IRC: 76-1979

TENTATIVE GUIDELINES FOR STRUCTURAL STRENGTH EVALUATION OF RIGID AIRFIELD PAVEMENTS

THE INDIAN ROADS CONGRESS

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Published by

THE INDIAN ROADS CONGRESS
Jamnagar House, Shahjahan Road,
New Delhi—110011

Price Rs.80/-
(F (Plus Packing & Postage)

IRC : 76-1979

First Published: April 1980

Printed at PRINTAID, New Delhi

TENTATIVE GUIDELINES FOR STRUCTURAL STRENGTH EVALUATION OF RIGID AIRFIELD PAVEMENTS

1. INTRODUCTION

1.1. Pavement evaluation, in its most common connotation, implies the assessment of residual or available structural strength of the pavement. Evaluation is normally required either in connection with checking the adequacy of the existing pavements for increased design loads, or working out suitable overlay designs to restore or enhance their structural capacity. Evaluation is also needed to check the quality of a new construction.

1.2. As regards structural evaluation of rigid pavements while both direct load test and indirect reverse design methods are in use in the country, no guidelines about the criteria and methods of evaluation have so far been laid down. It is with a view to providing a standard basis for evaluation of the rigid airfield pavements, both in respect of test procedures and the evaluation criteria, that these guidelines have been prepared. Suggestions are also included for simplifying the test procedures where it is felt that this could be done without sacrifice of accuracy.

These guidelines were approved by the Cement Concrete Road Surfacing Committee (personnel given below) in their meeting held at Hyderabad on the 5th January, 1976.

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These were then processed by the Specifications and Standards Committee in their meeting held at New Delhi on the 16th May, 1977 subject to certain modifications which on the authorisation of the Committee were carried out by Dr. R.K. Ghosh, R.P. Sikka, B.R. Govind and Lt. Col. Avtar Singh, assisted by Y.R. Phull, M. Dinakaran and K. Arunachalam. These were later approved by the Executive Committee through circulation and the Council in their meeting held on the 28th October, 1979.

2. SCOPE

2.1. The standard describes the procedure for structural evaluation of rigid airfield pavements by two alternative methods, namely the "direct load test method" and the "indirect reverse design method" which are commonly adopted in the country.

2.2. The "direct load test method" provides actual load carrying capacity of the pavement taking into account the interaction between various pavement layers, extent of load transfer at joints etc., as actually obtained at site. The "reverse design method" on the other hand, involves indirect computation of the pavement strength based on evaluation of the individual design parameters. Since the interaction between different parts of the in-service pavement cannot be taken into account in the case of indirect method, and as the inherent approximations in the method also affect the evaluated strength value, from the point of accuracy of evaluation the direct load test method has a definite edge over the indirect method and is as such to be preferred.

2.3. The actual choice of the method in individual cases will, however, be dictated by other considerations as well, for instance the availability of suitable load testing reaction frame, testing facilities, time available for the study, the period for which airfield can be closed to traffic etc. For important works, every effort should be made to arrange direct load tests. However, when facilities for this are not available, a reasonably approximate assessment of the pavement structural strength can be had from the indirect method. Even if the reverse design method has to be adopted, it would be worthwhile conducting a few direct load tests for comparison. These tests could be done at locations where indirect tests are proposed to be carried out, so that the results could be tied together to assess actual interaction of the pavement components obtaining at site.

2.4. Both in the case of direct and indirect methods, after field data have been collected. the structural capacity of airfield pavements can be noted either in terms of LCN (Load Classification

Number) or LCG (Load Classification Group) method. While the former is based on corner loading, the latter is for internal loading conditions. Joints in airfield pavements in the country are in most cases not provided with dowel bars. For these situations, the corner loading condition is more appropriate. As such the LCN rating system is considered more suitable for conditions existing in the country, and the procedures described in the guidelines are based on that system.

2.5. The procedures recommended are intended for rigid airfield pavements in sound structural condition. If the pavement has any localised defective spots, such locations should not be selected for overall structural evaluation, as this might result in gross under rating of the pavement. Such defective spots should be grouped together and separately investigated to evaluate the reasons for the defects, as remedy for these may be in measures like mud jacking, improvement of drainage, removal and replacement etc., and not in superimposition of a thick overlay which may provide only temporary relief.

3. DIRECT LOAD TEST METHOD

3.1. General

The direct load test method essentially involves the application of static loads through a rigid plate on the existing pavement and noting the response in the form of deflections/strains. Based on the data collected, the structural capacity of the pavement is rated in terms of LCN through the use of appropriate charts. This method has the advantage that it gives the actual load carrying capacity of the pavement at the time of test, taking the different interactions into account. Since the results obtained by this method are dependent on test conditions, such as the time of testing, location of test points etc, it is necessary to follow a common procedure to determine the critical load carrying capacity of the pavement. Guidelines with regard to these conditions are given below:

(1) **Period of testing:** The period of testing should be such that it is critical for foundation strength (i.e. when the foundation saturation is at maximum or near-maximum) as well as for load transfer especially in the case of dummy joints (i.e. when the mean pavement temperature is minimum during the year). Early winter, following the rainy season, can be a good working compromise from these considerations. If it becomes necessary from other considerations to conduct the tests at any other period, appropriate adjustments, based on actual tests or engineering judgement, should be

applied in respect of foundation strength and degree of load transfer.

(2) **Locations of test:** In the case of undowelled pavements, 50 per cent tests should be carried out at the junction of transverse expansion joint and longitudinal construction joint, and the remaining at free slab corner at the junction of transverse and longitudinal expansion joint. For pavements having dowelled transverse expansion joints, however, the junction of longitudinal expansion or construction joint and the transverse dummy joint may be chosen as the test locations.

