Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements

This standard covers the mathematical processing of longitudinal profile measurements to produce a road roughness statistic called the International Roughness Index (IRI).

1. Scope
1.1 This practice covers the mathematical processing of longitudinal profile measurements to produce a road roughness statistic called the International Roughness Index (IRI).
1.2 The intent is to provide a standard practice for computing and reporting an estimate of road roughness for highway pavements.
1.3 This practice is based on an algorithm developed in The International Road Roughness Experiment sponsored by a number of institutions including the World Bank and reported in two World Bank Technical Papers (1, 2). Additional technical information is provided in two Transportation Research Board (TRB) papers (3, 4).

2. Referenced Documents

2.1 ASTM Standards:
   E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
   E867 Terminology Relating to Vehicle-Pavement Systems
   E950 Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
   E1082 Test Method for Measurement of Vehicular Response to Traveled Surface Roughness
   E1170 Practices for Simulating Vehicular Response to Longitudinal Profiles of Traveled Surfaces
   E1215 Specification for Trailers Used for Measuring Vehicular Response to Road Roughness
   E1364 Test Method for Measuring Road Roughness by Static Level Method
   E1656 Guide for Classification of Automated Pavement Condition Survey Equipment
   E2133 Test Method for Using a Rolling Inclinometer to Measure Longitudinal and Transverse Profiles of a Traveled Surface

3. Terminology

3.1 Definitions:
   3.1.1 Terminology used in this practice conforms to the definitions included in Terminology E867.
   3.1.2 Definitions of Terms Specific to This Standard:
   3.2.1 International Roughness Index (IRI), n—an index computed from a longitudinal profile measurement using a quarter-car simulation (see Practice E1170) at a simulation speed of 80 km/h (50 mph).
   3.2.2 Discussion—IRI is reported in either metres per kilometre (m/km) or inches per mile (in./mile). (Note—1 m/km = 63.36 in./mile.)

3.2 Mean Roughness Index (MRI), n—the average of the IRI values for the right and left wheel tracks.

3.2.3 Discussion—Units are in metres per kilometre or inches per mile.

3.2.4 Travelled surface roughness—the deviations of a surface from a true planar surface with characteristics dimensions that affect vehicle dynamics, ride quality, dynamic loads, and drainage, for example, longitudinal profile, transverse profile, and cross slope.
3.2.5 *true International Roughness Index*, \( n \)— the value of IRI that would be computed for a longitudinal profile measurement with the constant interval approaching zero.

3.2.6 *wave number*, \( n \)— the inverse of wavelength.

3.2.6.1 Discussion—Wave number, sometimes called spatial frequency, typically has units of cycle/m or cycle/ft.

3.2.7 *wheel track*, \( n \)— a line or path followed by the tire of a road vehicle on a traveled surface.

4. Summary of Practice

4.1 The practice presented here was developed specifically for estimating road roughness from longitudinal profile measurements.

4.2 Longitudinal profile measurements for one wheel track are transformed mathematically by a computer program and accumulated to obtain the IRI. The profile must be represented as a series of elevation values taken at constant intervals along the wheel track.

4.3 The IRI scale starts at zero for a road with no roughness and covers positive numbers that increase in proportion to roughness. Fig. 1 associated typical IRI values with verbal descriptors from World Bank Technical Paper No. 46 (2) for roads with bituminous pavement, and Fig. 2 shows similar associations for roads with earth or gravel surfaces.

5. Significance and Use

5.1 This practice provides a means for obtaining a quantitative estimate of a pavement property defined as roughness using longitudinal profile measuring equipment.

5.1.1 The IRI is portable in that it can be obtained from longitudinal profiles obtained with a variety of instruments.

5.1.2 The IRI is stable with time because true IRI is based on the concept of a true longitudinal profile, rather than the physical properties of a particular type of instrument.

5.2 Roughness information is a useful input to the pavement management systems (PMS) maintained by transportation agencies.

