also being recorded.

Figure 1 illustrates a notional deflection criterion curve which is obtained by drawing a line dividing the plots of the deflection of failed or failing pavements and those in good condition. The magnitude of the deflection that should not be exceeded if the pavement is required to have a long life is indicated by the ordinate 'a'. Deflections greater than 'a' indicate that a reduced pavement life can be expected. For instance, if a deflection of 'y' is measured on a pavement after it has carried 'x_1' amount of traffic (see Fig 1) it can be predicted that the pavement can carry approximately a further 'x_2' amount of traffic before failing.

Studies in Britain by TRRL[2] have established deflection criterion curves for the principal types of construction that are used for the main roads in the UK. An example is shown in Fig 2.

Research by the Overseas Unit in Kenya, Turkey, Malaysia and elsewhere has shown that similar deflection criterion curves cannot be established for tropical conditions unless other factors are taken into account.

2.5 : Methods of Measuring Deflection

Engineers require a method of measuring the relevant properties of the existing road so that an overlay can be designed to reduce the stresses in the existing road to safe levels and at the same time ensure that the overlay itself does not fail prematurely.

The properties of an existing road are usually extremely variable hence any test method needs to be non destructive and fairly quick so that sufficient measurements can be made to take proper account of this variability.

A road pavement behaves essentially like a multilayer elastic structure hence it is the elastic properties which are usually required and these are most easily determined by measuring the deflection of the structure under a given load.

Various equipments have been developed for the measurements of deflections. There are:

1. Static Deflection Equipment: Devices that measure the deflection response of a pavement to slowly applied loads are static deflection devices. The most commonly used static deflection device is the Benklemen Beam.

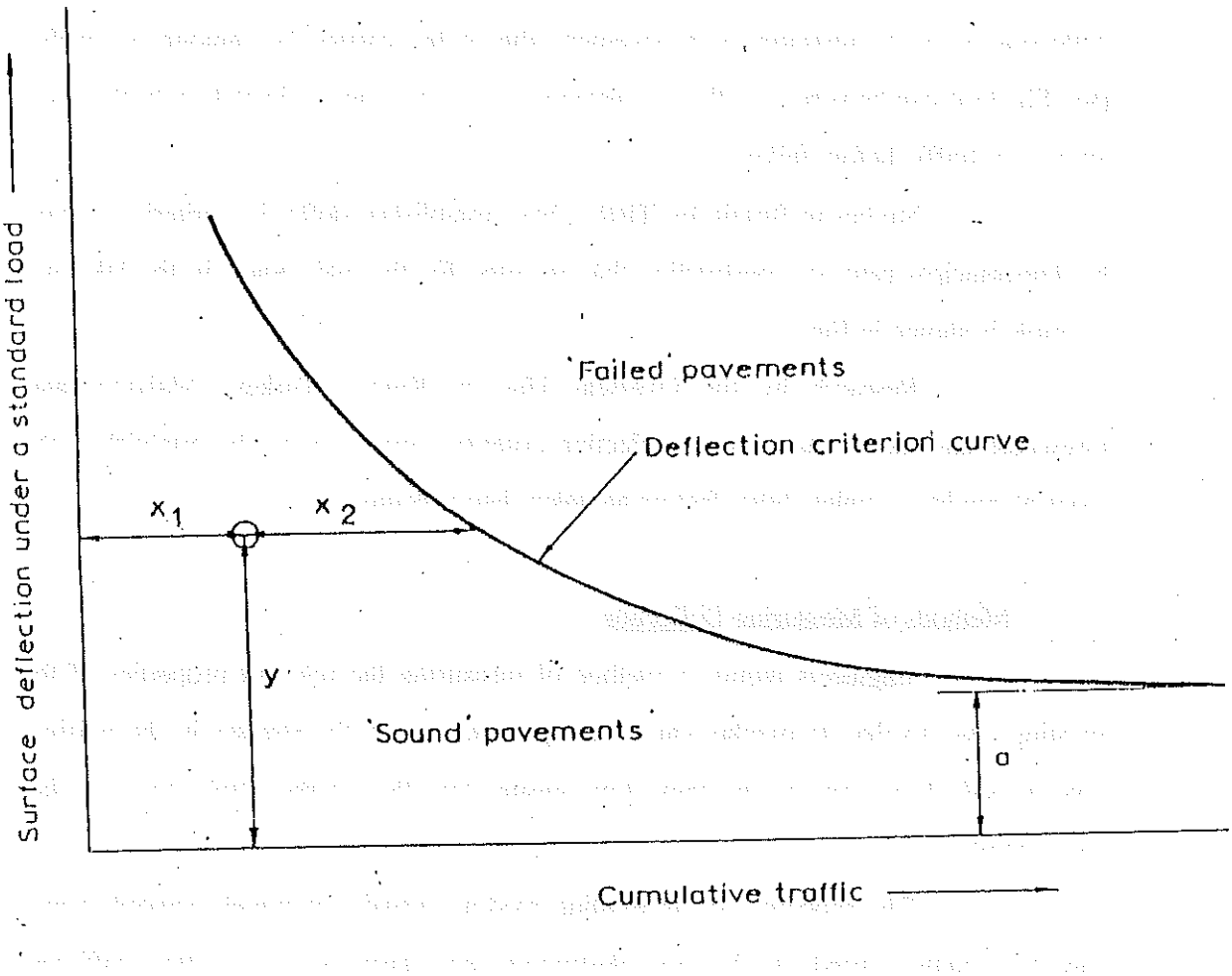


Fig. 1 A notional deflection criterion curve.

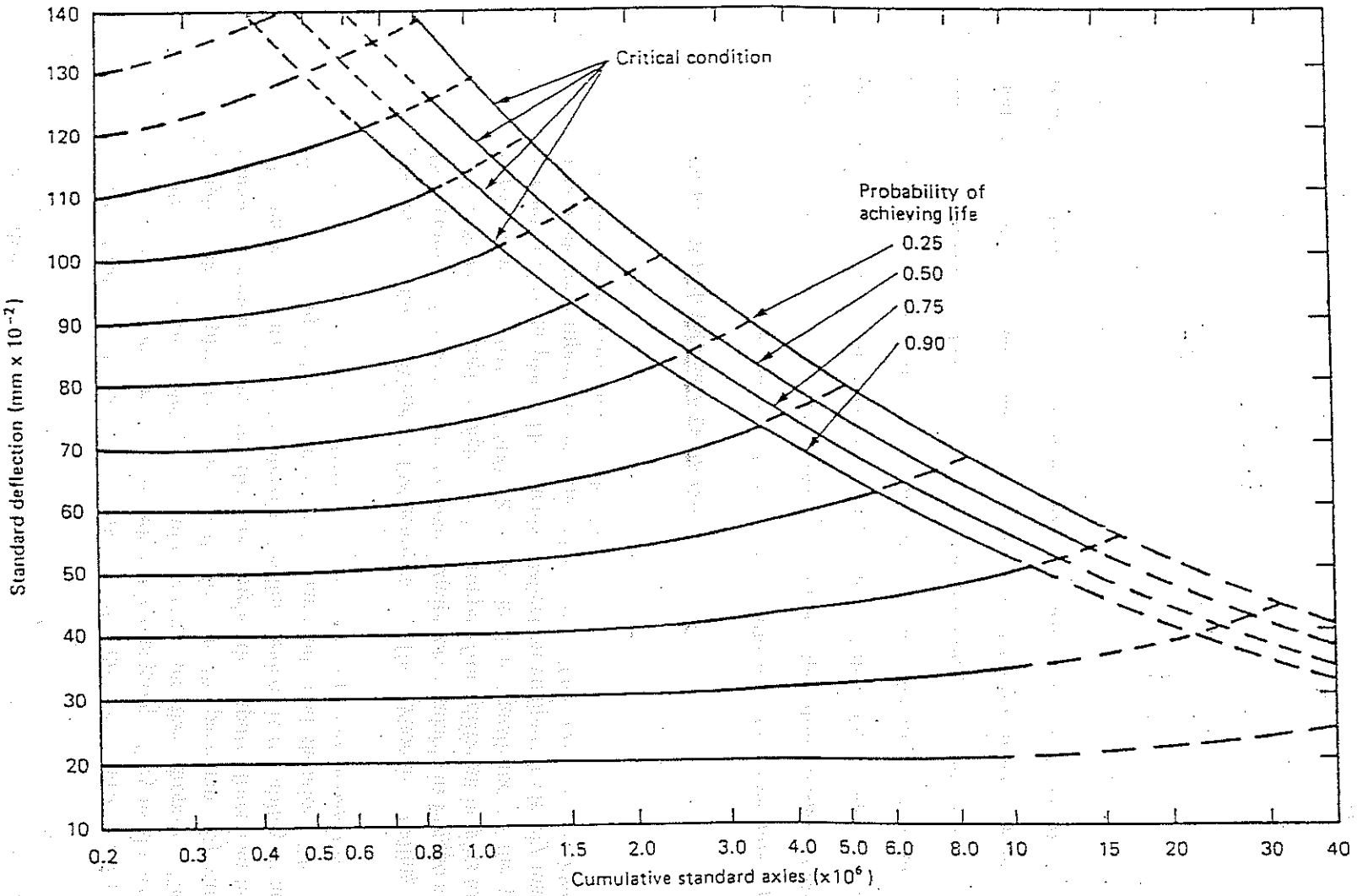


Fig. 2 Relation between standard deflection and life for pavements with non-cementing granular road bases.

2. Automated Beam Deflection Equipment: Equipments that automatics the Benklemen Beam process is placed in this class

3. Steady State Dynamic Deflection Equipment: Steady state dynamic deflection devices (also called vibrators) produce a sinusoidal vibration in the pavement with a dynamic force generator. The most commonly used and commercially available devices are the Dynaflect and Road Rater

4. Impulse Deflection Equipment: All devices that deliver a transient force impulse force to the pavement surface are included in this group. They used a weight that is lifted to a given height on a guide system and then dropped. The falling weight strikes a plate that transmits the force to the pavement. By varying the amount of weight falling and the drop height, the impulse force can be varied. The major advantage of the impulse loading devices is the ability to accurately model a moving wheel load in both magnitude and duration. The resulting deflection closely simulates deflections caused by a moving wheel load

5. Phoenix Falling Weight Deflectometer: The Phoenix Falling Weight Deflectometer is also a trailer mounted equipment available in Europe and in the United States. A single weight can be dropped from different heights to develop impact loads of 1040 to 5000 kg. The load is transferred to the pavement through a circular plate. The impulse deflection equipment closely matches the magnitude and impulse of moving wheel loads. This aspect is considered to be very important in pavement evaluation.

2.6 : Factors Which Influence Deflections

There are many factors that influence the measured pavement deflection. These factors can be divided, in general, into three groups: load factors, pavement factors, and climate factors. If the effects of these factors are not considered, the interpretation of the results can be very difficult and misleading. Currently, a sizable amount of research is directed at a better understanding and interpretation of NDT deflection results. The main objective is to adjust all deflection measurements to a set of standard conditions (such as load, temperature, moisture, etc.) whereby data collected at different times or by different agencies can be compared.

The factors that influence pavement deflection are:

2.6.1 : Load Factors

Ideally, the NDT deflection equipment should be capable of subjecting the pavement to load conditions that are similar to those of the design (e.g., 9,000-pound (3978 kg) wheel load) and/or to the actual loading conditions. Unfortunately, not every commercially available NDT deflection device is capable of exactly simulating the

design load. Some devices are capable of generating only a fraction of the design load. Some others may be capable of generating the magnitude of the design load but not its frequency. The impulse deflection equipment come the closest in simulating the design load conditions.

The type and magnitude of the load influences the deflection response of the pavement. As the load increases, the deflection of the pavement will also increase. Since most pavement materials are stress dependent (see block 5), the relationship between load and deflection is normally not linear as shown in figure 3-7.8. Test results obtained using NDT deflection equipment that produce light loads need to be extrapolated as shown in the figure. This extrapolation may lead to a significant error and consequently, wrong decisions concerning pavement conditions and rehabilitation. Therefore, it is strongly recommended that pavement trafficked by heavy trucks be tested using NDT deflection devices that produce loads approximating those of heavy truck loads. This eliminates the problem of extrapolating data from light to heavy loads.

Even when the load applied by several different types of devices is equal, the measured deflections may be different. The inherent differences in load types tend to produce different pavement responses. The static load devices tend to produce deflections significantly larger than those produce by moving wheel loads. Deflection measurement made using steady dynamic deflection devices vary with the load frequency.

In general, the falling weight deflectometer devices have been shown to produce a surface deflection most closely simulating that produced by a moving wheel load.

2.6.2 : Pavement Factors

The stiffness of the pavement/subgrade system affects the measured deflection. Stiffer pavement sections cause lower deflections. This should not be interpreted as stiffer pavement sections mean better pavement performance. Pavement performance is a function of several variables (deflection is one of them). Seasonal measurements of pavement deflection made at the AASHO road test for similar pavement sections with three different base materials (crushed stone, asphalt cement treated base, and cement treated base) showed that the seasonal variations of deflection are different and they depend on the material type. For example, pavement with a

crushed stone base showed higher deflection for all seasons than pavement sections having cement or asphalt treated bases. Further, the crushed stone base seems to be very sensitive to moisture conditions (i.e., much higher deflection during spring thaw than at any other time).

The structural conditions of the pavement (e.g., cracked/uncracked) also affects the pavement deflection as follows:-

1. Deflections obtained from asphalt pavements in or near distressed areas (e.g., alligator cracking, linear cracks), will normally be much higher than in non-distressed areas.

2. Deflections in wheel paths are typically higher than between wheel paths.

3. Deflections taken near or over hydraulic structures (e.g. culverts) may be significantly higher.

4. Cuts, sections at grade, and fills may show significantly different deflections.

5. Changes in the pavement structure or roadbed soil will significantly affect deflections.

6. Random variations in pavement stiffness/strength caused by variation in compaction, material properties, water contents, etc. will result in high variation in deflections along a typical project, even when measured closely together (e.g., 10 ft, 3 m). Coefficients of variation for deflection measurements along a project are typically around 20 to 30 percent or higher.

2.6.3 : Climatic Factors

There are several climatic factors that may affect deflections on a daily and/or seasonal basis. These must be considered in the project deflection survey.

1. Temperature affects asphalt pavement deflections greatly. Higher mean pavement temperatures cause the asphalt concrete binder to soften thereby, producing higher deflections.

2. The season of the year also has a great effect on asphalt pavement deflections in some climatic areas. There are four distinct seasons in cold climatic areas as follows:

   a) The period of deep frost (typically winter season) when the pavement is the strongest

b) The period during which the frost is beginning to disappear from the pavement/subgrade system (spring thaw) and the deflection increases greatly.

c) The period during which the excess free water from the melting frost leaves the pavement/subgrade. The soil begins to recover, and the deflection decreases rapidly (early summer season).

d) The period during which the deflection levels off slowly as water content slowly decreases

3. Pavement factors may interact with seasonal climatic factors to affect the deflections.

4. For pavements in areas that do not experience freeze-thaw, the deflection follows more of a single curve, with the peak deflection occurring in the wet season where significant free moisture exists. In relatively dry areas, the period of maximum deflection may occur in the hot summer when the asphalt surface softens due to intense solar radiation.

Thus, it is important to consider the time of day as well as season of the year when measuring deflections and interpreting their meaning. Generally, deflection measurements are corrected to a standard temperature (70 ^{0}F 22 ^{0}C) and season equivalent deflection based on locally developed procedures.