(3) **Number of test locations and selection of test sites:** For airfield evaluation one test is recommended for every 60 m length in case of runways and 60-90 m length in case of taxi tracks and aprons. In general, a total of 15-20 determinations may be required for proper statistical evaluation of the test data. These recommendations may be treated as general broad guidelines only, and depending on the site conditions the test locations and frequency may be left to the discretion of the Engineer-in-Charge.

(4) **Time of testing:** Since tests are conducted on slab corners which are the most vulnerable portions of the slab, as far as possible the tests should be done at the most critical time of the day when the load carrying capacity of the corners will be the minimum from considerations of pavement warping, viz. early hours in the morning.

3.2. Test Procedure

3.2.1, **General:** The test is performed on selected pavement corner by loading it through 45 cm diameter plate and measuring deflections at the top of the loaded slab corner and the three adjoining slab corners. The loading frame for use in the tests should be of a capacity 50 per cent higher than the equivalent single wheel load corresponding to the original design LCN value of the pavement.

A thin layer of fine sand or plaster of paris may be used below the test plate, where required, to ensure full contact with the pavement. Also a seating load of 3000 kg may be applied initially for about 10 seconds and released before commencement of the test proper.

Basically two procedures (I and II) are available for the test within the scope of LCN method viz. load test well beyond cracking and load test upto imminent cracking. A third alternative, that is testing upto standardised value of working deflection to directly obtain the working load, is also suggested as a modified and simpler procedure (III) requiring much less test loads as compared to the first two alternatives. While any of the first two procedures may be adopted independently for the test, the third procedure based on working load deflection may be adopted in conjunction with either of the first two procedures. This procedure will be specially useful where either the testing is to be done expeditiously or where cracking of slabs due to testing is to be avoided.

3.2.2. **Procedure I. Load test beyond cracking:** In this procedure, in addition to the deflection gauges on slab corners, four additional deflection gauges are located along the bisector of the loaded corner angle as shown in Fig. 1. Load is applied in equal increments of 3000 kg and deflection readings taken after each load increment. After occurrence of cracks, the gauges on the main slab beyond the corner crack will register a lower or no increase in deflection with increase in load, while in case of other gauges including gauge 1 (Fig. 1) there will be a sudden increase. As soon as

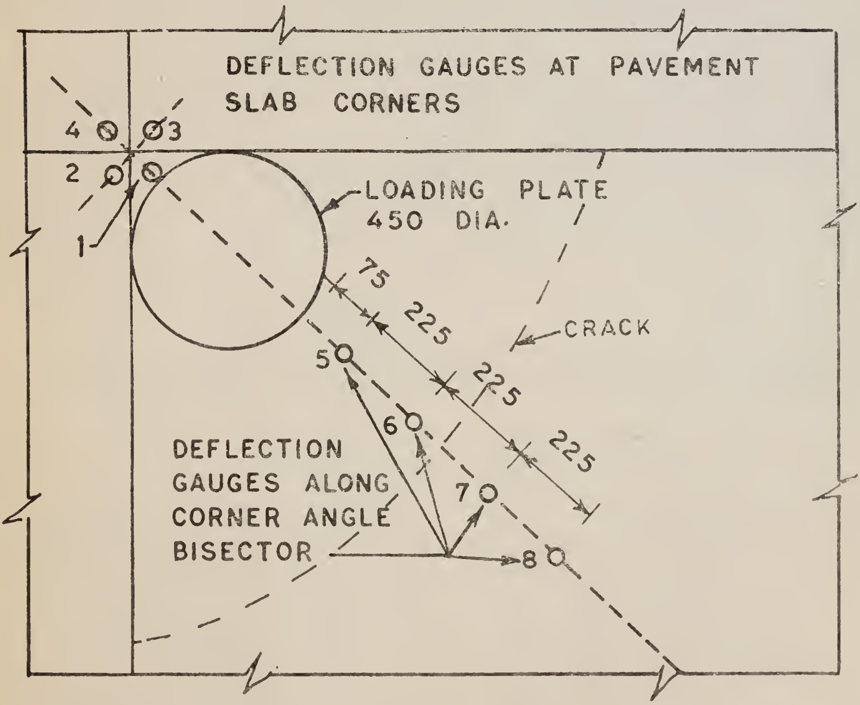


Fig. 1 Arrangement of deflection gauges for corner load test in airfields

this change in deflections is noticed, the test is stopped, and the load corresponding to the point of change taken as the failure load. As per the standard LCN procedure, safe working load is obtained by applying a factor of safety of 1.5 for non-channelised traffic areas and 1.8 for channelised traffic areas.

