

Pass-to-Coverage Computation for Arbitrary Gear Configurations in the FAARFIELD Program

December 2012

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LIST OF ACRONYMS

CDF	Cumulative damage factor
C/P	Coverage to pass
FAA	Federal Aviation Administration
FAARFIELD	FAA Rigid and Flexible Iterative Elastic Layered Design
HMA	Hot-mix asphalt
LEA	Layered elastic analysis
P/C	Pass to coverage
PCC	Portland cement concrete
XML	Extensible Markup Library

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) adopted FAA Rigid and Flexible Iterative Elastic Layered Design (FAARFIELD) as its standard thickness design procedure for airport pavements in September 2009. FAARFIELD incorporates the effects of airplane wander through a computed pass-to-coverage (P/C) ratio. The P/C ratio is always computed at the top of the subgrade for flexible pavements and at the pavement surface for rigid pavements. For flexible pavements and overlays, P/C computations at additional depths may be needed if the horizontal strain criterion at the bottom of asphalt layers is considered. This document describes the FAARFIELD-implemented procedure that allows computation of P/C ratio for arbitrary gear configurations in. This procedure also allows the calculation of pavement thicknesses for arbitrary gear configurations introduced by the user. This feature was not available in previous FAARFIELD versions.

The new FAARFIELD changes allow the user to specify arbitrary gear configurations with up to two wheel groups (wing gear and/or body gear) on one side of the airplane. To provide this extended capability, the Extensible Markup Library (XML) format for airplane data in the external library was modified, and a new procedure was written for calculating coverage-to-pass ratio for flexible and rigid pavements. Other changes were made to FAARFIELD to accommodate a new XML format for arbitrary gear configuration and an adaptation of a new procedure for calculating P/C ratio.

INTRODUCTION

The Federal Aviation Administration (FAA) Rigid and Flexible Iterative Elastic Layered Design (FAARFIELD) is the FAA airport pavement thickness design program. The FAARFIELD program contains a list of airplanes in internal and external libraries for which design can be performed.

Previously, the user only had the capability to add an airplane to the external library if it had a specific wheel arrangement as specified by the internal library. Modifications were made to FAARFIELD to allow the user to specify arbitrary gear configurations with up to two wheel groups (wing gear and body gear) on one side of the airplane. To provide this extended capability, the Extensible Markup Language (XML) format for airplane data in the external library was modified, and a new procedure for calculating the pass-to-coverage (P/C) ratio for flexible and rigid pavements was written. Other changes were made to FAARFIELD to accommodate the new XML format for arbitrary gear configurations and adaptation of the new procedure for calculating the P/C ratio.

THE P/C CONCEPT

The FAARFIELD failure models relate a computed structural response to the number of coverages a pavement structure can carry. In the case of flexible pavements, the primary structural response is vertical strain at the top of the subgrade. For rigid pavements, the response is bending stress at the bottom of the concrete slab. Coverages can be defined as a measure of the number of repetitions of the maximum strain (for flexible pavements) or stress (for rigid pavements) occurring at a particular location in the pavement [1]. In general, the number of coverages is different from the number of passes due to aircraft wander, but passes and coverages can be related through the P/C ratio.

FAARFIELD uses Miner's hypothesis to predict the fatigue life of a pavement structure [2].

THE P/C COMPUTATION FOR ARBITRARY GEAR CONFIGURATION

For a given gear configuration as shown in figure 1, the P/C ratio is calculated with the new procedure using the following steps:

1. Determine the rearmost wheel in each tandem group. A wheel is considered to belong to a tandem group when the center of the wheel is within the width of the trailing wheel in the tandem column, as shown in figure 2. These trailing wheels are identified by a white square in figure 1.
2. For each trailing wheel identified by a white square, determine the number of wheels in tandem associated with that trailing wheel. In the example of figure 1, each trailing wheel is associated with two other wheels in the tandem group.
3. Calculate the tandem distance for each pair of wheels in tandem.

4. Calculate the tandem factor F_{ind} for each trailing wheel. The tandem factor value depends on the number of wheels in the tandem group and the tandem distance.
5. Compute the coverage-to-pass (C/P) ratio from the area under the normal traffic distribution curve between the limits of the effective tire width (where the effective tire width is defined in a subsequent section).
6. Apply the tandem factor determined in step 4 to the C/P ratio determined in step 5, $(C/P)_{final} = (C/P) \times F_{ind}$.
7. The P/C ratio is the inverse of the C/P ratio computed in the above steps.