2.7 : Conducting the Deflection Field Survey

A survey method which is found suitable for roads showing variable surface conditions is as follows:

Deflection measurements should be made in both wheel paths of the slow lane on dual carriageways and in both lanes of the two lane carriageways.

1. Obtain deflections along the project length (deflection profile) on a basic pattern of ten equally spaced tests per km.

2. Additional tests on any area showing surface distress.

3. If needed, conduct a more detailed intensive deflection study in selected locations.

4. Measure the temperature of the pavement throughout the test period at a reference point.

It is important that the deflection survey is carried out at the time of the year when the pavement is weakest and normally in tropical climates, this is at the end of the rainy season when the subgrade moisture condition is wettest. If this is not possible, an adjustment factor should be developed and applied to relate the measured deflection to the deflection that would be obtained during the critical season.

While measuring the deflection properties of an existing road, it is desirable to record the surface condition and any deficiencies in drainage which may be contributing to pavement failure. A simple pavement condition survey may be adopted in which deformation and cracking are measured on a quantitative basis by the deflection survey team.

It is also necessary in interpreting deflection survey results to have a broad knowledge of the type of construction and subgrade of the old pavement. Trials pits at one kilometer intervals should be sufficient.

2.8 : Temperature-Deflection Relationships

The stiffness of the bitumen bound pavement materials is very much dependent on temperature. Therefore, in conducting the NDT deflection survey, it is necessary to measure the pavement temperature to correct deflection or moduali obtained to a standard temperature. The relationship is developed by locating a few points on the pavement and measuring deflections at each point from very early morning to late afternoon. Air (ambient) and pavement temperatures and deflections should be measured every half hour or every hour to determine the relationships between the temperatures and deflections. The locations selected should be representative of those to be measured over the entire project such as wheel paths. Using this data, a temperature correction curve can be developed for the project so that the deflections can be adjusted to a standard temperature.

It is not possible to produce general relationship for temperature correction and it is always necessary to measure the deflection/temperature relationship on any project. Fortunately, it is often found that little or no correction is needed because the bituminous layers are usually quite thin.

2.9 : Deflection-Season Relationship

Deflection depends very strongly on the properties on the subgrade. In areas where the moisture content of the subgrade changes seasonally the deflection will also change. Usually, it will be necessary to obtain deflection readings which are representatives of the most adverse conditions experienced during the year, hence it is normal practice to conduct surveys just after the rainy season. If this can not be done, attempts should be made to correct for the seasonal effects but this requires a considerable data bank of deflection results combined with rainfall records before it can be done readily. Fig-3 shows the effect of season of the year on the asphaltic pavement deflections in some climatic areas.

2.10 : Deflection Basins

A pavement deflection basin is a three-dimensional surface depression created by a load directly beneath, and in the vicinity of the centre of the load. Deflection basins are often assumed to be symmetrical, and displayed using two dimensional plots: distances from the centre of the load, and measured deflection at these distances.

The shape of the deflection basin as well as the magnitude of the deflection contain valuable information concerning the structural adequacy of the pavement and the attenuation of energy through the pavement section. For example, a narrow and deep deflection basin indicates that more work is being done by the pavement section in the vicinity of the centre of the load, and that higher stresses are being transferred to the roadbed soil. Consequently higher structural distresses can be found or might be expected. On the other hand, a wide and shallow deflection basin indicates that the applied load is being distributed to a wide area and that less stress is applied to the roadbed soil (Fig-4).

2.11 : Uses of NDT Testing

The results of NDT deflection testing can be used in a variety of ways to

i) Determine the structural uniformity of the project by identifying areas of significant weakness.

ii) Assess the structural adequacy of the pavement.

iii) Design overlays.

iv) Determine the amount each layer contributes to the deflection.

v) Determine the strength properties of the various pavement layers.

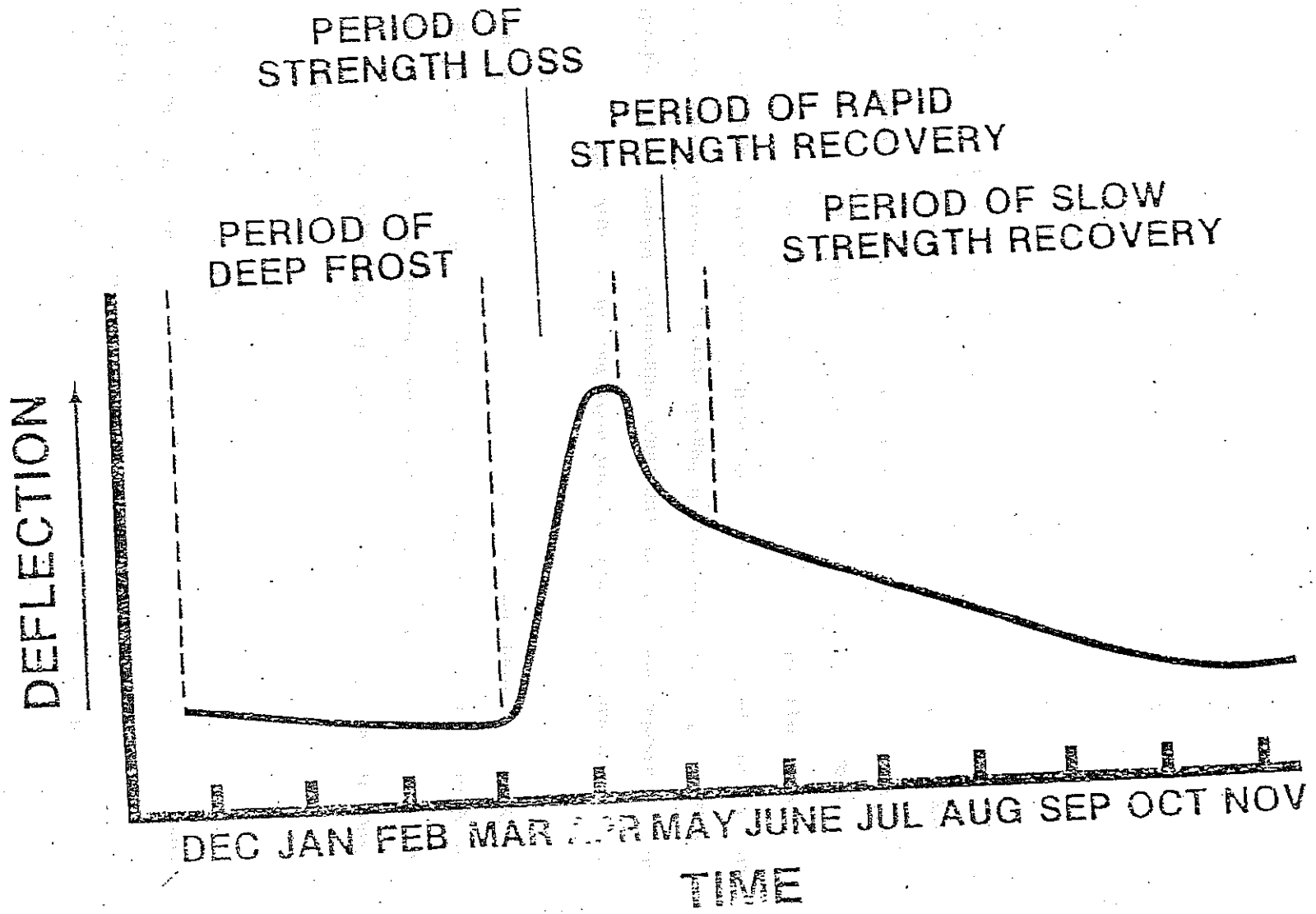
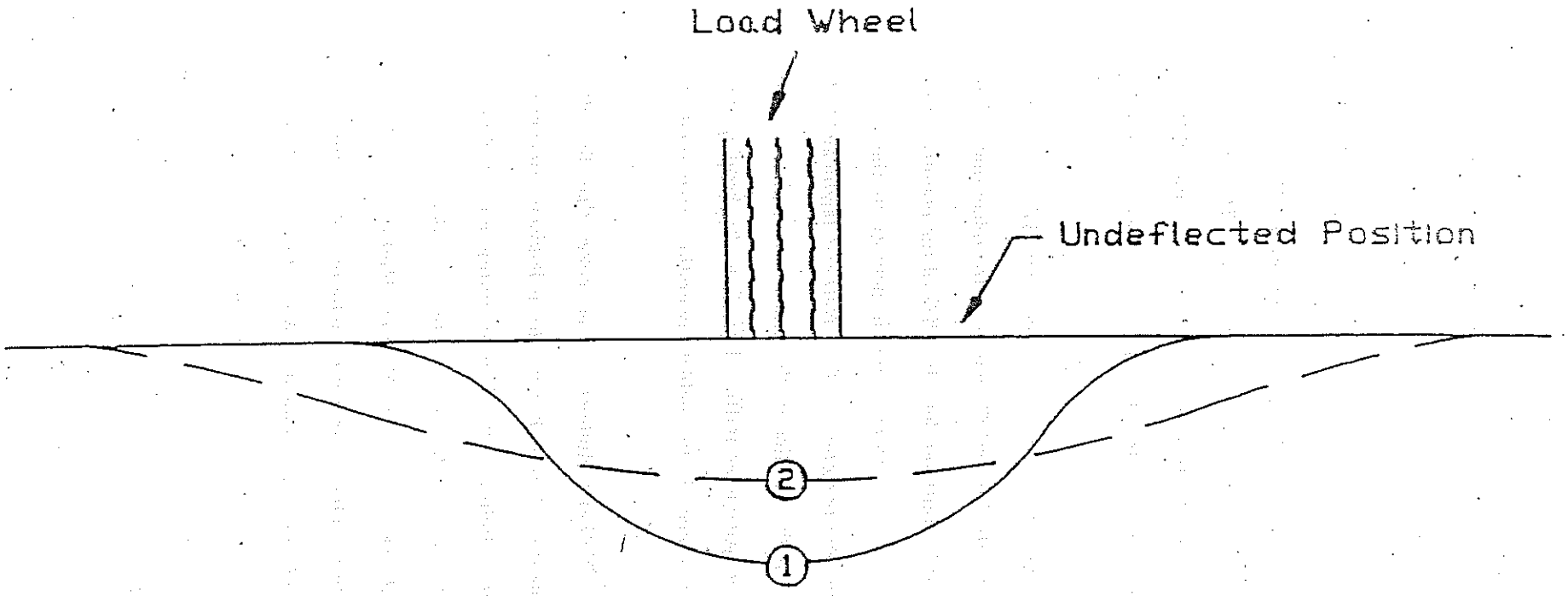


Fig-3

Influence of season on pavement deflection.



(1) Deep and narrow deflection basin

(2) Shallow and wide deflection basin

Fig-4

CHAPTER - III

THE STUDY

3.1 : General

Pakistan has a total road network of about 240,000 kms. Out of these, 134,000 kms are paved while the remaining 106,000 kms are unpaved. The existing road density in the country is 0.30 kms per sq. km of the area. However, the importance of the roads can be judged from the fact that they carry more than 90% of the country's freight traffic and passengers traffic. But the quality of the road network is generally poor.

Keeping in view the importance of some main arterial roads, nine number of these have been taken over by the Federal Government for rehabilitation and maintenance purposes. Though these roads constitute less than 5% of the country's total road network, but they are absolutely vital for socio-economic activity as they carry more than 60% of the country's freight and passenger traffic. National Highway (N-5) from Karachi to Peshawar (1762 kms) is the life line of the system, as it alone carries about 50% of the country's freight and passenger traffic. Therefore, by keeping only this road in good condition billions of rupees in the vehicle operating costs could be saved.

The condition of these National Highways is no better than the other roads in the country. Since the introduction of asphalt concrete in Pakistan, pavements are facing a severe problem of premature failure in the form of rutting and cracking of asphalt layers, caused predominately by poor quality control, bad mix design and ever increasing axle loads. The pavement distress data of the National Highway is collected by the NHA on continuous (yearly) basis whereas structural integrity of pavements is assessed by collecting falling weight deflection data annually. According to some recent studies, 76% of the National Highways have some level of cracking while 44% has got cracks even wider than 6 - 10mm and as such needs reconstruction. Then, 58% of the total network has some level of rutting and 26% have got even 1/2" to 1" deep ruts causing serious hazard levels to safety and increase in vehicle operating costs. As such about 3000 kms of the National Highway network is presently in need of reconstruction and about 1000 kms more will reach this stage in a year or two. As regards roughness, 50% of the road network is in poor condition. With change in roughness of the road from good to poor condition, the VOC increase for Rs 4/km to Rs. 26/km (6 - 7 times).

Maintenance or rehabilitation of the system without determining the cause(s) of pavement failures would be a futile effort as these failures keep re-occurring until and unless properly remedied through improved design and construction techniques. Therefore, the pavement failure study is essential as it would actually lay the foundation of a durable pavement. According to one conservative estimate, spending an amount of Rs. 6 billions on the road network a saving of Rs. 250 billions in the VOC could be achieved.

Thus determining the causes of the pavement failures is a need of the day.

3.2 : Sections selected for Analysis

As decided in the Research Advisory Committee meeting of NTRC, FWD (deflection) data for the network was obtained from NHA.

For the preliminary phase, it was considered appropriate to first analyze a few sections in order to evaluate what could be obtained from this data in the first phase. The following three sections were selected for analysis:

i) Karachi - Hyderabad
(Left Carriageway)

ii) Gujranwala Bypass
(North Bound Carriageway)

iii) Rawalpindi - Hassanabdal
(North bound Carriageway)

All the three sections lie on the National Highway (N-5). Although the traffic and the subgrade conditions at the three sections may not be exactly similar, but being part of the same National highway and for the sake of similarity pavement layers are assumed to be of same thicknesses.

NHA has purchased a FWD in 1995 for carrying out evaluation of its highway network. A lot of deflection data has been collected by NHA since than using this machine. The machine is capable of delivering various load levels to the pavement. The machine provides deflection at loading point as well as upto 48" from the centre of the load. The peak deflection (D_0) under the centre of the load is a measure of the overall strength (stiffness) of the pavement structure and is a good indication of the overall pavement condition and is a function of the (a) foundation support, (b) under

pavement layer thicknesses, (c) layer strength and applied load. For any given thicknesses of the pavement layers, higher D_0 values indicate a weaker pavement and variability of the pavement structure can be observed by viewing the longitudinal profile for the maximum deflections along the length of a roadway.