3.2.3. **Procedure II. Load test upto imminent cracking:** In this procedure, instead of deflection gauges four mechanical strain gauges (Fig. 2) are used along the bisector of the loaded corner to

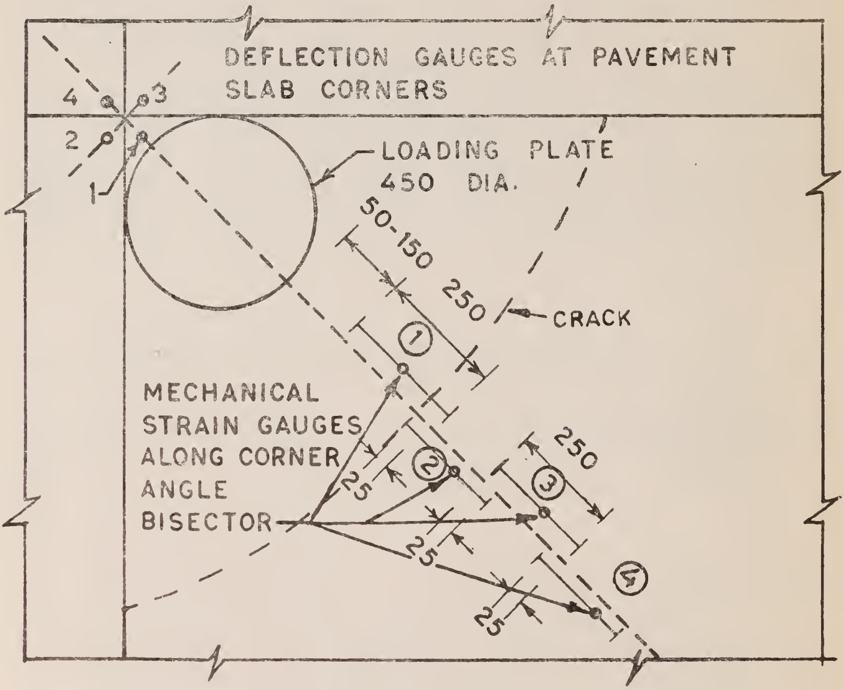


Fig. 2 Arrangement of strain gauges for detection of crack incidence for corner load test in airfields

detect the imminence of cracking, so that the test load may be taken as close as possible to the point of failure without actually causing a crack. As soon as the reading on any one strain gauge starts increasing rapidly relative to the adjacent gauges, the corresponding load is taken as the failure load and the safe working load obtained by applying a factor of safety of 1.5/1.8 as in procedure I.

In case of both the above procedures I and II, if the pavement does not show any sign of cracking upto the full capacity of the loading frame, the safe working load can be calculated from the maximum applied load.

3.2.4. **Procedure III. Load test upto a standard working deflection:** In this procedure, a working deflection value is determined for each specific case by conducting failure load tests at 3-4 locations only and noting the failure deflection. The working deflection is obtained by applying a factor of safety of 1.5/1.8 to the average of the observed failure deflections.

This procedure is based on the fact that the load deflection curves for such pavement tests are practically linear within the failure load limit, and hence it is possible to apply factor of safety of 1.5/1.8 to faiiure deflection instead of the failure load. The load corresponding to the safe working deflection is taken as the safe working load. Since the value of failure deflection for a pavement is affected by factors such as slab thickness, concrete strength, area of loading, subgrade stiffness, etc., it is not possible to stipulate a single value of failure deflection. Because of this, it is necessary that in every case atleast 3-4 tests must be carried out to determine the failure deflection as the basis for further evaluation.

This procedure not only ensures that the pavement does not get cracked, but also smaller loads and less time are needed for completion of the test. Only four deflection gauges at the four corner tips are required for the test and no additional deflection or strain gauges are needed. In this deflection-based procedure, observations should be taken at equal deflection increments of 0.15-0.25 mm to obtain atleast 5-6 readings within the recommended working deflection range.

Note : The possibility of an occasional erratic result cannot however be ruled out, due to factors such as subgrade pumping, poor local drainage unusually weak spots in foundation or the slab etc. In such cases, when the slab cracks during the test, the working load should be obtained as per procedure I by applying a factor of safety of 1.5/1.8 to the failure load.

3.2.5. Illustrative load deflection/strain curves for the three procedures are shown in Fig. 3.

3.3. Adjustment for Load Transfer

3.3.1. The load carrying capacity of a slab evaluated by the direct load test method includes a component due to load transfer at the joints. This component will always be available if the test is carried out at the minimum temperature the slab is likely to