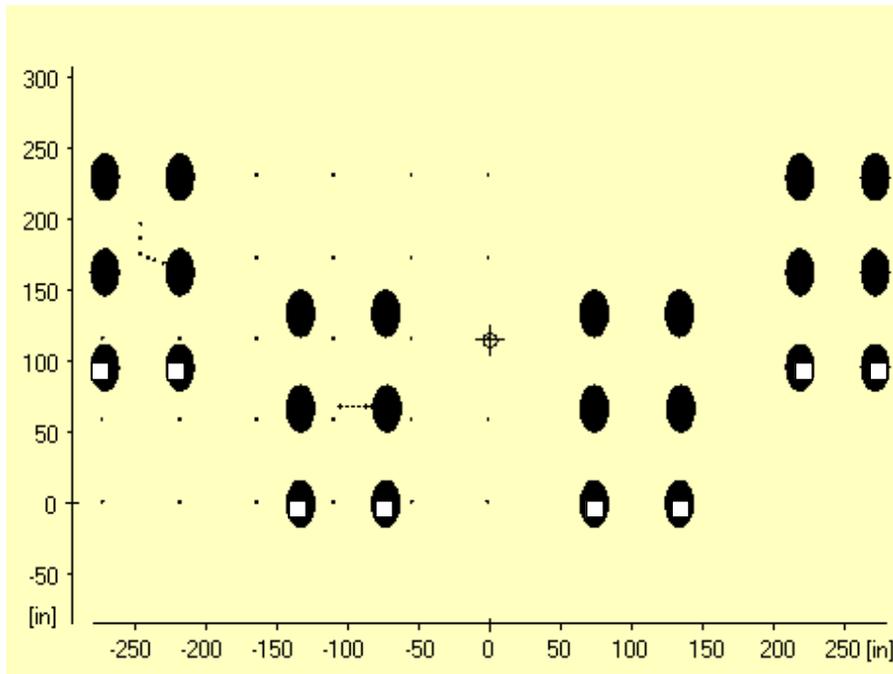


Figure 1. Airplane Gear Configuration With Marked Trailing Wheels

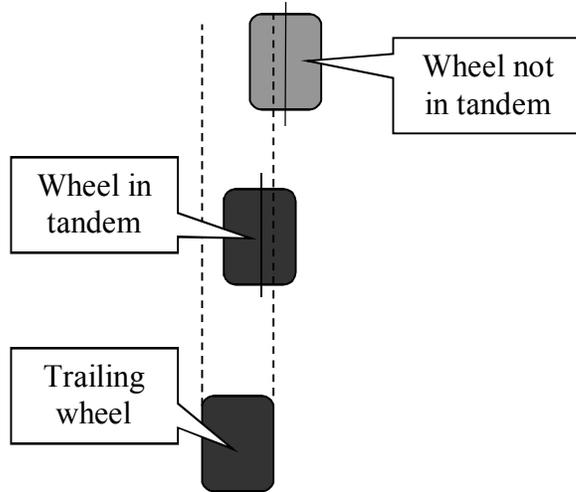


Figure 2. Wheels in Tandem

TANDEM FACTOR FOR RIGID PAVEMENTS

For tandem distances shorter than or equal to 72 inches, a factor of one is applied to the number of passes of tandem wheels. For tandem distance longer than 72 inches, a factor of two is applied to the number of passes of tandem wheels. For groups of three or more tires in tandem, the tandem factor is equal to N , where N is the number of tires in tandem. This applies only to cases where the tandem distance between all pairs of tires is longer than 72 inches. When there are n number of pairs of tires for which the tandem distance is shorter than or equal to 72 inches, the tandem factor is equal to $N - n$.

TANDEM FACTOR FOR FLEXIBLE PAVEMENTS

Consider two tires in tandem: let b be the net distance between the front and rear tires (i.e., the center-to-center tandem spacing minus the length of the tire contact patch), and let h be the total pavement thickness to the top of the subgrade. Then, the tandem factor F_{ind} is defined as follows:

$$F_{ind} = 1 \quad \text{where } h/b \geq 2 \quad (1)$$

$$F_{ind} = N - (N - 1) \times [(h/b) - 1] \quad \text{where } 1 < h/b < 2 \quad (2)$$

$$F_{ind} = N \quad \text{where } h/b \leq 1 \quad (3)$$

Thus, for cases where $h/2 < b < h$, the tandem factor for two wheels is defined by interpolation between 1 and 2, as shown in figure 3. For groups of three or more tires in tandem, the tandem is defined by interpolation between one and N , where N is the number of tires in tandem. This calculation assumes that the tandem distance is constant for all pairs of tires in the tandem group.