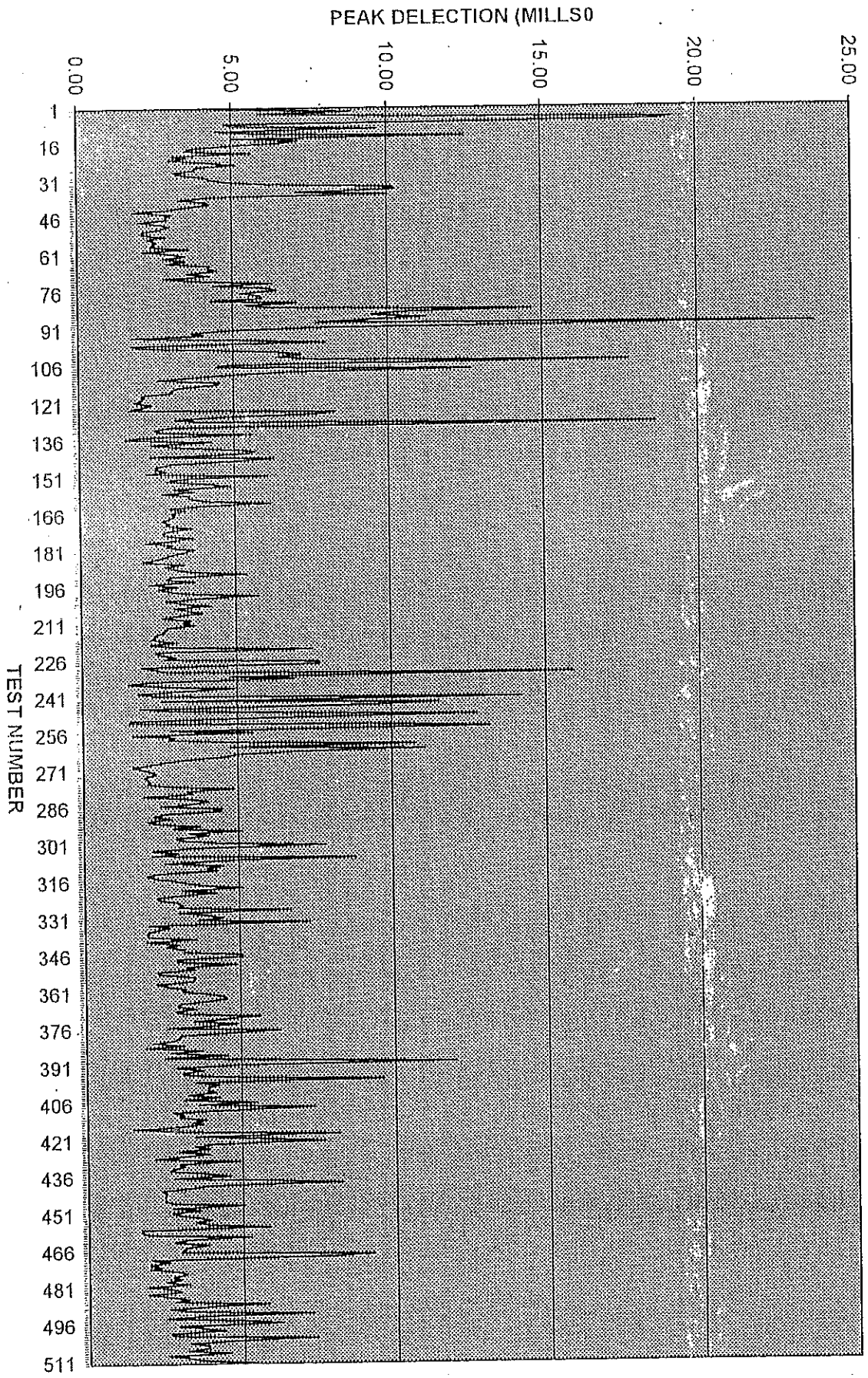
Before plotting, it was tried to convert the deflections measurements to the equivalent deflection at a standard temperature of 70°F, but it could not be done, as NHA has not yet developed temperature-deflections relationships. The other option was to apply certain deflection-temperature correction factor developed by some other agency. However, it was not considered appropriate to use such a relationship as the environmental conditions of our roads may completely differ from those where typical relationships were developed. Moreover, fortunately it was found through literature review that often little or no corrections is needed as subgrade and subbase are least susceptible to temperature changes and normal because the bituminous layers which is most prone to temperature changes is usually quite thin. As such the deflections measurements as taken by the FWD were used for analysis purposes.

3.3 : Data Results and Analysis

3.3.1: Karachi - Hyderabad section (135 km)

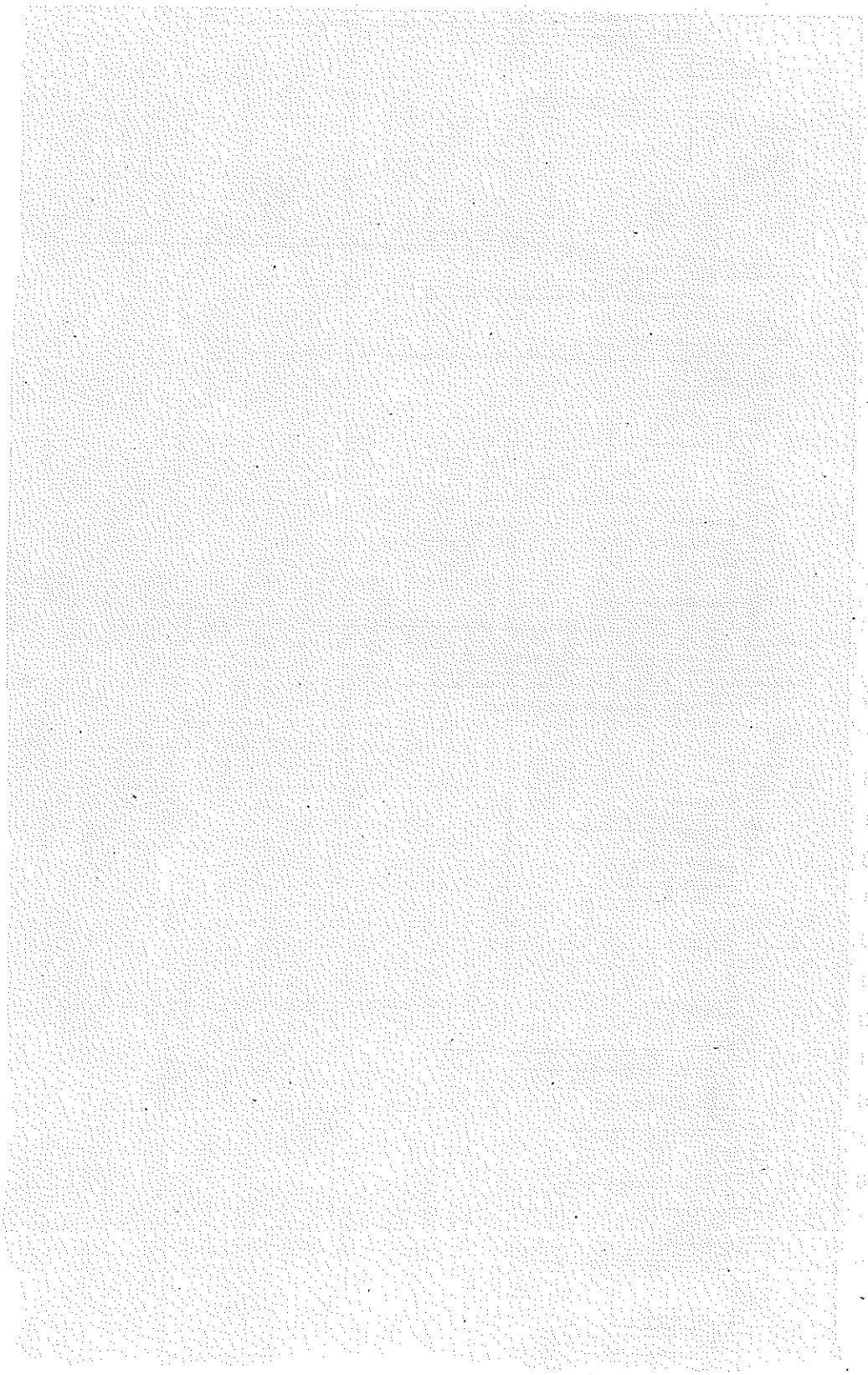
It comprises of the Northern carriageway of the road having a length of 135 kms. Deflection measurements have been taken at equal spacing of 250 meters. These deflection measurements were plotted against the chainage. Figure 5 shows deflection measurements under centre of the load values (D_o) versus chainages. The statistical analysis of the data has also been carried out and is given in Annexure-A.

The statistical analysis of Karachi-Hyderabad section shows an average deflection value of 4.18 mills, maximum value of 23.78 mills, and a minimum value of only 1.49 mills. The values of standard deviation and variance for Karachi-Hyderabad section are exceptionally low, and are indicative of the good quality of construction maintained on the section. Similarly, low values of average deflection imply that the pavement strength is quite high, and the deflection basin is quite small. Therefore, it can be concluded that with that high strength value the pavement would be able to resist (deformation) applied loads over an appreciable period of time. Though the pavements average deflection value is small but values as high as 32.87 mills indicate certain 'soft patches' in the pavement structure which may prove troublesome in future.



KARACH-HYDERABAD SECTION OF N-5 (NORTH)

Fig-5



On the other hand a 'stiff' pavement structure might result from a high overall pavement thickness.

3.3.2: Gujranwala - Bypass (15 Kms)

It comprises of the northbound carriageway of the 15 Km long by-pass. The deflection measurements have been taken at about 500 meters. The deflection measurement values under centre of the wheel load have been plotted against the chainages and are shown in Fig-6. The statistical analysis of the deflection data has also been carried out and is given in Annexure-B.

The statistical values obtained from the analysis of deflection data of the Gujranwala bypass, show an average deflective value of 12.30 mills, a maximum value of 19.68 mills and a minimum value of 5.63 mills. The standard deviation was found as 3.72 mills and a variance of 13.81 mills. Although the data is co-centric, with a coefficient of variance of 30, which is ordinarily considered as fair, but the high values of average deflection expresses the 'softness' of pavement, i.e. the deflection values are quite high and the pavement lacks strength to resist imposed loading and asphalt concrete might fail under alligator cracking.

This is a typical behavior of flexible pavements, built over resilient subgrades, such subgrades show big deformations under load. Big parts of these deformations will be recovered after the removal of the load. But, if the bituminous pavement is not flexible enough to follow these deflections, cracking will occur.

3.3.3: Rawalpindi-Hassanabdal

It comprises of the northbound carriageway of 45 Km long section. The deflection measurements have been taken at every 500 meters. The deflection measurements values under the centre of the wheel load has been plotted against the chainages and is shown in Fig-7. The statistical analysis of the data has also been carried out and is attached as Annexure-C.

The analysis of deflection data shows an average value of 9.03 mills, maximum value of 28.19 mills and a minimum value of 3.32 mills. The standard deviation and coefficient of variance is quite high. This eccentricity of deflection data explicitly shows the variation in pavement characteristics which is turn indicate the variability of either pavement, thickness and variability of material properties or both.

DEFLECTION ON GUJRANWALA BY-PASS (NORTH) OF N-5

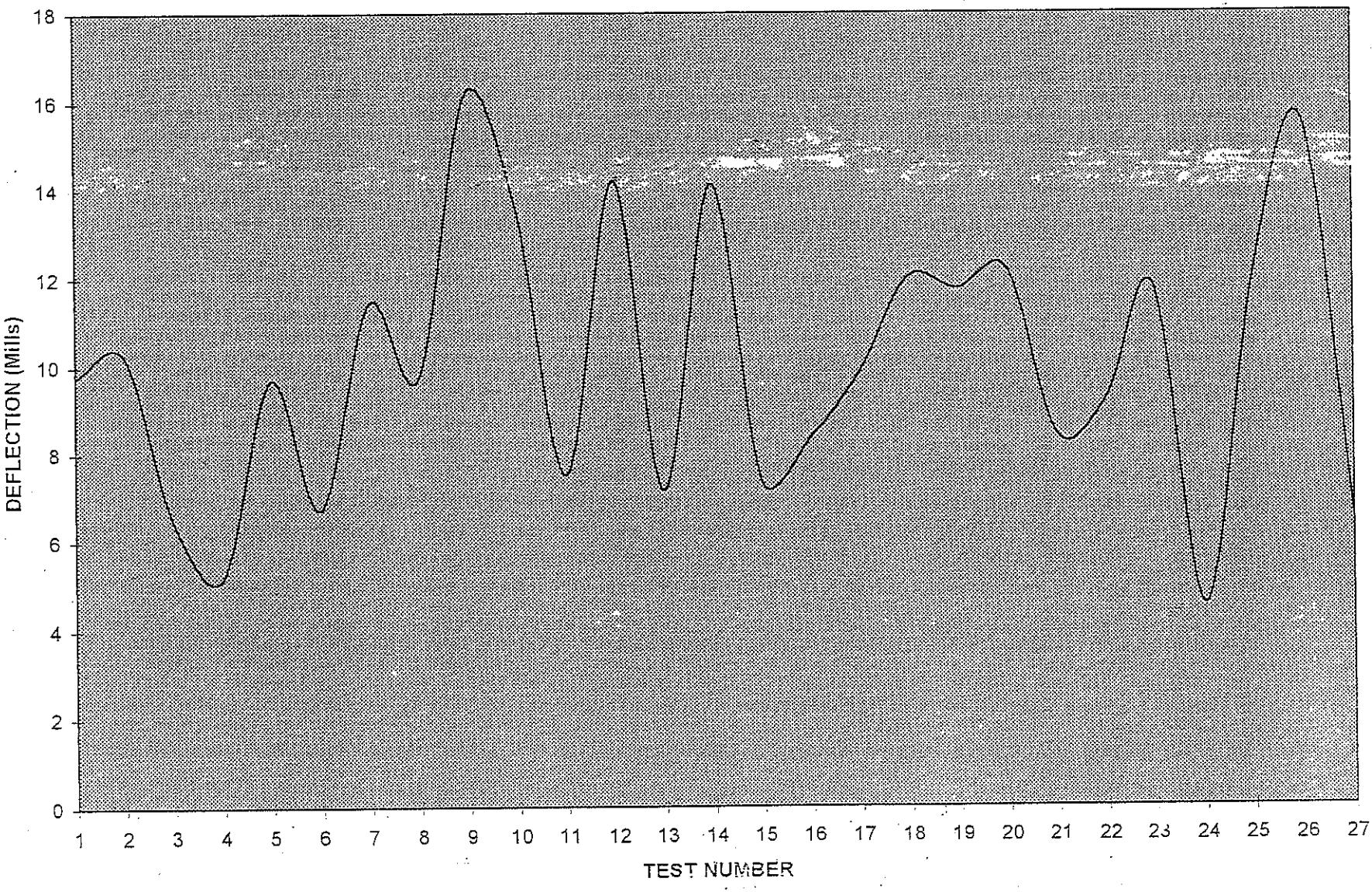
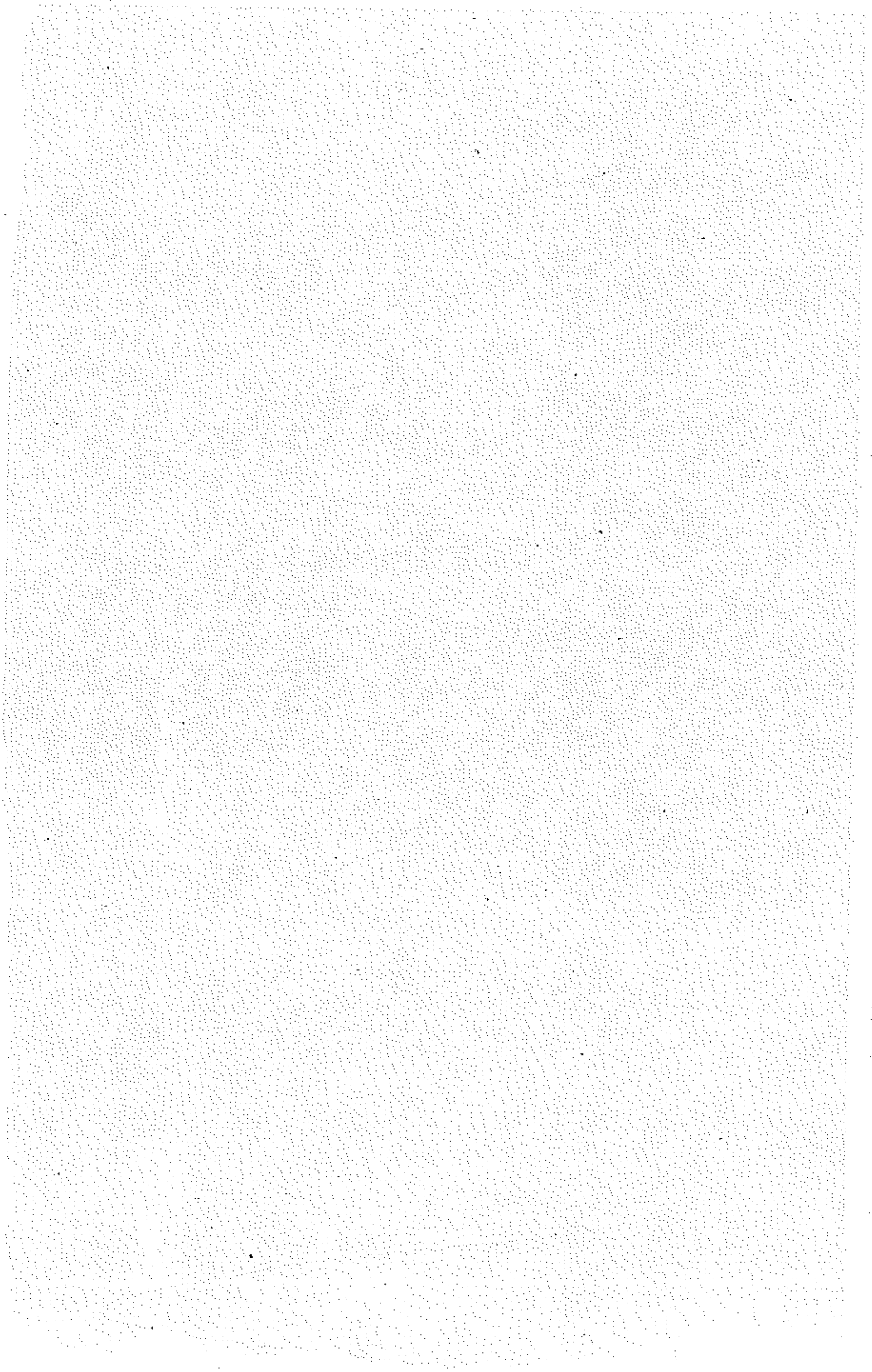