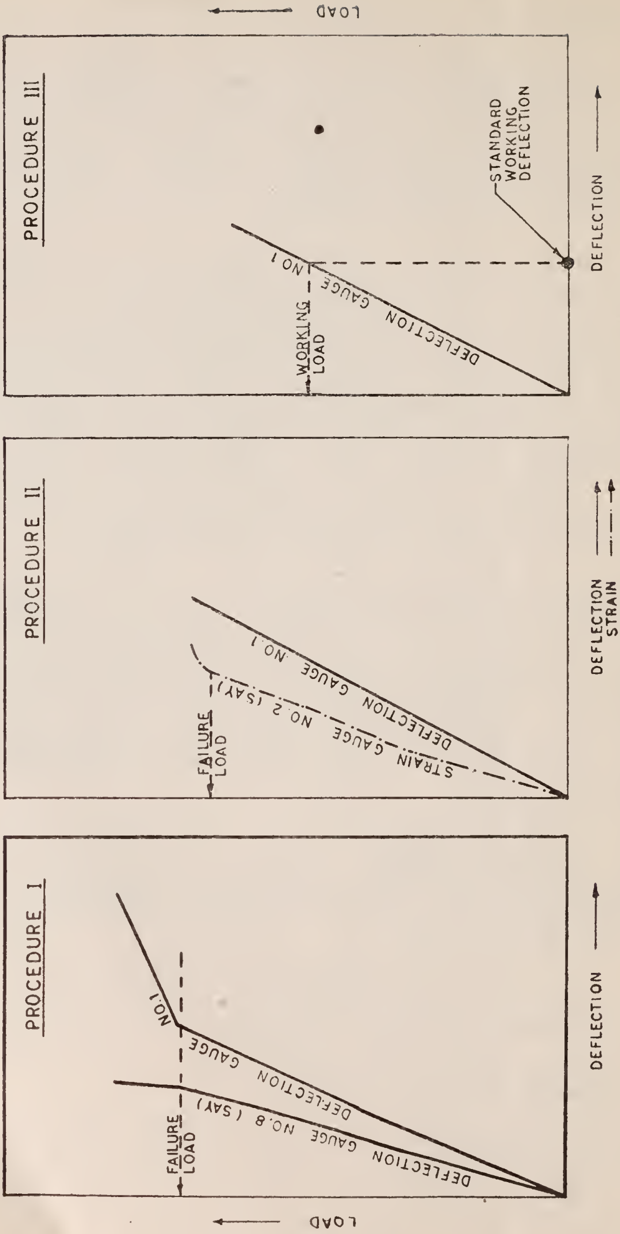


Fig. 3 Illustrative load-deflection/strain curves for the three alternative procedures for LCN tests

attain. As such if the load test is conducted when the slab is at its minimum temperature, no correction for load transfer need be applied. However, if the test is conducted when the slab temperature is higher than the minimum attainable in service, the evaluated load capacity should be reduced by a suitable correction factor to take care of the possible reduction in load transfer when the slab temperature falls down to the minimum value.

3.3.2. According to the current state of knowledge, adjustment for load transfer is an arbitrary process based on experience. It will be, therefore, desirable to conduct the load tests during the coldest part of the year as far as feasible so that the need for load transfer adjustment is obviated. Where this is not possible, the correction factor to be applied may be evaluated on the following lines. The load transfer actually available during the time of test is first determined. The load transfer which will always be available even when the slab is at its minimum temperature is then assessed. The correction factor is taken to be the difference between the two.

3.3.3. The load transfer actually available during time of the test can be evaluated by assuming that its magnitude is directly proportional to the measured deflection of the respective corners. If S1, S2, S3 and S4 are the recorded deflections of gauges 1,2,3 and 4 respectively (see Fig. 1 for position of the gauges), the load transfer will work out to:

$$\left(1 - \frac{S1}{S1+S2+S3+S4}\right) \times 100 \text{ per cent}$$

3.3.4. The minimum load transfer which will always be available is assumed as the average of the lowest quartile of the observed load transfers subject to a maximum value of 20 per cent (see foot note* for procedure). If the measured load transfer is x per cent and the minimum load transfer y per cent, the corrected load capacity will be [100-(x—y)] per cent of the measured load capacity.

3.3.5. The above applies to cases where the joints are not provided with load transfer devices. If the pavement contains load transfer devices like dowels or continuous reinforcement, the component of load transfer will be higher and most of it will be available

*Note : A frequency distribution table is prepared for the measured load transfers. The lower values below the first quartile (25 per cent frequency) are considered and their average value obtained subject to a maximum of 20 per cent.

even at the minimum temperature. Some reduction should however be anticipated, to account for which it is recommended that a reduction of 10 per cent in the measured load transfer of slab may be applied.

3.4. Determination of Safe LCN Rating

3.4.1. Knowing the safe working load and the contact area of the test plate, the LCN rating for pavement of any test location may be obtained from the standard LCN chart vide Fig. 4.

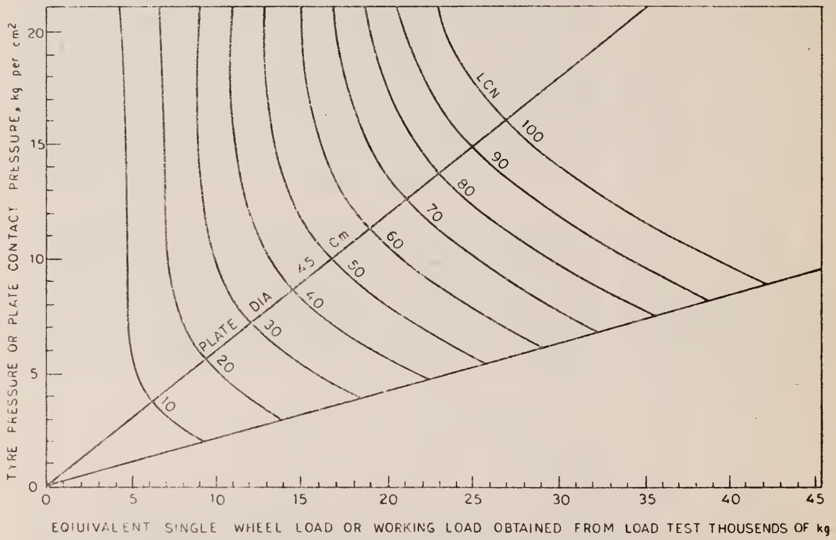


Fig. 4 LCN in terms of load, contact pressure/diameter of contact area for rigid pavements

3.4.2. For assessing the safe LCN rating of the pavement as a whole, the safe working load should be calculated statistically for a confidence level of 1 in 15, by subtracting 1.5 times the standard deviation from the average of the working loads calculated with respect to individual tests.

This value should then be examined in relation to individual LCN test values to see whether any test locations have exceptionally low values, so that the same may be considered separately for appropriate remedial measures.

3.4.3. An illustrative example of calculation of safe LCN for an airfield runway is given in *Appendix-1.*

4. INDIRECT REVERSE DESIGN METHOD

4.1. General

Where direct evaluation by load tests is not possible due to any reason, indirect evaluation may be done by reverse design method.