5.2.1 The IRI for the right wheel track is the measurement of road surface roughness specified by the Federal Highway Administration (FHWA) as the input to their Highway Performance Monitoring System (HPMS).

5.2.2 When profiles are measured simultaneously for both traveled wheel tracks, then the MRI is considered to be a better measure of road surface roughness than the IRI for either wheel track.

Note 1—The MRI scale is identical to the IRI scale.

5.3 IRI can be interpreted as the output of an idealized response-type measuring system (see Test Method E1082 and Specification E1215), where the physical vehicle and instrumentation are replaced with a mathematical model. The units of slope correspond to accumulated suspension motions (for example, metres), divided by the distance traveled (for example, kilometres).

5.4 IRI is a useful calibration reference for response-type systems that estimate roughness by measuring vehicular response (see Test Method E1082 and Specification E1215).

5.5 IRI can also be interpreted as average absolute slope of the profile, filtered mathematically to modify the amplitudes associated with different wavelengths (3).

6. Longitudinal Profile Measurement

6.1 The longitudinal profile measurements can be obtained from equipment that operate in a range of speeds from static to highway traffic speeds.

6.2 The elevation profile measuring equipment used to collect the longitudinal profile data used in this practice must have sufficient accuracy to measure the longitudinal profile attributes that are essential to the computation of the IRI.

7. Computation of International Roughness Index (IRI)

7.1 This practice consists of the computation of IRI from an algorithm developed in the International Road Roughness Experiment and described in the World Bank Technical Papers 45 and 46 (1, 2). Additional technical information provided in two TRB papers (3, 4).

7.2 A Fortran version of this algorithm has been implemented as described in Ref (3).

7.2.1 This practice presents a sample computer program “IRISMP” for the computation of the IRI from the recorded longitudinal profile measurement.

7.2.1.1 The computer program IRISMP is a general computer program which accepts the elevation profile data set as input and then calculates the IRI values for that profile data set.

7.2.1.2 A listing of the IRISMP computer program for the computation of IRI is included in this practice as Appendix X2.

7.2.1.3 A provision has been made in the computer program listing (Appendix X2) for the computation of IRI from recorded longitudinal profile measurements in either SI or inch-pound units.

7.2.2 The input to the sample IRI computer program is an ASCII profile data set stored in a 1X,F8.3,1X,F8.3 Fortran format. In this format, the profile data appear as a multi-row, two column array with the left wheel path profile data points in Column 1 and the right wheel path points in Column 2. The profile data point interval is discretionary. However the quality of the IRI values computed by this algorithm is a function of the data point interval.

7.2.2.1 If the input to the IRI computer program is in SI units, the elevation profile data points are scaled in millimetres with the least significant digit being equal to 0.001 mm.

7.2.2.2 If the input to the IRI computer program is in inch-pound units, the elevation profile data points are scaled in inches with the least significant digit being equal to 0.001 in.

7.3 The distance interval over which the IRI is computed is discretionary, but shall be reported along with the IRI results.
### Validation of the IRI program

Validation of the IRI program is required when it is installed. Provision for the IRI program installation validation has been provided in this practice.

#### 7.4.1 Sample Profile Data Set

The sample profile data set TRIPULSE.ASC has been provided in SI units in Appendix X2 for validation of the computer program installation.

#### 8. Report

Include the following information in the report for this practice:

- **Profile Measuring Device**—The Class of the profile measuring device used to make the profile measurement as defined in Test Method E950 and Test Method E1364 shall be included in the report.

- **Longitudinal Profile Measurements**—Report data from the profile measuring process shall include the date and time of day of the measurement, the location of the measurement, the

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#### FIG. 1 Road Roughness Estimation Scale for Paved Roads With Asphaltic Concrete or Surface Treatment (Chipseal)

<table>
<thead>
<tr>
<th>Roughness (m/km IRI)</th>
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<tbody>
<tr>
<td>0</td>
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<td>4</td>
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<tr>
<td>6</td>
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<td>8</td>
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<td>10</td>
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</table>

- **Ride comfortable over 120 km/h.** Undulation barely perceptible at 80 km/h in range 1.3 to 1.8. No depressions, potholes or corrugations are noticeable; depressions < 2 mm/3 m. Typical high quality asphalt 1.4 to 2.3, high quality surface treatment 2.0 to 3.0.