Fig-6



DEFLECTION ON RAWALPINDI HASSANABAL SECTION OF N-5 (NORTH)

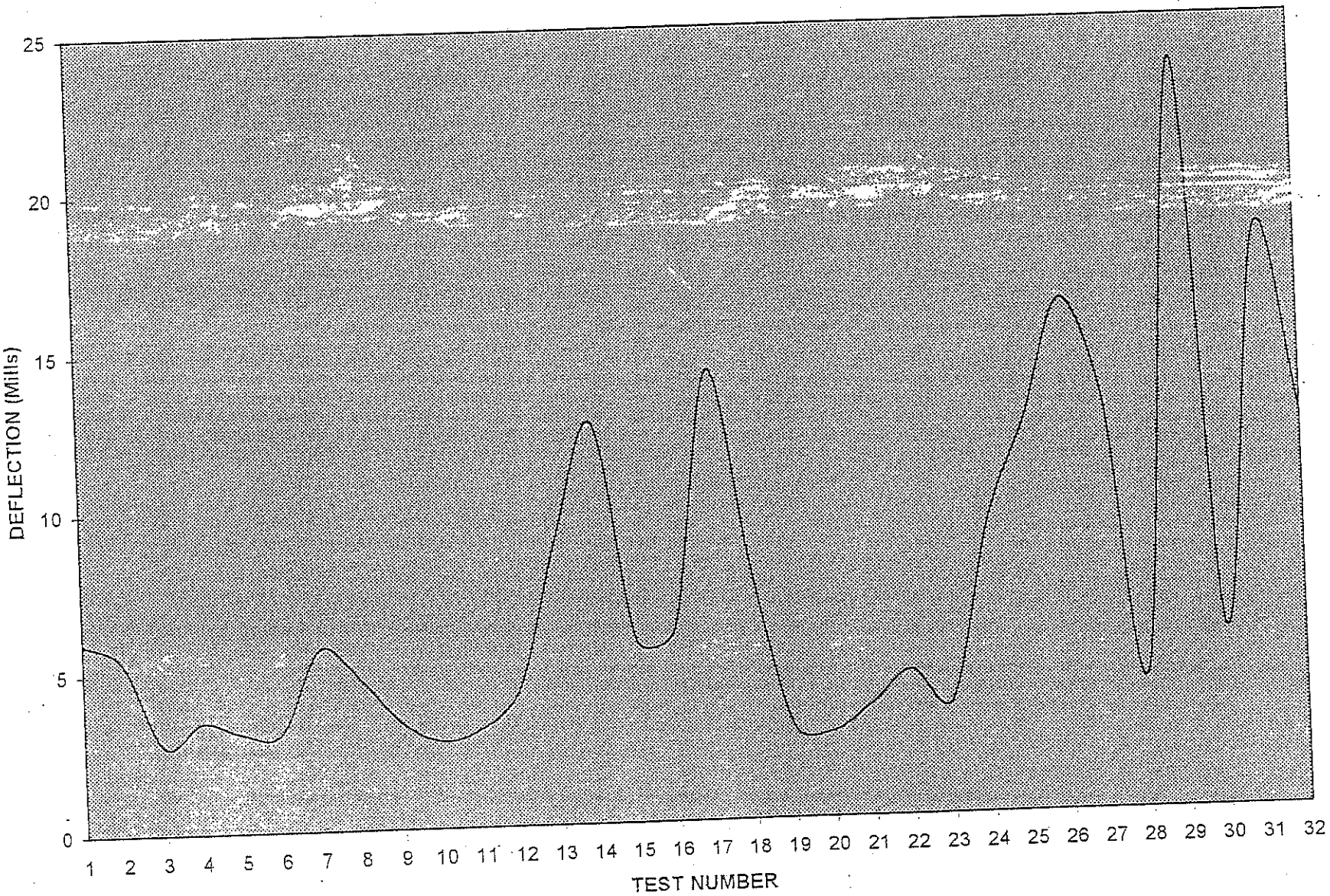
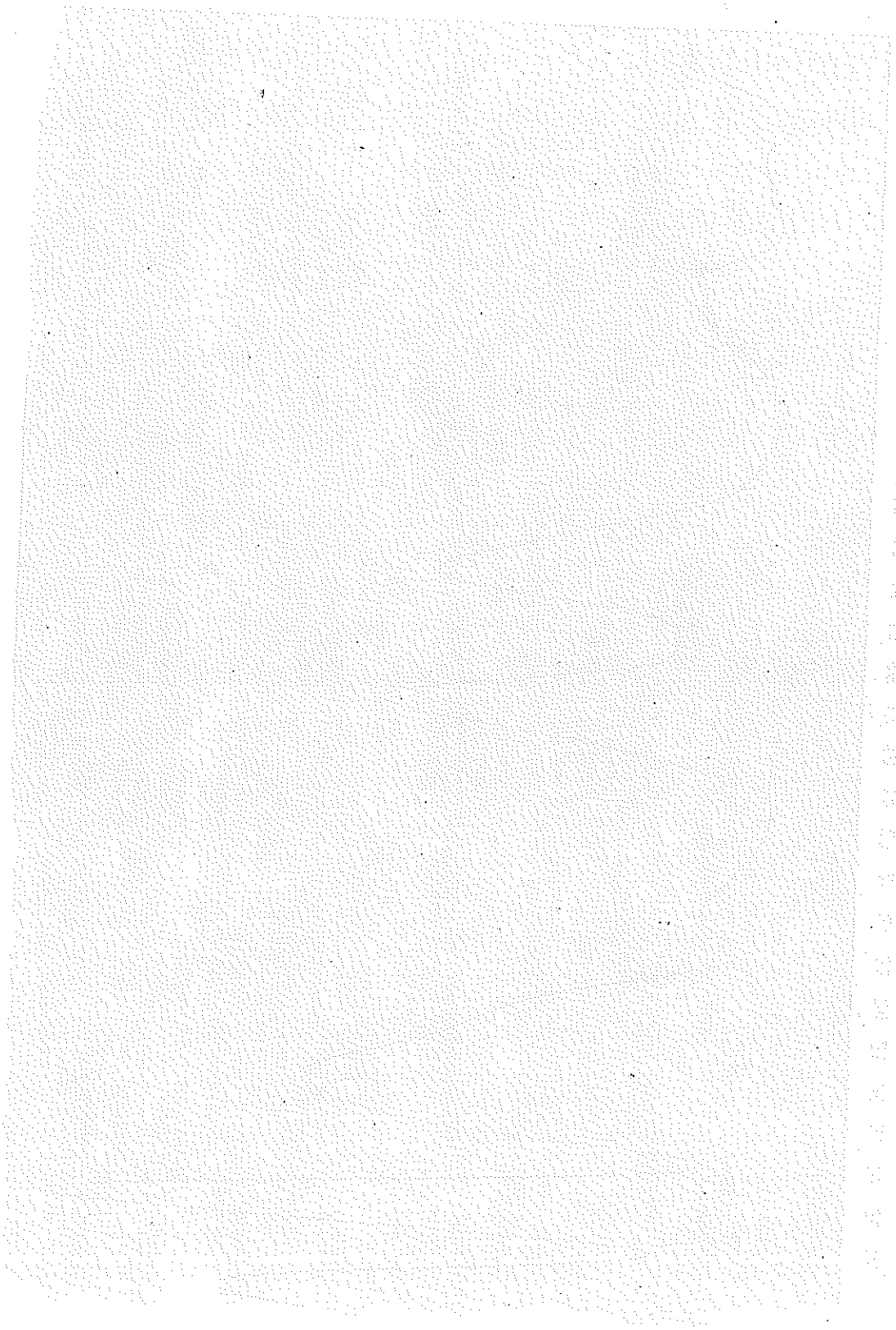


Fig-7
24



The high 'band width' of the deflection data shows several 'soft-patches' in the pavement structure.

These deflection values indicate that if the pavement will not be flexible enough to resist high rates of loading, cracking might set-in, accompanied with other forms of deformations like rutting, depressions etc.

Conclusions:

(1) The above mentioned results have been inferred from the analysis of deflection data. However, it is not possible to determine the causes of pavement failure from this data as it is constrained by ;

(a) Deflection depends on the properties, including thickness of subgrade, subbase and asphaltic layers. It is therefore essential that the structural composition of the pavement is fully known. The deflection data of NHA does not provide information about the pavement structure to which the deflection data is related.

(b) There are many factors that influence the measured pavement deflection. These factors are load factors, pavement factors and climate factors and a complete knowledge of these factors for correct interpretation of the data is very essential. These factors have not been detained by NHA while taking deflection measurements.

(2) From the analysis of few sections of deflection data, it can be concluded that the properties of the existing roads are extremely variable and hence any single testing method would not be sufficient to predict the causes of pavement failure or otherwise the life of pavement until and unless destructive testing is carried out side by side. It is therefore imperative that in addition to the deflection measurements, destructive testing techniques (coring, pitting and collection of samples) are used to determine the causes of the pavement failures.

(3) It is recommended that cores of asphaltic concrete mixes and samples of subgrade, subbase and aggregate base course materials be collected from adjacent sections where failures had occurred and adjacent sections having similar environmental and loading conditions where pavements are intact and then analysing the results of the two to arrive at definite conclusions regarding causes of pavement failures.

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
13000	9175	4.48	3.61	2.83	1.93	1.46	0.77	0.54	23.3	18.5	1163
13250	9066	8.83	6.93	5.41	3.66	2.63	1.36	0.86	22.9	19.0	584
13501	9128	5.86	5.18	4.33	3.46	2.88	1.94	1.40	22.9	19.1	885
13751	9028	10.30	8.74	7.13	5.23	4.04	2.39	1.71	22.7	19.1	498
14001	8872	19.20	15.33	11.45	8.70	6.57	3.65	2.33	22.9	19.2	263
14250	8900	18.75	14.52	9.39	5.93	3.83	1.59	1.01	22.6	19.3	270
14502	9071	4.79	4.01	3.27	2.55	2.12	1.36	0.98	22.9	19.1	1077
14753	9175	5.00	4.01	3.10	2.04	1.46	0.69	0.43	22.6	19.1	1044
15001	9071	9.69	7.81	6.10	4.02	2.69	1.25	0.77	22.6	19.3	532
15256	9160	4.48	3.61	2.85	1.93	1.38	0.69	0.43	22.4	19.2	1162
15501	9105	5.70	4.66	3.63	2.60	1.98	1.05	0.61	22.2	18.8	909
15751	9023	12.47	9.62	7.38	4.90	3.16	1.27	0.64	22.0	19.0	411
16003	9128	5.07	4.08	3.16	2.16	1.54	0.71	0.35	22.0	19.1	1024
16251	9128	7.12	5.71	4.46	2.96	2.02	0.83	0.40	22.2	19.0	729
16500	9082	6.54	5.59	4.60	3.52	2.74	1.60	1.01	22.0	19.2	790
16750	9043	4.72	3.80	2.94	2.06	1.59	0.99	0.73	21.8	18.6	1090
16974	9144	3.69	2.91	2.19	1.36	0.93	0.42	0.28	22.2	18.7	1409
17250	9105	3.48	2.63	1.96	1.34	1.03	0.65	0.50	21.8	18.6	1488
17501	9128	5.63	4.66	3.77	2.71	2.06	1.11	0.72	22.2	19.0	922
17754	9155	3.06	2.44	1.94	1.46	1.17	0.71	0.50	22.0	18.4	1701
18004	9137	3.53	2.84	2.21	1.56	1.20	0.63	0.42	22.0	18.7	1473
18250	9160	2.97	2.32	1.79	1.25	0.97	0.56	0.36	21.8	18.8	1756
18500	9137	4.32	3.44	2.66	1.90	1.42	0.79	0.50	21.7	18.8	1202
18756	9089	5.11	4.37	3.46	2.49	1.93	1.03	0.63	21.6	18.3	1010
19001	9160	3.81	3.08	2.44	1.75	1.34	0.77	0.47	21.4	18.2	1368
19251	9137	3.81	3.03	2.44	1.79	1.46	0.89	0.61	21.4	18.6	1365
19501	9121	3.13	2.44	1.91	1.36	1.05	0.57	0.34	21.3	18.6	1657
19755	9144	3.36	2.63	2.04	1.46	1.17	0.63	0.43	21.1	18.4	1546
20753	9098	4.16	3.44	2.83	2.18	1.74	1.11	0.80	20.8	18.1	1244
20972	9144	4.32	3.56	2.85	2.12	1.71	0.97	0.65	20.8	18.3	1203
21254	9152	4.83	3.96	3.21	2.37	1.85	1.19	0.85	20.5	18.0	1076
21502	9087	6.21	5.13	4.18	3.11	2.35	1.22	0.67	20.8	18.6	832
21761	8989	10.14	8.98	7.40	5.62	4.51	2.85	2.05	20.8	18.1	504
22009	9012	10.25	8.57	7.13	5.49	4.39	2.59	1.62	21.1	18.4	500
22250	9044	7.05	5.99	4.93	3.64	2.77	1.46	0.80	21.2	18.2	729
22505	9077	10.02	8.57	7.10	5.31	4.06	2.22	1.25	22.0	19.1	515
22751	9109	4.27	3.56	2.85	2.16	1.79	1.20	0.94	22.0	18.8	1212
23002	9152	3.29	2.67	2.10	1.54	1.23	0.71	0.54	22.0	18.9	1580
23265	9136	4.16	3.44	2.85	2.20	1.81	1.08	0.73	22.0	19.2	1250
23502	9126	4.27	3.44	2.71	1.98	1.54	0.97	0.64	22.3	19.4	1214
23751	9160	3.57	2.84	2.21	1.48	1.03	0.54	0.36	22.6	19.4	1458
24002	9175	3.01	2.39	1.91	1.31	0.95	0.51	0.31	22.7	19.4	1732
24250	9152	1.82	1.34	1.02	0.76	0.62	0.45	0.35	22.5	19.2	2857
24500	9160	3.06	2.32	1.77	1.20	0.89	0.49	0.36	23.1	19.9	1702
24751	9136	2.85	2.22	1.69	1.15	0.84	0.37	0.22	23.1	19.9	1823
25002	9136	2.90	2.32	1.79	1.25	0.95	0.51	0.35	23.1	20.0	1794
25253	9175	1.99	1.46	1.08	0.76	0.62	0.40	0.35	22.9	19.9	2628
25503	9132	2.73	2.22	1.77	1.34	1.07	0.63	0.42	23.2	20.3	1900
25753	9160	2.97	2.27	1.75	1.23	0.93	0.49	0.32	23.2	20.3	1756
26000	9132	2.62	2.10	1.64	1.20	0.89	0.49	0.31	23.5	20.3	1985
26253	9149	2.10	1.58	1.19	0.86	0.72	0.43	0.32	23.6	20.5	2475
26500	9175	2.10	1.62	1.22	0.86	0.66	0.37	0.26	23.6	20.6	2432
26750	9160	2.85	2.10	1.60	1.09	0.81	0.51	0.35	24.0	20.6	1828
27005	9136	2.27	1.74	1.29	0.86	0.64	0.34	0.22	23.6	21.3	2293
28800	9160	2.55	1.86	1.39	0.95	0.70	0.49	0.43	23.8	21.3	2046
29008	9136	2.45	1.86	1.39	0.92	0.73	0.43	0.31	24.1	21.7	2018