This method requires the same basic information for evaluating pavement structural strength, as is required in the case of design for a new pavement (with the obvious exception of design wheel load, and addition of actual pavement slab thickness), viz:

(i) Flexural strength of concrete in the pavement

(ii) Foundation strength in terms of k-value

(iii) Maximum temperature differential over pavement depth.

It is, however, necessary to determine the actual strength of concrete and pavement foundation by appropriate tests. Selection of test locations for this purpose should be on the same lines as suggested in para 3.1.

However, if effects of fatigue are also to be evaluated, a few additional test locations may be selected along the outer edges which are subject to much less traffic intensity.

4.2. Test Procedure

4.2.1. **Concrete strength**: Either beam or core samples may be recovered from the test locations for determination of concrete strength. While it is preferable to have beam samples for direct determination of flexural strength, core samples may have to be resorted to many a time from considerations of expediency, available equipment, time available for investigation, or the need to keep damage to the pavement from sample recovery to the minimum.

Concrete samples, whether beam or core, should be carefully examined for quality of compaction, and their dimensions accurately measured. Beam samples may be tested in flexure using third point loading, and concrete flexural strength determined there from. For cores, crushing strength results should be corrected for h/d ratio before determination of corresponding cube compressive strength. The crushing strength of cylinders with h/d ratio between 1 and 2 may be corrected to correspond to standard h/d ratio of 2 by multiplying with the correction factor obtained from the following equation:

$$f = 0.11\,n + 0.78$$

Where f = correction factor

$n = h/d$ ratio

The diameter "d" of cores recovered should not be less than 10 cm for concrete with maximum aggregate size of 10 mm and not less than 15 cm for concrete with maximum aggregate size of 40 mm.

Cube compressive strength may be taken as 1.25 times the corrected cylinder crushing strength. Conversion from cube compressive to flexural strength may be done using the chart given in Fig. 5.

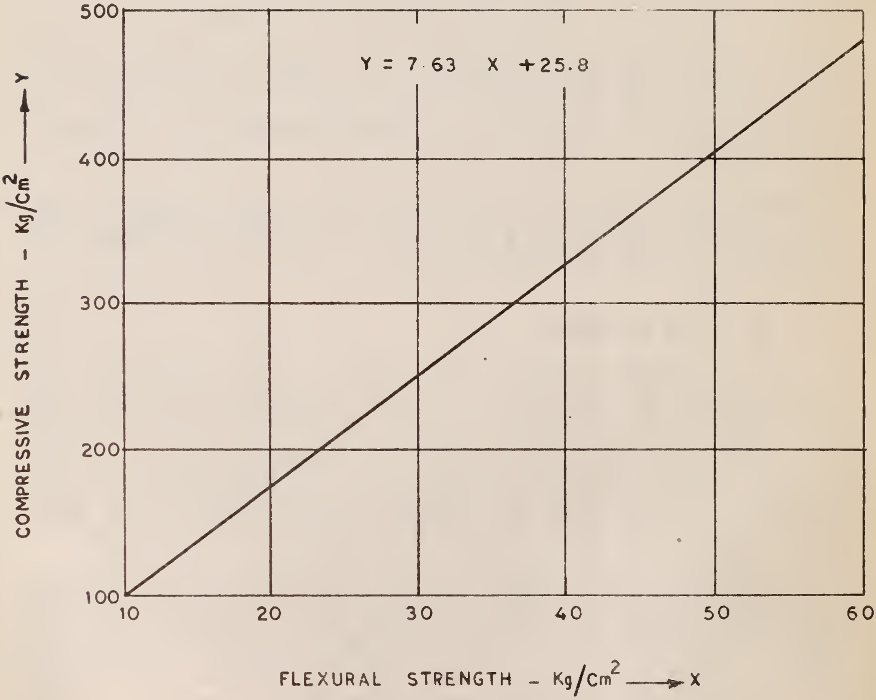


Fig 5 Statistical correlation between compressive and flexural strength of concrete

The strength tests should be done in accordance with the relevant I.S. specifications.

4.2.2. **Foundation strength:** Foundation strength in terms of its k-value is normally determined directly by conducting plate bearing tests on the foundation on which the slab rests (which could be earth subgrade, or a sub-base if provided) after removing sections of pavement slab. The test could be conducted on a 30 cm dia. Plate and converted subsequently to the standard k-value for 75 cm diameter plate by the approximate correlation:

$$k_{75} = 0.5\, k_{30}$$

where k_{75} and k_{30} are the k-values for 75 cm and 30 cm diameter plates respectively. It should, however, be noted that this correlation is based on homogenous foundation conditions, and in the case of layered construction i.e. when the test is conducted on a sub-base, the smaller plate will give a greater weightage to the stronger top layer. In such cases, direct conversion to 75 cm plate value by the above correlation somewhat over-estimates the foundation strength and should be regarded as very approximate only.

After conducting the test, the sub-base may be removed upto the subgrade level, noting its type and thickness, and a plate bearing test conducted to determine subgrade k-value, if considered necessary.