- **Ride comfortable up to 100-120 km/h.** At 80 km/h, moderately perceptible movements or large undulations may be felt. Defective surface; occasional depressions, patches or potholes (e.g. 5-15 mm/3 m or 10 - 20 mm/5 m with frequency 2-1 per 50 m), or many shallow potholes (e.g. on surface treatment showing extensive ravelling). Surface without defects; moderate corrugations or large undulations.

- **Ride comfortable up to 70-90 km/h,** strongly perceptible movements and swaying. Usually associated with defects; frequent moderate and uneven depressions or patches (e.g. 15-20 mm/3 m or 20-40 mm/5 m with frequency 5-3 per 50 m), or occasional potholes (e.g. 3-1 per 50 m). Surface without defects: strong undulations or corrugations.

- **Ride comfortable up to 50-60 km/h,** frequent sharp movements or swaying. Associated with severe defects: frequent deep and uneven depressions and patches (e.g. 20-40 mm/3 m or 40-80 mm/5 m with frequency 5-3 per 5 m), or frequent potholes (e.g. 4-6 per 50 m).

- **Necessary to reduce velocity below 50 km/h.** Many deep depressions, potholes and severe disintegration (e.g. 40-80 mm deep with frequency 8-16 per 50 m).
8.1.3 IRI Resolution—The number of digits after the decimal point depends on the choice of units. If the units are m/km, then results should be reported with two digits after the decimal point. If the units are in./mile, then the IRI results should be reported to a resolution of 0.1 in./mile.

9. Precision and Bias

9.1 The precision and bias of the computed IRI is limited by the procedures used in making the longitudinal profile measurement. Guidelines for measuring longitudinal profile are provided in Test Method E950 and Test Method E1364.

9.2 For the effects of the precision and bias of the measured profile on the computed IRI, see precision and bias in Appendix X1.
10. Keywords

10.1 highway performance monitoring system; HPMS; international roughness index; International Roughness Index; longitudinal profile; pavement management systems; pavement roughness; PMS

APPENDIXES

(Nonmandatory Information)

X1. PRECISION AND BIAS

X1.1 Precision:

X1.1.1 The precision of the computed IRI is limited by the procedures used in making the longitudinal profile measurement. Guidelines for measuring longitudinal profile are provided in Test Method E950 and Test Method E1364.

X1.1.2 IRI precision depends on the interval between adjacent profile elevation measures (see Test Method E950 and Test Method E1364). Reducing the interval typically improves the precision. An interval of 0.3 m (12 in.) or smaller is recommended. For some surface types, a shorter interval will improve precision. More information about the sensitivity of IRI to the profile data interval is provided in Ref (3).

X1.1.3 IRI precision is roughly equivalent to the precision of the slope obtained from the longitudinal profile measurements, for distances ranging from approximately 1.5 m (5 ft) to about 25 m (80 ft). For example, a relative error on profile elevation of 1.0 mm over a distance of 10 m corresponds to a slope error of 0.1 mm/m, or 0.1 m/km (6.3 in./mi).

X1.1.4 IRI precision is limited by the degree to which a wheel track on the road can be profiled. Errors in locating the wheel track longitudinally and laterally can influence the IRI values, because the IRI will be computed for the profile of the wheel track as measured, rather than the wheel track as intended. These effects are reduced by using longer profiles.

X1.1.5 Computational errors due to round-off are typically about two orders of magnitude smaller than those due to limitations in the profile measuring process, and can be safely ignored.