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
29258	9132	2.38	1.91	1.47	1.03	0.79	0.45	0.34	24.7	21.7	2180
29503	9121	3.64	2.91	2.19	1.50	1.09	0.51	0.33	24.6	22.0	1423
29753	9126	2.10	1.62	1.19	0.80	0.62	0.40	0.31	24.7	21.7	2469
30008	9105	2.97	2.22	1.60	1.05	0.79	0.51	0.38	24.7	22.0	1746
30249	9098	3.48	2.75	2.02	1.28	0.97	0.51	0.39	24.7	22.2	1487
30503	9105	2.78	2.22	1.69	1.25	1.01	0.69	0.53	24.5	22.1	1863
30754	9132	3.48	2.75	2.11	1.54	1.20	0.75	0.50	25.1	22.4	1492
31002	9121	2.90	2.15	1.64	1.15	0.89	0.59	0.44	24.7	22.4	1791
31253	9144	4.27	3.51	2.91	2.18	1.73	0.99	0.64	25.1	22.5	1217
31510	9061	4.20	3.56	2.91	2.24	1.85	1.14	0.81	24.9	22.9	1226
31736	9100	4.48	3.73	3.02	2.24	1.79	0.99	0.68	25.5	22.9	1154
32004	9155	3.53	2.84	2.24	1.65	1.36	0.79	0.67	26.1	24.0	1476
32252	9132	4.27	3.49	2.85	2.20	1.85	1.18	1.02	26.4	24.3	1215
32507	9147	2.78	2.27	1.83	1.43	1.18	0.69	0.63	26.1	24.0	1871
32756	9066	3.76	3.03	2.38	1.75	1.46	0.71	0.69	26.1	24.4	1371
32999	9079	6.26	5.30	4.44	3.42	2.80	1.64	1.18	26.6	25.0	825
33251	9094	4.39	3.73	3.11	2.49	2.10	1.33	1.09	26.0	24.6	1178
33503	9094	6.14	5.06	4.08	3.02	2.33	1.25	0.90	26.0	24.9	842
33772	9051	6.38	5.42	4.58	3.58	2.95	1.82	1.44	26.4	25.1	807
34060	9118	5.23	4.37	3.49	2.66	2.21	1.46	1.18	26.4	24.7	991
34251	9094	5.86	4.66	3.66	2.66	2.04	1.13	0.85	26.0	25.5	882
34506	8996	5.93	5.09	4.35	3.50	2.95	1.91	1.50	26.0	25.5	862
34750	8996	4.27	3.61	2.96	2.43	2.04	1.34	1.07	26.0	25.3	1197
35000	9019	7.05	5.99	5.04	4.00	3.30	2.05	1.51	25.8	25.9	727
35251	9073	5.42	4.54	3.71	2.82	2.24	1.28	0.97	25.8	26.5	952
35501	8973	6.26	5.30	4.33	3.30	2.64	1.52	1.13	25.3	26.2	815
35752	8988	14.64	11.77	9.65	7.17	5.62	3.04	2.13	25.6	26.6	349
36003	8978	10.21	8.69	7.21	5.62	4.45	2.51	1.83	25.6	26.4	500
36251	9016	9.51	8.10	6.66	5.09	4.06	2.17	1.65	25.8	26.8	539
36500	9006	11.23	9.27	7.54	5.23	3.75	1.96	1.44	25.8	26.7	456
36750	9001	9.23	7.76	6.27	4.76	3.69	2.04	1.49	26.0	26.1	555
37004	9058	7.68	6.30	5.10	3.75	2.91	1.60	1.17	26.1	26.8	670
37252	8721	23.78	20.42	16.50	9.71	7.47	3.81	2.29	26.0	26.9	209
37505	9063	8.20	6.88	5.54	4.14	3.22	1.80	1.27	26.0	27.3	629
37751	9094	4.90	4.01	3.21	2.37	1.85	0.97	0.73	26.0	27.0	1054
38001	9083	3.69	2.79	2.19	1.56	1.20	0.69	0.60	26.0	27.6	1400
38252	9123	4.04	3.44	2.83	2.24	1.90	1.20	0.94	26.1	27.7	1284
38512	9052	1.70	1.17	0.89	0.67	0.56	0.40	0.36	26.5	28.6	3033
39504	9008	5.63	4.61	3.68	2.71	2.10	1.11	0.80	26.1	28.5	910
39752	8985	7.96	6.19	4.77	3.30	2.46	1.28	0.99	26.4	28.5	641
40000	9094	1.70	1.17	0.89	0.67	0.56	0.40	0.36	26.5	28.6	3033
40283	9110	1.94	1.10	0.69	0.50	0.42	0.31	0.28	26.7	29.1	2672
40502	9047	4.09	3.15	2.24	1.50	1.09	0.59	0.54	26.9	29.9	1259
40756	8969	6.33	5.25	4.18	3.07	2.38	1.31	1.03	26.7	29.7	806
41002	9047	7.17	5.99	4.93	3.75	2.91	1.66	1.23	27.0	30.0	717
41250	9047	6.38	5.35	4.29	3.25	2.63	1.59	1.32	27.4	30.4	807
41500	8979	7.75	6.47	5.21	3.94	3.11	1.78	1.39	27.6	31.1	658
41751	8826	17.73	13.71	11.03	7.75	5.51	2.45	1.56	27.6	31.1	283
42000	9013	4.79	4.01	3.35	2.60	2.13	1.27	1.01	27.8	30.8	1070
42258	9013	4.44	3.73	3.04	2.35	1.96	1.22	1.00	27.6	31.1	1155
42503	8920	12.66	10.48	8.37	6.04	4.56	2.45	1.64	27.4	31.4	401
42752	8967	6.77	5.78	4.74	3.69	2.99	1.85	1.43	27.8	32.0	753
43001	9001	4.90	3.96	3.16	2.35	1.94	1.22	1.02	28.2	31.9	1044
43257	9045	3.48	2.75	2.16	1.71	1.43	0.94	0.90	28.0	32.7	1478
43502	9045	2.55	2.10	1.77	1.48	1.34	0.94	0.79	28.4	32.4	2020
43751	9001	4.55	3.73	3.02	2.29	1.82	1.05	0.68	28.4	32.9	1124

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
44003	8967	4.39	3.44	2.67	1.82	1.32	0.55	0.35	28.7	33.4	1161
44262	9024	3.25	2.63	2.08	1.59	1.28	0.79	0.69	28.2	32.9	1581
44501	9068	3.04	2.27	1.64	1.11	0.84	0.43	0.42	28.2	33.7	1698
44772	9036	3.01	2.27	1.60	1.03	0.76	0.40	0.36	28.2	33.7	1705
45001	9013	2.03	1.46	1.08	0.80	0.64	0.40	0.38	28.2	33.0	2522
45254	9013	2.10	1.58	1.16	0.78	0.62	0.37	0.38	28.4	33.2	2438
45500	8969	2.03	1.62	1.29	1.03	0.89	0.56	0.40	28.4	34.0	2510
45750	8985	1.82	1.34	0.94	0.70	0.58	0.37	0.43	27.8	32.7	2804
46003	9034	2.38	1.74	1.33	0.92	0.84	0.61	0.55	29.4	36.8	2156
46251	9013	2.01	1.46	1.08	0.78	0.70	0.54	0.45	29.4	38.1	2551
46502	8990	1.63	1.10	0.84	0.62	0.54	0.42	0.39	29.7	38.0	3127
46766	8912	8.27	6.81	5.69	4.33	3.47	2.05	1.25	29.8	36.8	613
47002	8940	7.64	6.40	5.30	3.94	3.03	1.68	0.98	29.7	36.9	666
47258	8995	4.34	3.56	2.91	2.32	1.98	1.28	0.96	30.0	37.4	1177
47501	9002	3.13	2.56	2.14	1.73	1.51	1.11	0.89	30.0	38.0	1636
47750	9002	3.99	3.08	2.42	1.75	1.40	0.89	0.61	30.2	37.6	1282
48000	8753	18.59	14.28	10.93	7.27	4.99	2.55	1.56	30.0	38.6	268
48251	9017	3.04	2.39	1.86	1.40	1.12	0.77	0.60	30.0	38.5	1689
48502	9041	2.45	1.98	1.53	1.15	0.99	0.83	0.71	29.7	36.8	2096
48751	9002	2.62	1.98	1.56	1.17	0.95	0.63	0.45	29.8	37.2	1957
49001	8963	5.58	3.84	2.66	1.48	0.95	0.49	0.39	30.0	37.7	913
49253	8979	2.01	1.39	1.00	0.67	0.56	0.37	0.35	30.2	36.6	2542
49501	9002	1.49	1.05	0.77	0.61	0.56	0.43	0.38	30.2	37.6	3424
49750	8963	4.27	3.15	2.33	1.54	1.09	0.63	0.46	30.3	38.0	1192
50000	8963	2.34	1.74	1.36	0.97	0.79	0.47	0.39	30.3	37.5	2182
50202	8947	3.13	2.32	1.81	1.28	0.95	0.54	0.40	30.0	38.0	1626
50579	8963	4.51	3.20	2.24	1.31	0.84	0.40	0.28	30.6	39.0	1131
50754	8924	5.65	4.25	3.24	2.12	1.40	0.69	0.47	30.3	39.5	898
51013	8924	5.42	4.25	3.29	2.20	1.51	0.57	0.28	30.7	39.5	937
51253	8959	2.27	1.58	1.17	0.78	0.58	0.40	0.34	30.7	39.2	2249
51501	8920	6.26	5.02	3.92	2.68	1.96	1.11	0.75	30.6	39.5	810
51754	8924	5.11	4.13	3.33	2.57	2.07	1.32	1.02	30.7	39.4	992
52002	8979	3.06	2.39	1.81	1.23	0.89	0.49	0.35	30.6	39.2	1669
52250	8974	2.55	1.98	1.52	1.23	1.07	0.77	0.61	30.7	39.2	2004
52503	8974	2.45	1.70	1.25	0.86	0.73	0.54	0.44	30.7	39.6	2081
52752	8907	2.80	1.91	1.33	0.89	0.64	0.43	0.32	30.7	39.7	1807
53002	8940	2.17	1.46	1.00	0.70	0.54	0.37	0.27	31.1	40.2	2340
53251	8803	6.05	4.25	2.77	1.34	0.76	0.26	0.13	31.1	40.5	827
53511	8846	3.20	2.39	1.85	1.34	1.03	0.43	0.31	30.9	41.2	1572
53773	8857	2.85	1.81	1.23	0.61	0.39	0.12	0.07	31.1	41.0	1768
54011	8891	4.20	2.79	1.91	1.15	0.81	0.45	0.32	30.9	40.8	1203
54252	8873	4.86	3.32	2.36	1.34	0.84	0.37	0.25	30.7	39.5	1039
54504	8912	3.01	2.22	1.64	1.05	0.79	0.40	0.25	31.1	39.7	1682
54754	8928	3.71	2.51	1.77	1.17	0.89	0.54	0.38	30.6	38.3	1367
55008	8967	2.66	1.81	1.25	0.76	0.50	0.23	0.16	30.3	38.8	1915
55250	8951	3.55	2.51	1.77	1.09	0.76	0.37	0.23	30.3	37.4	1434
55507	8966	3.53	2.75	2.19	1.62	1.26	0.71	0.44	30.7	37.9	1446
55751	8873	4.04	3.15	2.52	1.85	1.40	0.77	0.47	30.9	37.9	1249
57002	8940	6.14	5.02	4.11	2.96	2.24	1.08	0.61	31.1	37.7	828
57252	8963	3.88	3.32	2.74	2.24	1.90	1.31	1.00	30.9	37.5	1315
57500	8995	2.90	2.15	1.52	0.95	0.68	0.31	0.16	31.3	37.5	1766
57750	8978	3.41	2.67	2.14	1.54	1.18	0.75	0.59	31.3	37.8	1497
58001	8963	2.97	2.39	1.91	1.46	1.18	0.75	0.59	30.9	37.4	1718
58251	9007	3.06	2.39	1.86	1.28	0.99	0.65	0.50	31.1	38.1	1674
58500	8978	2.97	2.27	1.75	1.28	0.99	0.63	0.44	31.1	37.4	1721
58758	8947	2.62	1.91	1.39	0.92	0.70	0.40	0.30	30.9	37.5	1945