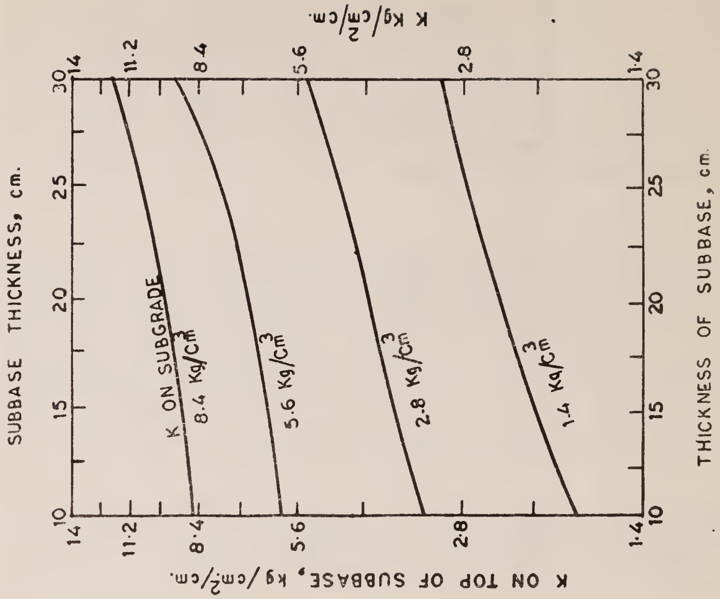
If direct determination of foundation k-value is not possible, an approximate indirect assessment can be made by conducting in-situ CBR test on the subgrade. From this, an approximate idea of the subgrade k-value may be obtained using the CBR k-value correlation given in Table 1.

If any sub-base is present over the subgrade, due allowance should be made for increase in the foundation k-value. For this purpose, the charts given in Fig. 6 may be made use of.

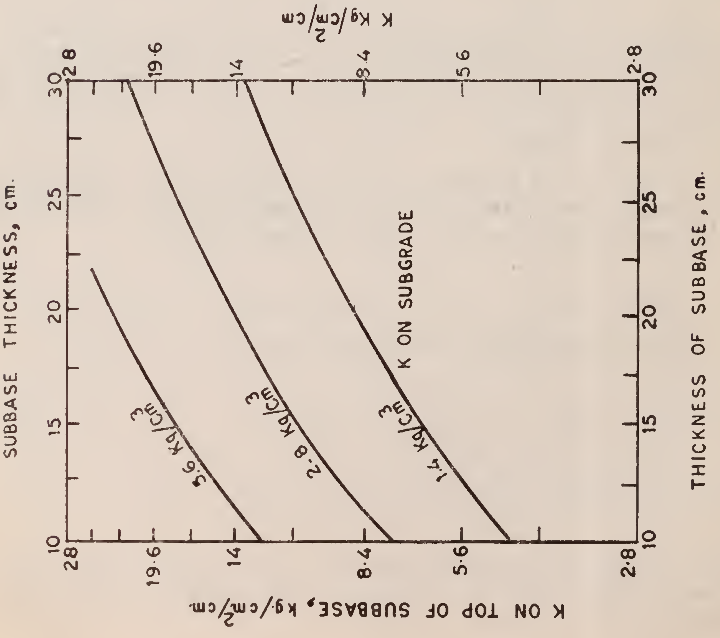
TABLE 1. APPROXIMATE K-VALUES CORRESPONDING TO CBR VALUES FOR HOMOGENOUS SOIL SUBGRADES

CBR value (%)	2	3	4	5	7	10	20	50	100
k-value (kg/cm^3)	2.08	2.77	3.46	4.16	4.86	5.54	6.92	13.85	22.16

4.2.3. **Supplementary soil tests:** Soil plasticity and grain-size analysis tests should also be carried out for determining the soil classification of the subgrade.



(a) NON TREATED SUBBASES



(b) CEMENT TREATED SUBBASES

Fig. 6 Allowance for increase in k-value due to provision of sub-base over subgrade

4.2.4. **Slab thickness:** Slab thickness may be determined by direct measurement of height on core or beam samples recovered from the pavement slab for concrete strength determination.

4.3. **Number of Test Locations and Selection of Test Sites**

Same considerations will apply in this case as for the Direct Load Test Method. Provisions of para 3.1 should therefore be followed in this respect.

4.4. **Analysis of Concrete/Foundation Strength Test Data**

The distribution of test data should be studied carefully both for concrete and foundation strength to see if the pavement section under investigation could be divided into zones of distinctly different concrete and foundation strengths, in which case "typical" strength values should be separately worked out for each zone. In case such sub-division is not possible, the strength data may be examined on an overall basis.

It is suggested that the "typical" strength values should be arrived at from actual test data for ensuring a confidence level of 1 in 15. This can be worked out by reducing the average of all the strength test values by 1.5 times their standard deviation. The dasign strength values may thereafter be obtained by applying a factor of safety of 1.1 to the typical values.

4.5. **Determination of Pavement Structural Strength**

4.5.1. **Pavement design procedure to be adopted:** The LCN method for airfield pavement design may be used. Knowing pavement thickness, concrete flexural strength and foundation *k*-value, the rated LCN for the pavement can be read directly from the chart, Fig. 7.

4.5.2. **Allowance for load transfer:** As in the case of evalution by direct load test (see para 3.3), it is necessary to assess the minimum load transfer that will be available at any location in the pavement. The critical locations from this consideration would be the same as those recommended in para 3.1.