X1.2 Bias:

X1.2.1 The bias of the computed IRI is typically limited by the procedures used in making the longitudinal profile measurement. Guidelines for measuring longitudinal profile are provided in Test Method E950 and Test Method E1364.

X1.2.2 IRI bias depends on the interval between adjacent profile elevation measures. An interval of 0.3 m (12 in.) or smaller is recommended. Shorter intervals improve precision but have little effect on bias. More information about the sensitivity of IRI to the profile data interval is provided in Ref (3).

X1.2.3 Many forms of measurement error cause an upward bias in IRI. (The reason is that variations in profile elevation due to measurement error are usually not correlated with the profile changes.) Some common sources of positive IRI bias are: height-sensor round-off, mechanical vibrations in the instrument that are not corrected and electronic noise. Bias is reduced by using profiler instruments that minimize these errors.

X1.2.4 Inertial profiler systems (see Test Method E950) include one or more filters that attenuate long wavelengths (low wave numbers). If the cut-off wavelength is too short, then the IRI computed from the profile will have a negative bias. A cut off wavelength of 91.4 m/cycle (300 ft/cycle) is considered sufficiently long.

NOTE X1.1—Profiles obtained with static methods are generally not filtered, and therefore this source of bias is not relevant for them.

X1.2.5 The measures from some inertial profilers are processed during measurement to attenuate short wavelengths and prevent aliasing. The effect is to smooth the profile measurement. If a smoothing filter is used and it affects wavelengths longer than 1 m (3.3 ft), then the computed IRI will have a negative bias.

NOTE X1.2—If the profiler includes a smoothing filter that affects wavelengths shorter than 1 m (3.3 ft) and longer than 250 mm (10 in.), no more smoothing is required during the computation of IRI.
X2. INTERNATIONAL ROUGHNESS INDEX COMPUTER PROGRAM

X2.1 Included in this appendix is the coding in Fortran language for a computer subroutine, SUBROUTINE IRI, (see Fig. X2.1), which calculates the International Roughness Index as prescribed by this practice. A sample main program is also included, which when executed, prompts the user for the name of a data file containing the profile data to be processed and the

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C============================================================================================================
C Sample IRI Fortran Computer Program
C
C Sample program to read a data file containing two tracks of road
C profile elevation data into a "DATA" array, call SUBROUTINE IRI
C and print a final report of International Roughness Index.
C If the input profile data are in English units, the elevation values
C are converted from inch to mm units and the sampling interval, from
C feet to meters; the computed IRI values are returned as m/km and
C converted to in/mi.
C (SUBROUTINE IRI is called to perform the IRI computation as
C prescribed by this practice.)
C
PROGRAM IRISMP
C
C DELT --> DX
C PROFL(1058) --> left track profile
C PROFR(1058) --> right track profile
C AVEIRIL --> IRI, left track
C AVEIRIR --> IRI, right track
C AVEIRI --> (AVEIRIL+AVEIRIR)/2.
C UNITSC --> see UNITSC (SUBR IRI)

REAL DELT, SECLEN
REAL BASE, UNITSC, PROFL(1058), PROFR(1058)
REAL AVIRIL, AVIRIR, AVEIRI

BYTE ANSWER
CHARACTER NAME*12

INTEGER NPTS, NREC, I
NREC = 0

WRITE(*,1000)
1000 FORMAT(/'Enter data file name (in single quotes)'/
1 ('TRIPULSE.ASC' in example): '$')

READ(*,*) NAME(1:12)