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
59004	8947	2.90	2.03	1.56	1.05	0.81	0.49	0.34	30.9	37.2	1757
59255	8979	2.78	2.03	1.52	0.97	0.68	0.37	0.24	31.1	37.3	1837
59498	8963	3.64	2.63	1.89	1.17	0.84	0.45	0.28	30.9	37.2	1399
59751	8908	2.97	1.98	1.35	0.84	0.58	0.37	0.29	30.7	36.9	1708
60003	8997	2.66	1.86	1.29	0.89	0.68	0.40	0.30	31.1	37.1	1921
60252	8979	2.73	1.91	1.33	0.86	0.64	0.37	0.28	31.1	36.6	1868
60502	8841	3.64	2.27	1.52	0.95	0.70	0.40	0.31	31.3	37.2	1380
60751	8807	3.06	2.10	1.47	0.92	0.70	0.43	0.30	31.3	37.2	1637
61001	8990	2.10	1.46	1.08	0.80	0.68	0.49	0.40	31.1	37.8	2432
61251	9017	2.97	2.15	1.58	1.11	0.87	0.51	0.39	31.3	39.1	1729
61501	8974	2.78	1.86	1.22	0.76	0.54	0.34	0.24	31.3	39.4	1836
61750	8997	3.69	2.84	2.19	1.59	1.26	0.75	0.49	31.3	40.0	1386
62000	8947	3.41	2.44	1.79	1.23	0.87	0.49	0.31	31.4	39.7	1492
62251	9002	2.97	2.15	1.54	1.09	0.81	0.48	0.31	31.4	39.9	1726
62504	8947	2.73	1.77	1.29	0.86	0.62	0.37	0.21	31.1	38.3	1862
62754	8963	2.38	1.58	1.16	0.84	0.68	0.43	0.36	31.3	41.0	2139
63005	9057	2.03	1.34	0.94	0.64	0.48	0.26	0.18	31.4	39.7	2535
63251	8924	3.36	2.44	1.77	1.11	0.76	0.31	0.15	32.2	40.0	1509
63516	8885	2.73	1.81	1.25	0.76	0.50	0.23	0.14	32.3	39.9	1849
63752	8963	3.01	2.10	1.47	0.92	0.64	0.34	0.22	32.2	39.1	1692
64002	8963	3.64	2.39	1.52	0.84	0.50	0.20	0.08	32.3	38.7	1399
64251	8919	5.35	3.73	2.66	1.59	1.03	0.45	0.28	32.6	39.0	948
64519	8956	2.92	1.86	1.22	0.72	0.48	0.26	0.21	32.6	39.1	1744
64752	8940	2.78	1.81	1.25	0.84	0.64	0.37	0.22	31.7	39.1	1829
65006	8940	3.69	2.75	2.02	1.36	0.99	0.48	0.31	31.7	38.6	1378
65252	8978	2.22	1.53	1.22	0.97	0.84	0.63	0.52	32.0	39.8	2301
65501	8903	3.13	2.15	1.50	0.97	0.73	0.43	0.35	32.0	39.7	1618
65757	8932	2.52	1.62	1.19	0.84	0.68	0.48	0.34	32.0	39.8	2013
66000	8908	2.90	2.27	1.77	1.34	1.15	0.85	0.64	32.3	39.5	1749
66250	8926	3.48	2.56	1.91	1.36	1.03	0.69	0.53	32.0	39.0	1458
66501	8897	5.70	4.30	3.33	2.37	1.87	1.20	0.93	32.0	39.2	888
66751	8854	3.81	2.96	2.33	1.65	1.32	0.79	0.57	32.3	39.1	1322
67009	8932	2.73	2.10	1.69	1.36	1.20	0.85	0.67	32.6	39.0	1859
67258	8830	3.29	2.63	2.04	1.62	1.34	0.94	0.69	32.2	38.9	1525
67501	8901	4.20	3.32	2.69	2.06	1.77	1.22	0.92	32.2	38.6	1204
67751	8942	3.01	2.34	1.89	1.40	1.11	0.69	0.48	31.8	38.9	1688
68002	8947	3.48	2.67	2.16	1.73	1.48	1.11	0.90	31.8	38.3	1462
68251	8919	3.92	3.03	2.29	1.73	1.42	0.97	0.71	32.2	38.8	1293
68501	8932	3.13	2.27	1.50	0.89	0.68	0.49	0.43	31.3	38.1	1623
68751	8908	2.62	1.91	1.47	1.15	0.99	0.69	0.53	31.7	39.3	1936
69000	8908	3.57	2.87	2.27	1.71	1.26	0.51	0.33	31.4	38.8	1418
69262	8932	3.29	2.44	1.83	1.15	0.58	0.23	0.21	32.0	39.7	1542
69501	8932	3.64	2.67	1.94	1.28	1.01	0.69	0.57	32.0	39.2	1394
69751	8908	2.85	2.22	1.71	1.31	1.12	0.79	0.63	31.8	40.0	1778
70001	8854	2.73	2.03	1.44	1.00	0.79	0.51	0.42	31.4	38.9	1842
70268	8924	2.62	1.86	1.35	0.92	0.70	0.40	0.29	31.7	40.0	1940
70504	8924	2.38	1.70	1.25	0.86	0.68	0.37	0.27	31.7	39.6	2130
70752	8901	2.38	1.81	1.35	1.00	0.81	0.49	0.34	31.8	39.5	2125
71001	8951	2.27	1.70	1.19	0.76	0.56	0.37	0.30	31.7	39.8	2247
71252	8908	3.06	2.15	1.58	1.09	0.87	0.51	0.38	31.7	39.4	1656
71500	8942	2.22	1.58	1.10	0.78	0.64	0.40	0.32	31.4	39.2	2292
71751	8947	2.97	2.22	1.69	1.23	1.03	0.77	0.49	31.3	38.7	1715
72000	8881	7.43	4.61	3.00	1.71	1.20	0.75	0.55	33.6	40.2	680
72252	8991	2.41	1.58	1.23	0.95	0.87	0.63	0.56	32.6	39.8	2125
72502	8897	2.52	1.70	1.23	0.80	0.64	0.49	0.43	32.2	39.4	2006
72755	8991	3.04	2.15	1.64	1.15	0.89	0.54	0.38	32.0	40.5	1684

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
73000	8924	2.69	1.86	1.33	0.97	0.80	0.59	0.50	32.0	40.2	1889
74503	8857	7.64	5.35	3.77	2.18	1.42	0.69	0.46	32.6	40.6	659
74750	8857	7.64	5.35	3.77	2.18	1.42	0.69	0.46	32.6	40.6	659
75005	8951	1.94	1.39	1.04	0.76	0.58	0.37	0.31	32.6	40.9	2626
75251	8951	2.34	1.50	1.02	0.56	0.39	0.28	0.24	32.6	40.5	2179
75503	8901	2.73	1.81	1.29	0.87	0.66	0.43	0.36	32.7	40.0	1852
75751	8753	15.90	12.30	8.70	4.90	3.07	1.27	0.82	32.6	40.8	313
76002	8966	4.79	3.10	2.08	1.25	0.95	0.59	0.43	32.6	40.0	1065
76252	8857	6.84	4.73	3.33	1.93	1.26	0.59	0.43	32.9	40.6	736
76511	8979	2.15	1.34	0.81	0.50	0.39	0.26	0.18	32.3	40.8	2376
76750	8951	1.49	1.05	0.84	0.67	0.54	0.30	0.13	32.6	41.4	3405
76999	8979	3.01	2.22	1.60	1.17	0.99	0.71	0.57	32.0	40.7	1695
77255	8826	4.90	3.32	2.08	1.48	1.09	0.57	0.47	31.7	32.6	1023
77501	8880	3.13	1.77	1.16	0.84	0.76	0.59	0.54	31.3	31.0	1613
77531	9044	1.82	1.29	1.00	0.79	0.70	0.54	0.39	29.8	32.6	2823
77751	9002	2.34	1.62	1.22	0.89	0.79	0.56	0.45	29.8	31.9	2192
78000	8896	14.20	10.96	7.33	3.30	2.19	0.97	0.72	29.1	30.4	356
78254	9078	2.57	1.70	1.22	0.84	0.70	0.51	0.39	29.1	30.9	2009
78500	8915	11.51	8.45	6.18	3.86	2.44	1.03	0.61	28.9	30.4	440
78757	8946	9.39	7.00	5.24	3.27	2.10	0.79	0.42	29.1	30.3	542
79013	9138	1.87	1.34	1.06	0.78	0.70	0.57	0.47	28.9	30.4	2781
79259	9078	2.90	2.32	1.83	1.46	1.24	0.83	0.58	28.9	30.4	1782
79501	9008	6.77	5.37	4.13	2.74	1.87	0.83	0.50	28.9	30.4	756
79751	8876	12.73	9.84	7.31	4.28	2.63	0.89	0.55	28.9	28.6	397
80003	9083	6.10	4.25	3.08	1.88	1.28	0.65	0.46	28.9	29.7	847
80251	9146	1.59	1.05	0.75	0.58	0.53	0.45	0.40	28.7	29.8	3274
80515	9068	1.54	0.93	0.64	0.42	0.33	0.26	0.22	28.7	30.0	3345
80747	8935	10.49	8.05	6.41	4.39	3.05	1.34	0.71	28.7	29.3	484
81001	8920	13.17	9.27	6.18	3.21	1.96	0.65	0.35	28.7	29.2	335
81254	9078	2.85	2.22	1.75	1.31	1.07	0.71	0.50	28.4	29.2	1812
81506	9063	5.51	4.20	3.24	2.24	1.65	0.91	0.59	28.7	29.4	935
81752	9024	1.63	1.10	0.77	0.50	0.37	0.23	0.16	28.7	29.3	3139
82004	9078	2.97	2.15	1.58	1.15	0.95	0.68	0.49	28.7	29.1	1740
82252	9001	2.78	1.81	1.25	0.76	0.54	0.26	0.15	29.1	28.9	1842
82506	9006	4.79	3.80	2.94	2.18	1.65	0.94	0.65	29.3	29.0	1070
82751	8904	10.77	7.40	5.12	2.99	1.90	0.82	0.40	29.1	29.3	470
83002	8946	4.79	3.73	3.02	2.32	1.82	1.11	0.78	29.3	29.2	1062
83252	8881	11.05	8.29	6.35	4.25	2.85	1.14	0.58	29.1	29.2	457
83500	8930	7.01	5.61	4.52	3.33	2.60	1.46	0.94	29.1	29.2	725
83752	8969	4.95	3.84	2.99	2.24	1.77	1.03	0.71	29.4	29.1	1030
84003	9091	4.60	3.68	2.91	2.16	1.69	0.94	0.61	29.7	29.0	1124
84261	9006	3.36	2.32	1.58	0.95	0.64	0.37	0.13	29.4	28.9	1523
84500	8928	2.66	1.91	1.39	0.95	0.78	0.45	0.42	29.4	28.5	1907
84751	8912	2.22	1.58	1.14	0.84	0.70	0.49	0.67	29.4	28.6	2284
84769	9193	1.63	1.22	0.91	0.67	0.56	0.40	0.32	24.4	22.2	3197
85019	9193	1.94	1.46	1.04	0.70	0.56	0.34	0.23	24.4	24.7	2697
85269	9172	2.27	1.50	1.19	0.78	0.58	0.37	0.29	24.5	24.7	2302
85520	9177	2.34	1.81	1.35	0.97	0.81	0.54	0.44	24.7	24.8	2234
85771	9167	1.99	1.46	1.08	0.76	0.61	0.42	0.35	24.7	24.8	2626
86027	9133	2.10	1.62	1.14	0.81	0.70	0.47	0.38	25.3	25.3	2471
86270	9177	2.17	1.70	1.33	1.03	0.86	0.69	0.55	24.9	25.4	2402
86520	9151	2.10	1.58	1.19	0.89	0.76	0.51	0.42	25.4	25.7	2475
88269	9117	2.90	2.34	1.96	1.59	1.38	1.03	0.84	26.5	27.2	1790
88520	9063	4.83	3.80	2.88	2.01	1.51	0.91	0.67	26.7	27.3	1066
88769	9156	3.36	2.75	2.14	1.62	1.34	0.82	0.55	26.7	27.4	1548
89019	9167	3.53	2.91	2.35	1.90	1.63	1.17	0.88	26.7	27.7	1478

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
89270	9141	1.94	1.39	1.02	0.78	0.72	0.51	0.45	27.0	27.8	2681
89519	9110	3.53	2.63	1.91	1.31	0.97	0.59	0.38	27.3	28.0	1469
89769	9110	4.04	2.96	2.21	1.40	0.97	0.45	0.28	27.0	28.3	1282
90021	9141	3.53	2.44	1.64	0.97	0.70	0.37	0.29	27.3	28.6	1474
90274	9138	2.50	1.81	1.31	0.86	0.64	0.40	0.32	26.7	28.0	2079
90521	9123	4.44	3.37	2.44	1.46	1.03	0.59	0.50	26.4	28.9	1169
90769	9133	4.44	3.49	2.74	1.93	1.51	0.99	0.72	26.1	28.6	1170
91020	9110	2.62	1.91	1.41	1.03	0.87	0.63	0.55	26.4	28.9	1980
91270	9084	2.27	1.70	1.29	0.95	0.73	0.40	0.34	26.4	29.3	2280
91520	9008	2.85	2.03	1.47	1.00	0.79	0.57	0.49	26.5	29.4	1798
91770	9091	2.10	1.46	1.02	0.72	0.66	0.49	0.43	26.5	30.0	2459
92019	9099	2.34	1.62	1.19	0.80	0.64	0.45	0.38	26.7	29.7	2215
92269	9063	3.76	2.91	2.19	1.48	1.07	0.51	0.26	26.5	29.7	1371
92519	9008	2.90	2.27	1.79	1.42	1.24	0.85	0.58	26.7	29.8	1769
92801	9029	5.11	3.27	2.08	1.17	0.87	0.57	0.44	26.7	30.4	1004
93019	9068	3.41	2.75	2.14	1.50	1.12	0.56	0.36	26.9	29.9	1512
93269	9084	4.04	3.08	2.21	1.28	0.81	0.42	0.32	26.9	30.7	1278
93520	9029	3.01	2.22	1.58	1.05	0.84	0.54	0.42	26.9	30.9	1704
93771	9029	3.18	2.22	1.52	0.92	0.62	0.28	0.18	27.0	31.6	1616
94019	9013	4.44	3.15	2.14	1.23	0.76	0.23	0.11	26.9	32.0	1155
94381	9006	7.80	5.83	4.08	2.20	1.32	0.45	0.22	27.3	31.3	656
94521	9123	3.48	2.56	1.89	1.23	0.87	0.43	0.28	26.9	31.3	1491
94769	9123	2.22	1.62	1.19	0.78	0.56	0.28	0.19	26.7	31.6	2338
95019	9047	3.06	2.27	1.69	1.09	0.76	0.37	0.22	27.3	31.9	1681
95271	9024	2.22	1.70	1.25	0.89	0.68	0.40	0.24	27.0	31.9	2313
95524	8930	8.78	6.47	4.60	2.71	1.85	0.89	0.51	26.7	32.2	578
95770	9006	4.34	3.37	2.54	1.73	1.26	0.63	0.36	27.0	32.2	1179
96019	9079	2.62	1.98	1.52	1.11	0.89	0.51	0.36	27.0	32.2	1974
96269	9068	4.51	3.56	2.79	2.04	1.59	0.97	0.63	27.0	31.8	1144
96519	9084	3.99	3.08	2.38	1.65	1.20	0.57	0.27	27.4	31.7	1293
96769	9001	4.27	3.32	2.63	1.81	1.34	0.71	0.39	27.0	32.6	1197
97019	9063	2.45	1.74	1.19	0.78	0.56	0.37	0.27	27.4	32.6	2101
97269	9044	2.03	1.39	1.00	0.61	0.45	0.31	0.20	27.6	32.7	2531
97520	9099	2.27	1.58	1.14	0.72	0.54	0.28	0.22	27.4	32.9	2284
97803	9063	2.85	2.22	1.71	1.31	1.07	0.71	0.54	27.8	33.8	1809
98019	9071	3.32	2.39	1.77	1.17	0.81	0.37	0.22	28.2	33.5	1555
98272	9071	3.83	3.03	2.41	1.85	1.49	0.94	0.65	28.0	33.8	1347
98519	8985	5.11	4.30	3.50	2.68	2.19	1.36	1.01	28.2	33.5	999
98770	9013	3.18	2.75	2.21	1.79	1.48	1.05	0.85	28.4	33.5	1614
99021	9008	4.27	3.49	2.85	2.18	1.77	1.08	0.69	28.0	33.6	1198
99269	9138	3.13	2.32	1.71	1.17	0.87	0.49	0.34	28.5	33.5	1660
99522	9177	2.34	1.86	1.47	1.09	0.87	0.51	0.36	28.9	34.2	2234
99770	9071	2.45	1.91	1.50	1.11	0.93	0.54	0.38	29.3	34.2	2103
100019	9055	3.04	2.32	1.79	1.25	0.95	0.51	0.35	29.4	34.6	1696
100269	9060	3.18	2.51	1.89	1.28	0.99	0.49	0.31	29.1	34.8	1622
100519	9084	3.04	2.27	1.71	1.17	0.87	0.43	0.28	29.1	34.8	1701
100779	8946	6.61	5.54	4.43	3.33	2.49	1.28	0.69	29.4	35.1	770
101025	9021	3.01	2.22	1.58	1.00	0.68	0.31	0.22	29.4	35.6	1703
101275	9055	3.95	2.96	2.27	1.46	1.03	0.49	0.30	29.7	36.1	1305
101520	9006	4.46	3.32	2.46	1.56	1.07	0.49	0.34	29.4	35.8	1148
101826	9021	3.71	2.51	1.77	1.09	0.76	0.42	0.31	29.7	36.3	1381
102018	8962	7.24	5.42	3.99	2.43	1.59	0.61	0.38	29.8	36.8	704
102270	8978	2.10	1.58	1.19	0.89	0.76	0.54	0.46	30.0	36.5	2429
102522	9039	2.73	1.98	1.48	0.92	0.68	0.43	0.32	30.2	36.8	1881
102790	9006	2.45	1.81	1.39	1.00	0.81	0.54	0.38	30.0	37.4	2088
103018	8981	2.10	1.46	1.10	0.84	0.68	0.34	0.18	30.0	36.5	2430