Contribution to load capacity due to load transfer may be assessed by conducting actual load tests, noting deflections of adjacent slabs upto anticipated design equivalent single wheel load for the pavement. Only a limited number of tests on typical joints would be adequate. (Similar tests can also be conducted to assess the load transfer capacity of typical cracks in the pavement). The

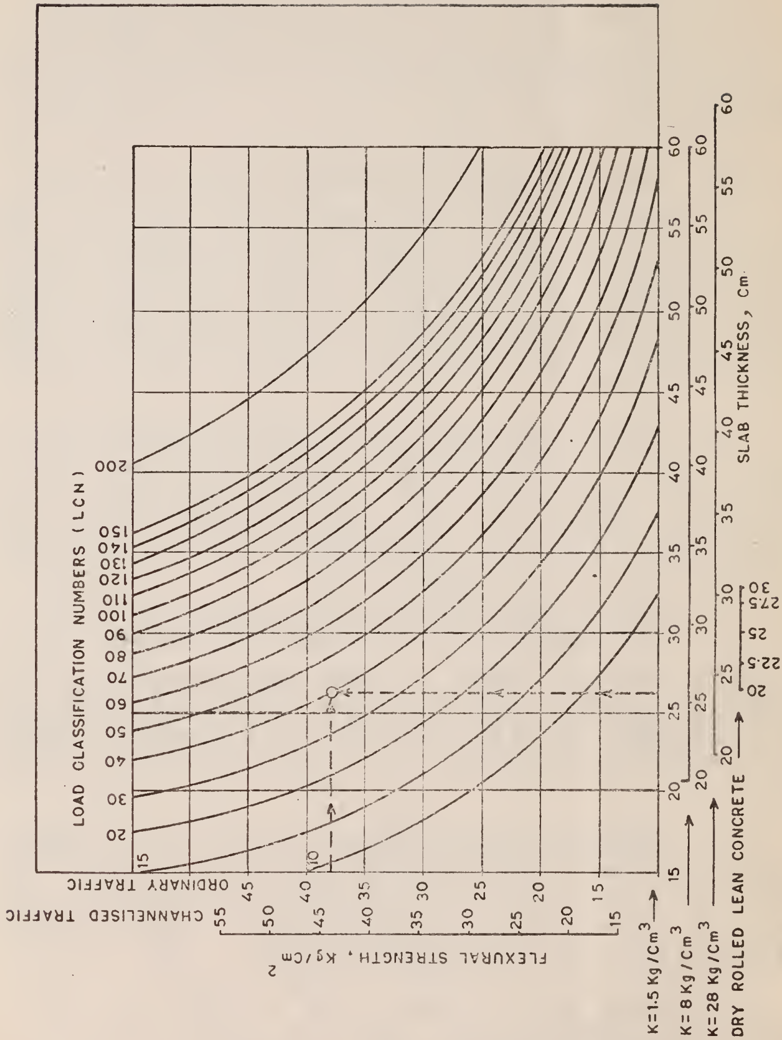


Fig. 7 LCN design chart for rigid pavements

test will however, have to be conducted in the coldest part of the year when load transfer is at its critical minimum; otherwise a correction factor will have to be applied as explained in para 3.3.

The total assessed load carrying capacity of the pavement at any location shall be obtained by combining the individual slab load carrying capacity, as calculated in para 4.5.1., with the load transfer capacity at joints.

4.5.3. An example illustrating the structural strength evaluation of an airfield pavement by reverse design method is given in *Appendix-2*.

Appendix 1

ILLUSTRATIVE EXAMPLE FOR CALCULATION OF SAFE LCN FOR AN AIRFIELD RUNWAY FROM FAILURE TEST LOADS AND MEASURED LOAD TRANSFER VALUES

Location	Failure load, max. applied load (tonnes)	Safe loads Col. (2)/1.5 (tonnes)	Measured load transfer (per cent)	Adjusted load transfer (per cent)	Deductable load transfer (per cent) Col. 4-Col. 5	Corrected safe load, x (tonnes) Col. (3) $\left[1-\frac{\text{Col. (6)}}{100}\right]$	LCN (from Fig. 4)	$x-\bar{x}$	$(x-\bar{x})^2$	Calculations for LCN
1	2	3	4	5	6	7	8	9	10	11
1.	34.5	23.0	0	0	0	23.0	80	2.6	6.76	
2.	34.5	23.0	24.32	10	14.32	19.7	65	0.7	0.49	Standard deviation for the set
3.	34.5	23.0	16.66	10	6.66	21.4	70	1.0	1.00	of safe loads given in Col. (7):
4.	34.5	23.0	18 03	10	8.03	21.1	70	0.7	0.49	
5.	24.6	16.4	0	0	0	15.7	50*	4.0	16.00	
6.	29.6	19.7	0	0	0	19.7	65	0.7	0.49	$\sigma=\sqrt{\frac{(x-\bar{x})^2}{n-1}}$
7.	34.5	23.0	25.66	10	15.66	19.4	65	1.0	1.00	
8.	34.5	23.0	8.45	8.45	0	23.0	80	2.6	6.76	
9.	29.6	19.7	0	0	0	19.7	65	0.7	0.49	
10.	27.1	18.0	22.65	10	12.65	15.7	46*	4.7	22.09	$=\sqrt{\frac{95.23}{29}}=1.81$
11.	34.5	23.0	25.45	10	15.45	19.5	65	0.9	0.81	
12.	32.0	21.3	0	0	0	21.3	70	0.9	0.81	L.C.L. (lower control limit)
13.	29.6	19.7	0	0	0	19.7	65	0.7	0.49	of overall corrected safe load
14.	34.5	23.0	22.05	10	12.05	20.2	67	0.2	0.04	for pavement for a tolerance
15.	27.3	18.2	0	0	0	18.2	56	2.2	4.85	level of 1 in 15
16.	29.6	19.7	0	0	0	19.7	65	0.7	0.49	
17.	29.6	19.7	0	0	0	19.7	65	0.7	0.49	$=\bar{x}-1.5\sigma$
18.	34.5	23.0	20.80	10	10.80	20.5	67	0.1	0.01	
19.	34.5	23.0	22 60	10	12.60	20.1	67	0.3	0.09	$=20.4-1.5\times1.81$
20.	32.0	21.3	1.80	1.8	0	21.3	70	0.9	0.81	
21.	32.0	21.3	14 63	10	4.63	20.3	60	0.1	0.01	= 17.7 tonnes.
22.	32.0	21.3	0	0	0	21.3	70	0.9	0.81	
23.	34.5	23.0	10 1	10	0.1	23.0	80	2.6	6.76	The corresponding overall
24.	29.6	19.7	10.1	10	0.1	19.7	65	0.7	0.49	safe LCN for the pavement
25.	32.0	21.3	8.9	8.9	0	21.3	70	0.9	0.81	(from Fig. 4)
26.	34.5	23.0	2.7	2.7	0	23.0	80	2.6	6.76	
27.	34.5	23.0	8.7	8.7	0	23.0	80	2.6	6.76	= 54*
28.	32.0	21.3	0	0	0	21.3	70	0.9	0.81	
29.	27.1	18.0	0	0	0	18.0	55	2.4	5.76	
30.	32.0	21.3	0	0	0	21.3	70	0.9	0.81	
						$\Sigma x=611.5$ Average $\bar{x}=20.4$			$\Sigma=95.23$	