WRITE(*,1010)
1010 FORMAT(//'Enter the number of samples in the profile.'/
1 ('101 in example) : '$')
```

FIG. X2.1 Sample Fortran Program Using Subroutine IRI to Compute International Roughness Index
parameters needed by the subroutine to compute the IRI. The subroutine is called and returns the computed IRI values to the main program which then displays them.

X2.2 The sample program can process data files containing two profile tracks in either SI or inch-pound units. For SI data, the program assumes the input amplitudes are stored in millimetre units; if inch-pound, inches. For the sample program, the maximum length road section that can be processed is limited to 1058 sample pairs.

X2.3 The sample data file shown in Fig. X2.2 and Fig. X2.3 is in SI units (mm) and contains 101 profile data point pairs. The tracks are identical. The recording interval for the data is 0.15 m.
SUBROUTINE IRI(PROF, NSAMP, DX, BASE, UNITSC, AVEIRI)

C Filter a longitudinal road profile and calculate IRI.

C
C <-> PROF REAL On input, an array of profile height values.
C <-> NSAMP INTEGER Number of data value in array PROF. Filtered
C profile always has fewer points than original.
C --> DX REAL Distance step between profile points (m).
C --> BASE REAL Distance covered by moving average (m).
C Use .250 for unfiltered profile input, and 0.0
C for pre-smoothed profiles (e.g. K.J. Law data).
C --> UNITSC REAL Product of two scale factors: (1) meters per unit
C of profile height, and (2) IRI units of slope.
C Ex: height is inches, slope will be in/mi.
C UNITSC = (.0254 m/in)*(63360 in/mi) = 1069.34
C <-- AVEIRI REAL The average IRI for the entire profile.

INTEGER I, I11, IBASE, NSAMP
REAL AMAT, AVEIRI, BASE, BMAT, CMAT, DX
REAL UNITSC, XIN, PROF, SFP1, ST, PR
DIMENSION AMAT(4, 4), BMAT(4, 4), CMAT(4, 4), PR(4),
& ST(4, 4), XIN(4), PROF(NSAMP)

C Set parameters and arrays.
CALL SETABC(653.0, 63.3, 6.0, 0.15, AMAT, BMAT, CMAT)
CALL SETSTM(DX/(80./3.6), AMAT, BMAT, ST, PR)
IBASE = MAX(INT(BASE/DX + 0.5), 1)
SFP1 = UNITSC/(DX*IBASE)

C Initialize simulation variables based on profile start.
I11 = MIN(INT(DX/DX + 0.5) + 1, NSAMP)
XIN(1) = UNITSC*(PROP(I11) - PROF(I))/(DX*I11)
XIN(2) = 0.0
XIN(3) = XIN(1)
XIN(4) = 0.0

C Convert to averaged slope profile, with IRI units.
NSAMP = NSAMP - IBASE
DO 10 I = 1, NSAMP
10 PROF(I) = SFP1*(PROP(I + IBASE) - PROF(I))
C Filter profile.
    CALL STFILT(PROF, NSAMP, ST, PR, CMAT, XIN)

C Compute IRI from filtered profile.
    AVEIRI = 0.0
    DO 20 I = 1, NSAMP
    20    AVEIRI = AVEIRI + ABS(PROF(I))
    AVEIRI = AVEIRI/NSAMP
    RETURN
END

C=================================================================
SUBROUTINE SETABC(K1, K2, C, MU, AMAT, BMAT, CMAT)
C=================================================================
C Set the A, B and C matrices for the 1/4 car model.
C
C --> K1 REAL  Kt/Ms = normalized tire spring rate, (1/s/s)
C --> K2 REAL  Ks/Ms = normalized suspension spring rate (1/s/s)
C --> C REAL C/Ms  = normalized suspension damper rate (1/s)
C --> MU REAL Mu/Ms = normalized unsprung mass (-)
C <-- AMAT REAL  The 4x4 A matrix.
C <-- BMAT REAL  The 4x1 B matrix.