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
103270	9005	2.01	1.29	0.89	0.53	0.37	0.23	0.21	30.2	37.2	2549
103519	9045	2.06	1.34	0.94	0.58	0.45	0.28	0.23	30.3	37.4	2502
103769	8974	3.60	2.51	1.75	1.07	0.73	0.42	0.35	30.0	37.7	1419
104019	9005	2.01	1.29	0.89	0.53	0.37	0.23	0.21	30.2	37.2	2549
105019	9044	3.04	2.22	1.60	1.09	0.84	0.49	0.35	30.2	38.9	1694
105269	9044	2.62	1.91	1.44	1.05	0.92	0.65	0.56	30.3	39.2	1966
105519	9005	3.20	2.44	1.89	1.32	1.03	0.65	0.50	30.6	39.0	1600
105519	9005	3.20	2.44	1.89	1.32	1.03	0.65	0.50	30.6	39.0	1600
105773	8990	5.07	3.89	3.02	2.12	1.69	0.99	0.72	30.7	39.1	1009
105773	8990	5.07	3.89	3.02	2.12	1.69	0.99	0.72	30.7	39.1	1009
106029	9013	2.97	2.10	1.54	1.09	0.84	0.57	0.44	30.9	39.8	1728
106029	9013	2.97	2.10	1.54	1.09	0.84	0.57	0.44	30.9	39.8	1728
106269	9013	4.90	3.89	3.16	2.37	1.94	1.25	0.90	31.1	40.2	1045
106519	9013	3.29	2.32	1.71	1.15	0.95	0.63	0.52	30.6	39.4	1556
106801	9029	3.53	2.67	2.02	1.34	0.99	0.54	0.36	30.6	39.0	1456
107020	8974	2.34	1.70	1.27	0.84	0.68	0.40	0.31	30.9	39.4	2185
107270	9013	2.38	1.91	1.52	1.23	1.07	0.65	0.49	30.7	39.4	2151
107520	8935	3.53	2.96	2.41	1.95	1.69	1.20	0.93	30.9	40.6	1441
107772	8974	3.53	2.79	2.21	1.73	1.46	1.05	0.81	30.9	41.1	1447
108020	8958	3.48	2.63	2.08	1.50	1.24	0.83	0.67	31.1	41.2	1464
108269	9013	2.29	1.74	1.41	1.09	0.89	0.63	0.52	31.3	41.5	2239
108520	8997	2.66	2.27	1.89	1.54	1.38	0.99	0.75	31.1	41.7	1921
108770	8990	3.25	2.67	2.21	1.81	1.59	1.19	0.90	31.4	41.7	1575
109037	8982	3.13	2.56	2.10	1.69	1.51	1.14	0.85	31.1	41.4	1632
109270	8974	3.97	3.15	2.52	1.85	1.54	1.05	0.88	31.3	41.3	1285
109520	8959	4.51	3.56	2.85	2.10	1.63	1.01	0.78	31.3	41.3	1130
109769	8958	4.55	3.68	2.94	2.24	1.79	1.17	0.80	31.1	41.0	1118
110019	8920	3.92	2.87	2.21	1.69	1.40	1.01	0.71	31.8	41.0	1293
110271	9005	3.04	2.22	1.71	1.28	1.05	0.71	0.60	31.4	41.3	1687
110519	8951	2.97	2.22	1.75	1.31	1.07	0.69	0.53	31.4	41.3	1716
110770	9013	3.57	2.79	2.24	1.69	1.38	0.91	0.74	31.3	41.9	1434
111019	8990	2.90	2.27	1.83	1.46	1.28	0.91	0.65	31.3	41.4	1765
111273	8990	3.13	2.39	1.89	1.34	1.12	0.75	0.57	31.3	41.9	1633
111519	8961	5.63	4.37	3.41	2.37	1.85	1.13	0.79	31.4	42.1	905
111769	8961	4.55	3.49	2.79	2.12	1.79	1.25	0.97	31.3	42.3	1119
112077	8852	3.48	2.39	1.83	1.36	1.12	0.82	0.64	31.4	41.7	1446
112271	8924	4.90	3.84	3.08	2.37	1.94	1.25	0.93	32.2	43.0	1035
112524	9052	4.20	3.10	2.46	1.79	1.40	0.85	0.65	32.0	42.8	1224
112779	9013	2.62	1.86	1.35	0.95	0.76	0.43	0.31	32.0	42.8	1959
113021	8974	6.26	4.61	3.38	2.10	1.40	0.57	0.31	32.0	42.8	815
113270	8959	4.72	3.37	2.46	1.56	1.09	0.56	0.32	32.0	43.7	1080
113528	9112	3.06	2.32	1.77	1.67	0.89	0.43	0.23	31.8	43.5	1693
113772	9135	3.01	2.22	1.69	1.23	0.95	0.54	0.31	32.0	43.7	1724
114019	9185	2.85	2.10	1.64	1.23	0.99	0.57	0.36	32.2	44.2	1833
114272	9091	2.15	1.46	1.02	0.58	0.45	0.26	0.18	32.7	44.2	2406
114522	9075	3.18	1.91	1.22	0.72	0.50	0.28	0.15	33.2	44.2	1625
114772	9091	1.89	1.17	0.81	0.58	0.48	0.31	0.26	33.1	44.5	2733
115027	8990	3.76	2.63	1.96	1.42	1.15	0.77	0.54	32.9	44.0	1360
115270	9052	2.73	1.58	1.19	1.03	0.93	0.69	0.55	32.7	43.9	1884
115526	9036	4.55	3.37	2.60	1.81	1.46	0.83	0.53	32.9	44.4	1128
115771	8990	2.55	1.46	1.04	0.84	0.70	0.51	0.39	33.1	43.9	2008
116023	8951	6.66	4.78	3.54	2.35	1.71	0.97	0.65	33.1	43.0	765
116272	8919	11.96	9.55	7.68	5.65	4.39	2.68	1.85	33.1	44.4	424
116528	8981	4.90	3.80	2.99	2.20	1.74	1.05	0.72	32.7	44.3	1041
116770	8974	2.90	2.15	1.69	1.40	1.20	0.93	0.67	32.9	44.0	1762
117020	8912	3.76	2.96	2.46	1.88	1.57	1.03	0.75	33.2	44.5	1348

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
117275	8971	3.20	2.39	1.83	1.28	1.01	0.65	0.49	32.6	44.0	1594
117520	8974	3.13	2.32	1.83	1.34	1.12	0.77	0.56	33.1	44.0	1631
117770	8924	5.07	3.73	2.75	1.88	1.46	0.94	0.67	33.6	45.3	1001
118021	8842	9.58	7.64	6.23	4.64	3.65	2.24	1.57	33.1	44.5	525
118270	8831	3.53	2.39	1.85	1.42	1.20	0.79	0.57	32.9	44.8	1424
118520	8974	4.27	3.27	2.61	2.04	1.71	1.11	0.72	32.9	45.0	1194
118769	8942	3.97	3.08	2.41	1.75	1.40	0.87	0.61	32.7	45.6	1281
119019	8951	3.92	3.03	2.52	1.96	1.65	1.00	0.71	32.7	45.4	1297
119271	9036	4.16	3.32	2.66	1.98	1.57	0.94	0.63	33.2	45.8	1236
119520	8942	3.29	2.56	2.02	1.51	1.24	0.79	0.58	33.2	45.1	1544
119771	8958	4.27	3.08	2.38	1.65	1.26	0.71	0.50	33.1	44.5	1192
120020	9036	3.13	2.39	1.91	1.48	1.26	0.91	0.64	32.9	44.3	1642
120281	8974	5.47	4.13	3.21	2.43	1.98	1.34	1.07	32.9	44.9	934
120528	8924	3.64	2.67	2.14	1.65	1.38	0.97	0.74	33.2	45.2	1393
120769	8885	7.31	5.78	4.62	3.47	2.77	1.74	1.23	32.9	43.5	691
121021	8896	5.07	3.49	2.54	1.73	1.34	0.91	0.69	32.9	43.6	998
122270	9002	2.78	1.81	1.41	1.15	1.07	0.83	0.72	33.5	43.9	1842
122523	9036	3.13	2.34	1.89	1.46	1.32	0.97	0.79	33.8	44.1	1642
122770	9013	2.97	2.39	1.91	1.54	1.32	0.97	0.79	33.8	41.8	1728
123013	9071	3.88	2.75	2.14	1.62	1.34	0.97	0.76	35.6	41.9	1330
123270	8946	3.43	2.39	1.83	1.43	1.24	0.91	0.74	34.9	42.6	1482
123529	8996	3.76	2.22	1.64	1.31	1.18	0.94	0.82	35.1	43.7	1360
123770	8946	3.04	2.03	1.69	1.31	1.15	0.87	0.74	34.9	45.0	1675
124020	8946	1.49	1.05	0.86	0.72	0.62	0.49	0.42	35.1	44.8	3403
124275	8907	3.25	1.98	1.60	1.28	1.12	0.91	0.83	34.6	44.5	1560
124522	8939	8.15	5.61	4.08	2.55	1.74	0.91	0.68	34.7	46.1	624
124775	8916	3.48	2.15	1.61	1.23	1.01	0.79	0.65	34.7	46.6	1457
125020	8973	5.77	4.20	3.08	2.10	1.74	1.08	0.82	34.4	45.0	884
125269	9079	7.64	5.66	4.21	2.76	2.10	1.25	0.93	34.7	44.7	676
125526	8978	4.16	2.75	2.11	1.65	1.38	0.99	0.83	35.5	45.4	1228
125770	8950	3.48	2.56	1.96	1.36	1.12	0.69	0.51	34.7	45.1	1462
126020	8939	3.95	2.75	1.91	1.28	0.99	0.59	0.43	35.1	44.4	1288
126270	9055	2.97	1.50	1.00	0.70	0.53	0.42	0.32	34.7	46.5	1736
126520	8985	3.95	2.39	1.64	1.11	0.84	0.51	0.39	35.3	45.4	1294
126771	9017	3.08	1.98	1.48	0.95	0.70	0.43	0.34	35.3	46.6	1663
127019	9043	2.17	1.46	1.10	0.86	0.73	0.49	0.32	35.6	46.6	2367
127270	9094	4.90	3.32	2.41	1.54	1.09	0.63	0.44	35.9	46.6	1054
127521	9001	2.97	1.91	1.33	0.86	0.68	0.45	0.36	35.3	46.6	1726
127769	9040	3.13	2.32	1.75	1.28	1.03	0.71	0.48	35.3	46.6	1642
128025	8923	2.78	1.98	1.41	1.05	0.89	0.59	0.49	35.3	46.1	1826
128270	9149	2.69	1.81	1.39	1.05	0.95	0.69	0.55	35.3	47.5	1937
128521	9071	3.88	2.67	1.91	1.32	1.03	0.65	0.49	35.6	47.2	1330
128771	8962	4.60	3.32	2.54	1.81	1.43	0.99	0.77	35.6	47.7	1108
129019	8978	2.80	1.81	1.35	1.03	0.89	0.59	0.46	35.9	46.3	1821
129271	8900	6.05	4.73	3.63	2.41	1.73	0.91	0.59	35.5	46.5	837
129520	8889	8.20	5.83	4.29	2.71	1.85	0.89	0.58	35.5	47.5	617
129769	8907	3.92	2.79	2.06	1.40	1.07	0.57	0.38	35.1	47.9	1291
130021	8985	3.25	2.32	1.83	1.34	1.05	0.59	0.38	35.1	47.4	1574
130274	9039	2.38	1.62	1.25	0.92	0.70	0.51	0.43	35.1	47.3	2158
130521	9045	2.57	1.70	1.33	1.03	0.89	0.65	0.49	35.1	47.9	2002
130771	9045	2.50	1.74	1.33	0.92	0.76	0.49	0.38	34.7	48.5	2058
131027	8962	2.50	1.62	1.19	0.97	0.84	0.57	0.46	35.3	47.8	2039
131270	9040	2.50	1.46	1.04	0.80	0.68	0.45	0.34	35.5	47.8	2057
131522	8967	2.73	1.58	1.19	1.00	0.84	0.57	0.46	35.5	48.9	1866
131770	8810	5.02	3.56	2.74	1.90	1.49	0.94	0.69	35.9	49.5	998
132019	8946	2.73	1.62	1.25	0.95	0.79	0.57	0.44	36.2	48.2	1862