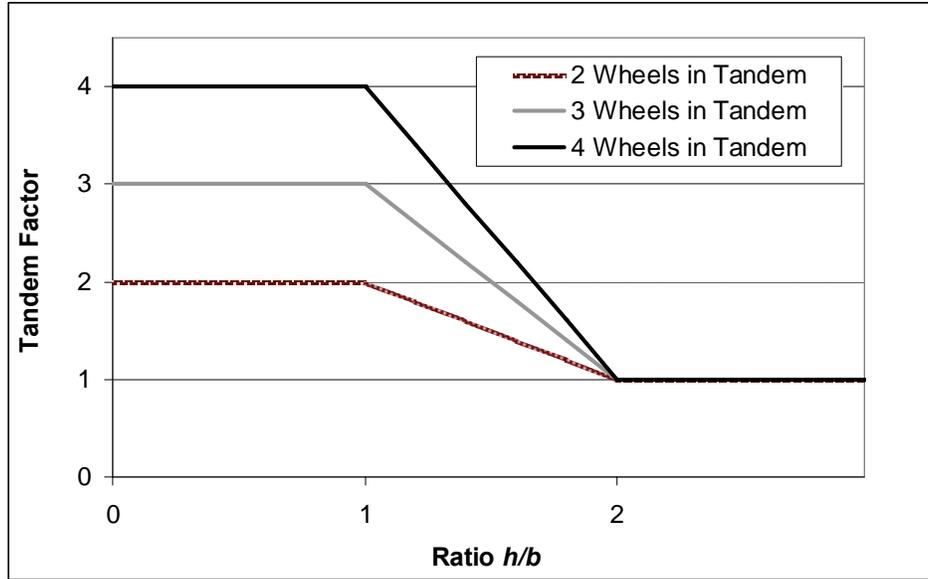


Figure 3. Tandem Factor as a Function of Ratio h/b and Number of Wheels for Flexible Pavements

In general, when the tandem distance between pairs of tires in tandem is not constant, the tandem factor is calculated for each pair of tires separately, then summed, and adjusted to account for the correct number of tires in the tandem column.

As an example, consider a group of three tires in tandem with different tandem spacing between tires 1 and 2, and tires 2 and 3. The first tandem factor, F_{12} , is calculated for tires 1 and 2, and the second tandem factor, F_{23} , is calculated for tires 2 and 3. The tandem factor for the group is calculated as $F_{ind} = F_{12} + F_{23} - 1$. Similarly, the tandem factor for a group of four tires would be calculated as $F_{ind} = F_{12} + F_{23} + F_{34} - 2$, and in general, for a tandem group consisting of N tires:

$$F_{ind} = F_{12} + F_{23} + \dots + F_{(N-1)N} - (N - 2) \quad (4)$$

Note that for $N=2$ tires, the above formula reduces to $F_{ind} = F_{12}$.

EFFECTIVE TIRE WIDTH

The P/C ratio computation considers the pavement structure depth through the concept of effective tire width, as illustrated in figures 4 and 5. For both rigid and flexible pavements, the tire contact patch width is determined by assuming that the contact patch is in the shape of an ellipse with the ratio of the major axis to the minor axis equal to 1.6. For rigid pavements, the effective tire width is measured at the pavement surface, and it is equal to the nominal tire contact patch width. For flexible pavements, the effective tire width is measured either at the top of the subgrade (for the subgrade vertical strain criterion) or at the bottom of the asphalt layer (for the horizontal strain criterion). For simplicity, only the subgrade strain case is considered, but the procedure is similar for any depth of interest. Response lines are drawn at a slope of 1:2 from the contact patch edges to the top of the subgrade. Tires are considered to be either separate or combined, depending on whether the response lines overlap (figures 4 and 5). The

maximum value of vertical strain at the top of the subgrade is computed with all the wheels in the landing gear assembly acting on the pavement. The maximum computed strain is then assumed to act on the full effective width of each equivalent tire.