C <-- CMAT REAL  The 4x1 C matrix.

INTEGER    I, J
REAL       AMAT, BMAT, CMAT, K1, K2, C, MU
DIMENSION  AMAT(4, 4), BMAT(4), CMAT(4)

C Set default for all matrix elements to zero.
    DO 10 J = 1, 4
         BMAT(J) = 0
         CMAT(J) = 0
    DO 10 I = 1, 4
         AMAT(I, J) = 0
    10

C Put 1/4 car model parameters into the A Matrix.
    AMAT(1, 2) = 1.
    AMAT(3, 4) = 1.
    AMAT(2, 1) = -K2
    AMAT(2, 2) = -C
    AMAT(2, 3) = K2
    AMAT(2, 4) = C
    AMAT(4, 1) = K2/MU
    AMAT(4, 2) = C/MU
    AMAT(4, 3) = -(K1 + K2)/MU
    AMAT(4, 4) = -C/MU

FIG. X2.1 Sample Fortran Program Using Subroutine IRI to Compute International Roughness Index (continued)
C Set the B matrix for road input through tire spring.
   BMAT(4) = K1/MU

C Set the C matrix to use suspension motion as output.
   CMAT(1) = -1
   CMAT(3) = 1

RETURN
END

SUBROUTINE SETSTM(DT, A, B, ST, PR)

C Compute ST and PR arrays. This requires INVERT for matrix inversion.

C --> DT REAL Time step (sec)
C --> A REAL The 4x4 A matrix.
C --> B REAL The 4x1 B matrix.
C <-- ST REAL 4x4 state transition matrix.
C <-- PR REAL 4x1 partial response vector.

INTEGER I, ITER, J, K
LOGICAL MORE
REAL A, A1, A2, B, DT, PR, ST, TEMP
DIMENSION A(4, 4), A1(4, 4), A2(4, 4), B(4)
DIMENSION PR(4), ST(4, 4), TEMP(4, 4)

DO 20 J = 1, 4
  DO 10 I = 1, 4
    A1(I, J) = 0
  10   ST(I, J) = 0
    A1(J, J) = 1.
  20   ST(J, J) = 1.

C Calculate the state transition matrix ST = exp(dt*A) with a Taylor series. A1 is the previous term in the series, A2 is the next one.
ITER = 0
30   ITER = ITER + 1
    MORE = .FALSE.
  DO 40 J = 1, 4
    DO 40 I = 1, 4
      A2(I, J) = 0

FIG. X2.1 Sample Fortran Program Using Subroutine IRI to Compute International Roughness Index (continued)
DO 50 J = 1, 4
  DO 50 I = 1, 4
    A1(I, J) = A2(I, J)*DT/ITER
    IF (ST(I, J) + A1(I, J) .NE. ST(I, J)) MORE = .TRUE.
  50 CONTINUE
END

C Calculate particular response matrix: PR = A**-1*(ST-I)*B
C
SUBROUTINE STFILT(PROF, NSAMP, ST, PR, C, XIN)
C
INTEGER I, J, K, NSAMP
REAL C, PR, PROF, ST, X, XIN, XN
DIMENSION C(4), PR(4), PROF(NSAMP), ST(4, 4), X(4), XIN(4), XN(4)

C Initialize simulation variables.
  DO 10 I = 1, 4
  10 X(I) = XIN(I)

FIG. X2.1 Sample Fortran Program Using Subroutine IRI to Compute International Roughness Index (continued)
C Filter profile using the state transition algorithm.
  DO 40 I = 1, NSAMP
    DO 20 J = 1, 4
      XN(J) = PR(J)*PROF(I)
      DO 20 K = 1, 4
        XN(J) = XN(J) + X(K)*ST(J, K)
    DO 30 J = 1, 4
    30  X(J) = XN(J)
    PROF(I) = X(1)*C(1) + X(2)*C(2) + X(3)*C(3) + X(4)*C(4)
  40 CONTINUE
  RETURN
END

C================================================================================================

SUBROUTINE INVERT(Y1, N)
C================================================================================================

C This routine will store the inverse of N x N matrix Y1 in matrix YINV.
C It was copied from "Numerical Recipes."  
C
C Y1 --> Real    The matrix to be inverted.
C YINV --> Real  The inverse of matrix Y1.
C
INTEGER      N, INDX, I, J
REAL*4       Y1, YINV, D, A
DIMENSION    Y1(N, N), YINV(4, 4), INDX(4), A(4, 4)