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
132273	8907	3.64	2.15	1.44	1.03	0.78	0.57	0.46	35.6	48.9	1390
132520	8962	2.73	1.74	1.33	0.97	0.81	0.57	0.45	35.6	48.5	1865
132769	8924	2.97	2.03	1.58	1.17	1.01	0.69	0.55	35.5	46.1	1711
133019	9040	3.57	2.32	1.75	1.28	1.07	0.75	0.60	35.3	47.1	1438
133271	9060	3.97	2.84	2.24	1.71	1.46	0.94	0.58	35.1	46.3	1298
133519	9040	3.48	2.10	1.52	1.15	0.93	0.69	0.51	34.4	46.1	1477
133818	8930	3.97	2.56	1.94	1.36	1.03	0.59	0.39	34.0	44.8	1279
134022	8969	5.86	4.42	3.35	2.35	1.96	1.40	1.11	34.4	45.1	870
134281	8978	1.75	0.81	0.75	0.58	0.39	0.36	0.19	34.4	45.4	2914
134934	9024	1.70	1.34	1.00	0.72	0.62	0.45	0.35	34.6	44.7	3010
135271	9024	1.94	1.34	0.97	0.76	0.70	0.51	0.42	34.6	44.3	2647
135520	9008	5.23	3.32	2.17	1.42	1.12	0.69	0.53	34.7	44.0	979
135769	9008	3.20	2.44	1.92	1.54	1.32	0.97	0.78	35.1	43.8	1601
136024	9024	2.78	1.98	1.52	1.18	1.01	0.71	0.57	35.5	46.8	1846
136271	8981	3.88	2.27	1.69	1.36	1.23	0.91	0.75	35.6	46.8	1317
136533	8967	3.25	1.53	1.22	1.28	0.58	0.57	0.26	35.3	46.8	1571
136801	9060	3.06	1.74	1.33	1.17	1.09	0.97	0.86	35.3	46.8	1684
137041	9024	3.01	1.74	1.27	1.57	0.99	0.69	0.57	35.6	47.4	1703
137269	8959	9.25	7.04	5.68	4.39	3.55	2.31	1.71	35.9	46.7	551
137540	8974	7.87	6.26	5.16	4.14	3.44	2.43	1.90	36.0	47.7	648
137837	9039	2.06	1.29	0.92	0.68	0.53	0.37	0.22	36.5	47.1	2501
138022	8930	2.62	1.50	1.08	0.86	0.73	0.51	0.39	36.9	47.1	1941
138285	8985	1.99	1.10	0.81	0.70	0.62	0.45	0.32	36.5	46.8	2574
138529	8930	2.34	1.17	0.89	0.76	0.64	0.45	0.35	36.4	46.8	2174
138770	8920	1.99	1.10	0.81	0.70	0.62	0.45	0.32	36.5	46.8	2574
140346	8959	3.01	1.58	1.02	0.76	0.58	0.20	0.15	35.9	45.8	1691
140543	8935	3.18	1.10	0.64	0.53	0.25	0.31	0.24	35.6	45.3	1600
140773	9001	2.73	1.74	1.29	0.92	0.73	0.45	0.32	36.2	45.6	1873
141023	8974	2.97	1.34	0.83	0.64	0.53	0.31	0.24	34.7	44.7	1720
141272	9008	2.50	1.29	0.81	0.55	0.45	0.28	0.22	34.9	44.4	2050
141525	8896	3.25	1.98	1.19	0.67	0.45	0.22	0.11	35.1	41.8	1558
141776	9036	1.87	1.17	0.75	0.47	0.37	0.23	0.15	35.3	42.3	2750
142025	8868	2.85	1.62	0.94	0.55	0.45	0.26	0.20	35.3	42.1	1770
142278	8912	2.97	2.03	1.25	0.70	0.48	0.26	0.15	35.3	42.9	1708
142523	8907	1.94	1.29	0.85	0.61	0.50	0.28	0.21	35.5	42.4	2613
142773	9029	2.55	1.74	1.08	0.70	0.54	0.31	0.21	34.9	42.8	2017
143024	8947	3.25	1.58	0.85	0.53	0.48	0.34	0.25	34.9	41.6	1567
143271	8951	2.78	1.86	1.25	0.84	0.70	0.51	0.40	35.3	41.8	1631
143565	8951	5.82	3.73	2.74	1.96	1.59	1.08	0.82	35.3	44.1	875
143774	8946	3.88	1.91	1.33	1.11	1.01	0.77	0.57	34.9	44.1	1312
144026	8990	2.62	1.34	0.97	0.76	0.64	0.49	0.42	35.3	43.2	1954
144279	9013	3.36	1.91	1.39	1.05	0.89	0.65	0.50	35.3	44.2	1524
144596	9006	7.24	4.49	2.69	1.42	0.99	0.56	0.36	34.9	43.5	707
144798	9006	3.69	1.86	1.22	0.84	0.68	0.43	0.30	35.0	43.3	1388
145023	8990	2.50	1.46	1.04	0.76	0.62	0.37	0.27	35.3	42.8	2046
145059	8962	5.18	2.63	1.58	0.89	0.73	0.51	0.38	34.7	42.1	983
145269	9001	6.21	3.61	2.41	1.48	1.09	0.65	0.48	34.6	42.3	824
145519	8967	2.90	1.50	0.94	0.58	0.45	0.26	0.16	34.4	42.3	1761
145769	8915	3.64	1.98	1.25	0.72	0.48	0.26	0.13	34.4	42.1	1391
146019	9071	4.39	2.56	1.58	0.89	0.68	0.37	0.25	34.6	43.0	1175
146269	9029	2.66	1.62	1.08	0.67	0.48	0.28	0.18	34.6	41.8	1928
146537	9024	2.73	1.77	1.25	0.78	0.56	0.28	0.20	35.5	41.2	1878
146770	8912	7.36	6.23	5.27	4.25	3.65	2.59	1.89	34.7	42.8	689
147024	9103	4.83	2.51	1.58	0.92	0.64	0.40	0.31	34.7	42.8	1071
147269	9063	3.29	1.81	1.25	1.03	0.70	0.40	0.26	35.1	42.1	1565
147520	9047	3.88	2.10	1.35	0.97	0.64	0.40	0.31	34.9	42.4	1327

KARACHI-HYDERABAD N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
147770	9029	3.88	2.15	1.41	0.92	0.70	0.40	0.30	35.1	41.6	1324
148019	9099	3.20	2.03	1.33	0.84	0.61	0.31	0.29	34.9	41.1	1617
148269	9013	4.55	3.15	2.27	1.42	0.95	0.45	0.27	35.1	40.5	1125
148520	8974	2.57	1.46	0.97	0.58	0.39	0.23	0.17	35.1	40.6	1986
148769	9024	3.25	2.15	1.50	0.97	0.73	0.43	0.31	35.3	40.8	1581
149020	8946	3.69	2.46	1.66	0.86	0.50	0.20	0.11	35.5	40.2	1379
149270	8951	5.35	3.51	2.33	1.31	0.87	0.37	0.27	35.3	39.8	952
COUNT	511	511	511	511	511	511	511	511	511	511	511
MINIMUM	8721	1.49	0.81	0.64	0.42	0.25	0.12	0.07	20.50	18.00	
MAXIMU	9193	23.78	20.42	16.50	9.71	7.47	3.81	2.33	36.90	49.50	
RANGE	472	22	20	16	9	7	4	2	16	32	
AVERAG	9008	4.18	3.13	2.38	1.68	1.30	0.77	0.56	29.92	35.39	
VARIANC	7196	7.17	4.87	3.03	1.46	0.83	0.26	0.13	16.27	74.17	
ST.DEVIA	85	2.68	2.21	1.74	1.21	0.91	0.51	0.36	4.03	8.61	
COV	1	64	71	73	72	70	66	64	13	24	

N-5 RAWALPINDI HASSANABADAL NORTH										
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave
m	lbf	mils	mils	mils	mils	mils	mils	mils	øF	øF
155100	8849	7.64	6.19	5.19	4.12	3.3	2.25	1.58	74.8	65.9
155620	8818	6.66	5.13	4.33	3.38	2.76	1.85	1.37	74.5	87.2
156100	8872	3.43	3.03	2.71	2.33	1.99	1.45	1.1	74.6	73.1
156600	8784	4.32	3.73	3.29	2.69	2.27	1.5	1.13	74	82.2
157100	8888	3.95	3.49	3.1	2.52	2.36	1.82	1.54	73.6	81.7
157600	8939	3.83	2.99	2.49	2.05	1.65	1.19	0.86	73.8	74.5
158101	8814	7.19	5.61	4.77	3.69	2.91	1.94	1.57	72.9	86.6
158602	8798	6	5.09	4.41	3.51	2.83	1.8	1.27	73.2	72.2
159101	8798	4.27	3.63	3.13	2.58	2.1	1.36	0.97	73.6	85.8
159601	8759	3.43	2.79	2.41	2.08	1.8	1.34	1.09	73.8	66.5
160103	8779	3.83	2.79	2.21	1.51	1.07	0.54	0.36	73.6	76.7
160600	8853	5.37	3.92	3.08	2.16	1.6	0.91	0.63	72.5	89.4
160940	8670	11.4	7.52	5.52	3.59	2.56	1.56	1.14	73.8	84.5
161602	8654	15.27	11.03	8.2	5.44	3.61	1.45	0.63	74.2	86.6
162101	8686	7.08	4.61	3.18	1.74	0.93	0.23	0.03	73.6	83.8
162600	8736	7.29	5.61	3.96	2.13	1.41	0.91	0.74	73.2	64.1
163106	8609	17.17	11.37	7.76	5.01	3.57	2.05	1.51	73.2	82.1
163601	8702	9.81	7.76	5.27	3.28	1.96	0.8	0.53	73.2	83.8
166103	8764	3.64	3.1	2.71	2.27	1.85	1.28	0.88	74.6	73.6
166600	8779	3.32	2.63	2.21	1.71	1.38	0.94	0.72	73.8	85.4
167100	8764	4.39	3.92	3.38	2.72	2.27	1.48	1.05	74.8	79.6
167600	8721	3.32	2.63	2.21	1.71	1.38	0.94	0.72	73.8	85.4
168100	8748	4.46	3.56	3	2.33	1.88	1.34	1.04	75.2	84.5
168612	8581	11.56	8.93	7.02	4.85	3.5	2.19	1.72	75.2	84.4
169100	8675	15.06	10.2	7.01	3.78	2.05	0.51	0.2	76.2	74.8
169191	8499	20.3	14.93	11.7	7.84	5.41	2.82	1.86	75.8	83.5
169648	8577	16.02	12.54	9.89	6.99	5.03	2.9	1.94	71.8	77.5
170105	8714	5.42	3.84	2.75	1.65	1.15	0.8	0.65	72.2	70.2
170602	8294	29.19	21.8	16.39	9.94	6.44	3.62	2.41	72.2	71.4
171103	8709	6.91	5.18	3.77	2.35	1.67	1.14	0.94	71.8	71.5
171532	8444	22.19	16.5	11.29	6.04	3.42	1.57	1.13	72.9	69.1
172107	8538	15.32	11.13	8.26	5.32	3.51	1.74	1.11	72.2	67
COUNT	32	32	32	32	32	32	32	32	32	32
MINIMUM	8294	3.32	2.63	2.21	1.51	0.93	0.23	0.03	71.8	64.1
MAXIMUM	8939	29.19	21.8	16.39	9.94	6.44	3.62	2.41	76.2	89.4
RANGE	645	25.87	19.17	14.18	8.43	5.51	3.39	2.38	4.4	25.3
AVERAGE	8713	9.03	6.79	5.21	3.54	2.55	1.51	1.08	73.71	78.27
VARIANCE	18786	42.94	22.10	11.38	4.00	1.65	0.53	0.27	1.22	55.63
ST.DEVEATIO	137	6.55	4.70	3.37	2.00	1.28	0.72	0.52	1.11	7.46
COV	1.57	72.55	69.27	64.79	56.47	50.35	48.09	48.19	1.50	9.53

Gujranwala By-pass N-5 (North)

GUJRANWALA BY-PASS N-5 (NORTH)											
Distance	Load	D0	D1	D2	D3	D4	D5	D6	Air	Pave	Modulus
m	lbf	mils	mils	mils	mils	mils	mils	mils	øC	øC	Mpa
2230	8848	12.26	10.65	9.27	7.53	6.16	4.21	2.93	14.30	11.00	410
2730	8829	12.94	10.89	9.02	6.95	5.28	3.25	2.17	13.80	10.90	388
3231	8934	8.08	6.52	5.18	3.83	2.99	1.96	1.47	14.00	11.30	629
3731	8973	6.61	5.61	4.58	3.61	2.85	1.82	1.23	14.70	11.30	772
4236	8934	11.84	9.91	8.15	6.19	4.7	2.76	1.85	14.20	10.80	429
4730	8918	8.31	7.07	5.88	4.66	3.78	2.48	1.76	14.00	10.90	610
5235	8852	13.9	11.15	9.04	6.78	5.12	3.08	1.93	14.30	11.50	362
5733	8840	11.82	9.5	7.62	5.73	4.4	2.59	1.75	14.00	10.90	425
6232	8701	19.66	15.9	13.14	9.8	7.31	4.33	2.76	14.30	11.20	252
6729	8778	16.37	13.59	11.25	8.59	6.67	3.93	2.59	14.70	11.50	305
7234	8913	9.46	8.45	7.4	6.17	5.09	3.39	2.27	15.10	11.50	536
7730	8752	17.21	14.07	11.54	8.68	6.58	3.95	2.51	14.90	11.60	289
8230	8923	8.9	7.12	5.71	4.31	3.31	2.19	1.58	15.20	11.60	570
8732	8747	17.28	14.33	11.89	9.15	7.05	4.25	2.74	14.90	11.30	288
9232	8950	8.94	7.36	6.13	4.7	3.71	2.45	1.82	14.70	11.20	569
9732	8891	10.16	8.5	7.1	5.22	4.25	2.66	1.92	14.50	10.90	498
10232	8869	12.21	10.63	8.85	6.83	5.28	3.22	2.07	14.30	11.30	413
10733	8791	14.32	11.49	9.46	7.09	5.35	3.31	2.21	14.20	11.00	349
11235	8830	14.08	11.18	9.15	6.8	5.01	2.86	1.89	14.30	11.20	357
11732	8790	14.88	11.89	9.62	7.17	5.34	2.96	1.92	14.20	11.20	336
12230	8869	10.3	8.86	7.54	6.08	4.87	3.2	2.18	14.20	11.00	490
12729	8915	11.23	8.79	7.13	5.29	4.04	2.57	1.77	14.00	11.00	451
13231	8875	14.2	11.2	8.85	6.47	4.84	2.94	2.04	14.20	11.20	355
13730	9001	5.63	4.68	3.77	2.91	2.33	1.68	1.3	14.00	10.70	909
14230	8869	14.76	11.85	9.6	7.17	5.51	3.25	2.22	13.80	11.00	342
14735	8745	18.8	15.45	12.66	9.72	7.08	4.39	3.05	13.80	10.60	264
15083	8895	7.96	6.59	5.44	4.15	3.3	2.13	1.61	14.00	11.30	635
COUNT	27	27	27	27	27	27	27	27	27	27	27
MINIMUM	8701	5.63	4.68	3.77	2.91	2.33	1.68	1.23	13.80	10.60	252
MAXIMU	9001	19.66	15.9	13.14	9.8	7.31	4.39	3.05	15.2	11.6	909
RANGE	300	14.03	11.22	9.37	6.89	4.98	2.71	1.82	1.4	1	657
AVERAG	8860	12.30	10.12	8.33	6.35	4.90	3.03	2.06	14.32	11.14	453.07
VARIANC	5743	13.81	8.85	6.03	3.42	1.83	0.60	0.22	0.15	0.07	25422.53
ST.DEVIA	76	3.72	2.98	2.46	1.85	1.35	0.78	0.47	0.39	0.27	159.44
COV	1	30	29	29	29	28	26	23	3	2	35