**Note :* Examining the individual LCN values vis-a-vis L.C.L. (lower control limit), it is seen that only 2 values marked with astericks fall below L.C.L. out of a total of 30 values (corresponding to a tolerance levelof 1 in 15). However, in view of relatively low value vis-a-vis overall safe LCN rating of 54, the location with LCN 46 may be investigated separately to ascertain if there is any specific reason for its low rating, and for rectification of the same.

Appendix 2

AN EXAMPLE ILLUSTRATING THE STRUCTURAL STRENGTH EVALUATION OF AIRFIELD PAVEMENT BY REVERSE DESIGN METHOD

1. **Test Data**

Slab thickness, $h=25$ cm

Compressive strength (kg/cm^2) of pavement concrete cores, 25 cm high 15 cm dia (at 10 locations)
385, 355, 320, 360, 340, 295, 325, 360, 330, 310.

CBR values of subgrade (at 10 locations)=13.0, 12.0, 10.5, 10.0, 11.0, 12.5, 11.5, 12.5, 10.5, 11.5.

Thickness of WBM subbase=25 cm

Measured load transfer, per cent
(at 10 locations)=12.66, 13.03, 8.40, 14.63, 6.80, 10.1, 10.1, 8.9, 6.7, 8.7

Tyre pressure of predominant gear assembly using the pavement=10 kg/cm^2

2. **Calculation of Structural Strength of the Pavement**

(1) **Assessment of Flexural Strength of Concrete**

From the 10 values of core compressive strength, average, $\bar{x}=338$ kg/cm^2
Standard deviation, $\sigma=27.3$ kg/cm^2
$\therefore$ for a tolerance level of 1 in 15,
min. core strength$=\bar{x}-1.5\ \sigma=297$ kg/cm^2

Applying a factor of safety of 1.1,
design core strength$=297/1.1=270$ kg/cm^2

Height/diameter ratio of cores, $n=\frac{25}{15}=5/3$

Correction factor for height/diameter ratio :
$f=0.11\ n+0.78$
$=0.1833+0.78=0.9633$

Corrected core compressive strength
$=270\times0.9633=260$ kg/cm^2

Cube Compressive Strength
$=1.25\times$core compressive strength
$=1.25\times260=325$ kg/cm^2

From Fig. 5, for compressive strength of 325 kg/cm^2, flexural strength of pavement concrete $f_b=40$ kg/cm^2.

(2) Assessment of k-value of sub-base

From the 10 values of subgrade CBR,
average, $\bar{x}=11.5$ per cent

Standard deviation, $\sigma=1.0$ per cent

For a tolerance level of 1 in 15,
min. CBR value$=\bar{x}-1.5\,\sigma=11.5-1.5=10.0$ per cent

From Table 1, k-value of subgrade,
(corresponding to CBR value of 10%)=5.54 kg/cm^2/cm

From Fig. 6(a), for subgrade k-value of 5.54 kg/cm^2/cm and subbase thickness of 25 cm, k-value on top of subbase=8 kg/cm^3.

(3) Assessment of Pavement Slab LCN

From Fig. 7, for unchannelised traffic (for middle of runway),
for $h=25$ cm, $k=8.0$ kg/cm^2 and $f_b=40$ kg/cm^2,

Pavement LCN=40

3. **Correction for Load Transfer**

(1) Calculation of Minimum Load Transfer

Since all the values obtained are less than 20 per cent, and none of them is zero, taking the average of all these values, the level to which the higher values of load transfer will get reduced=10.0 per cent.

$\therefore$ adjusted load transfer values (per cent)=10.0, 10.0, 8.40, 10.0, 6.8, 10.0, 10.0, 8.9, 6.7, 8.7

From these values, $\bar{x}=8.95\%$, $\sigma=1.32\%$

Most probable min. available load transfer
$=\bar{x}-1.5\,\sigma=8.95-1.5\times1.92$
$=8.95-1.98=6.97\%$

(2) Modified Pavement Slab LCN taking into account Load Transfer

From Fig. 4, for tyre pressure of 10 kg/cm^2, equivalent single wheel load (ESWL) corresponding to LCN 40 (without load transfer)=13000 kg.

Accounting for load transfer,

Actual load carrying capacity of

the pavement$=13{,}000\times\dfrac{100}{100-6.97}=13980$ kg.

Corresponding LCN (from Fig. 4)=42.

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