DO 8 I = 1, N
  DO 9 J = 1, N
    9  A(I, J) = Y1(I, J)
  CONTINUE
DO 10 I = 1, N
  DO 20 J = 1, N
    20  YINV(I, J) = 0.0
    10  CONTINUE
CALL LUDCMP(A, INDX, D)
DO 30 J = 1, N
  CALL LUITEM(A, INDX, YINV(1, J))
DO 40 I = 1, N
  DO 50 J = 1, N
    50  Y1(I, J) = YINV(I, J)
  CONTINUE
RETURN
END

FIG. X2.1 Sample Fortran Program Using Subroutine IRI to Compute International Roughness Index (continued)
SUBROUTINE LUDCMP(A, INDEX, D)
C This routine was copied from "Numerical Recipes" for matrix inversion.
C
INTEGER N, INDEX, NMAX, I, J, IMAX, K
REAL*4 A, TINY, VV, D, AAMAX, SUM, DUM
PARAMETER (NMAX = 100, TINY = 1.0E-20, N = 4)
DIMENSION A(N, N), INDEX(N), VV(NMAX)

D = 1.0
DO 10 I = 1, N
   AAMAX = 0.0
   DO 20 J = 1, N
      IF (ABS(A(I,J)) .GT. AAMAX) AAMAX = ABS(A(I,J))
      IF (AAMAX .EQ. 0.0) PAUSE 'Singular matrix'
      VV(I) = 1.0 / AAMAX
   20 CONTINUE
   DO 30 J = 1, N
      DO 40 I = 1, J-1
         SUM = A(I, J)
         DO 50 K = 1, I-1
            SUM = SUM - A(I, K) * A(K, J)
            A(I, J) = SUM
        50 CONTINUE
        AAMAX = 0.0
        DO 60 I = J, N
           SUM = A(I, J)
           DO 70 K = 1, J-1
              SUM = SUM - A(I, K) * A(K, J)
              A(I, J) = SUM
           70 DUM = VV(I) * ABS(SUM)
              IF (DUM .GE. AAMAX) THEN
                 IMAX = I
                 AAMAX = DUM
              ENDIF
           60 CONTINUE
        IF (J .NE. IMAX) THEN
           DO 80 K = 1, N
              DUM = A(IMAX, K)
              A(IMAX, K) = A(J, K)
              A(J, K) = DUM
           80 CONTINUE
           D = -D

FIG. X2.1 Sample Fortran Program Using Subroutine IRI to Compute International Roughness Index (continued)
FIG. X2.1 Sample Fortran Program Using Subroutine IRI to Compute International Roughness Index (continued)
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<th>Elevation 1</th>
<th>Elevation 2</th>
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... (pad with zeros to make a total of 101 numerical data)

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<th>Elevation 2</th>
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**Note 1**—Elevations are metric units (mm). The profile consists of identical right and left wheel tracks, each consisting of zero elevations everywhere except the triangular ‘pulse’ from 0.6 to 3.0 m peaking at 20.0 mm. The interval between elevations is 0.15 m and the total length is 15 m. This data set may be used as a test of the user’s implementation of IRI standard computation.

**FIG. X2.2 Sample Load Profile Input Data Set, TRIPULSE.ASC**
Enter data file name (in single quotes) 
("TRIPULSE.ASC" in example): "TRIPULSE.ASC"

Enter the number of samples in the profile. 
(101 in example) : 101

Enter the sampling interval, meters 
(.15 m in example) : .15

Is the input profile pre-smoothed (Y or N)? N

IRI, left = 4.36 m/km
IRI right = 4.36 m/km

International Roughness Index = 4.36 m/km
Distance = 15.0 meters

FIG. X2.3 Input/Output for RNSMP sample program using data input file ‘TRIPULSE.ASC’

REFERENCES


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