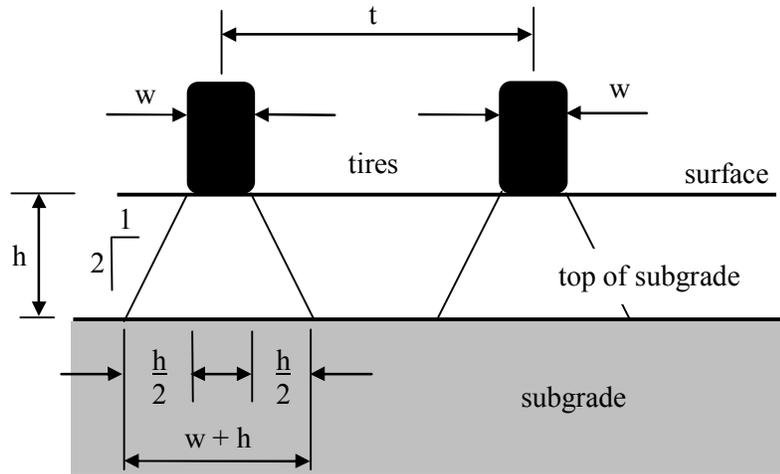


Figure 4. Equivalent Tire Width With No Overlap (Two equivalent tires)

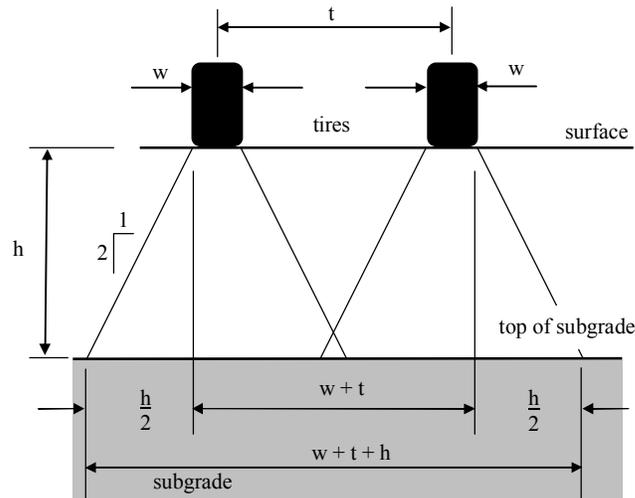


Figure 5. Equivalent Tire Width With Overlap (One equivalent tire)

THE P/C RATIO COMPUTATION FOR RIGID PAVEMENTS

Using the above definition of effective tire width, the C/P ratio may be defined as the probability that any part of the effective tire width covers the center point of a given strip. Then, the P/C ratio is simply the inverse of this probability. For rigid pavements, it is assumed that the critical surface is the contact surface of the pavement, and the effective width is therefore the nominal tire width w . The pavement surface is divided into 81 longitudinal strips, and the C/P ratio is computed for each offset. For each offset i , $(C/P)_i$ is computed using the probability formula [1].

$$(C/P)_i = \sum_{k=1}^{N_t} P \left[\left(x_i - \frac{w}{2} \right) \leq x_k \leq \left(x_i + \frac{w}{2} \right) \right] \quad (5)$$

where: N_t is the number of tires for the gear, x_i is defined as the lateral distance from a longitudinal reference line (e.g., the runway or taxiway centerline) to the midpoint of strip i , and x_k is the lateral distance from the same reference line to the centerline of tire k .

THE P/C RATIO COMPUTATION FOR FLEXIBLE PAVEMENTS

The P/C calculation for flexible pavements is conceptually the same as for rigid pavements. However, the calculation for flexible pavements considers that the critical surface is at the top of the subgrade layer. For simplicity, only the case where the top of the subgrade is critical is considered here. However, if the flexible design also considers horizontal strain in hot-mix asphalt (HMA) layers, then additional critical surfaces need to be considered at the bottom of the HMA layers. The P/C computation for these additional surfaces is the same as described below; only the depth to the critical surface is changed. Figures 4 and 5 show the width at the top of subgrade influenced by one tire and two tires, respectively. If it is assumed that the width of the subgrade strip influenced by a single tire is given by $w + h$ (figure 4), where w is the tire footprint width and h is the depth to the top of the subgrade, then the width of the strip influenced by two adjacent tires is $w + t + h$ (figure 5), where t is the center-to-center distance between tires. It is assumed here that the tires are sufficiently close together that they produce one equivalent tire at the critical surface. As illustrated in figure 5, this condition is satisfied when $h \geq t - w$.

The equivalent tire width w_{eq} is calculated for each airplane based on its gear configuration and the depth to the critical layer. For dual-wheel or dual-tandem airplane gears and $h \geq t - w$,

$$w_{eq} = w + t + h \quad (6)$$

Equation 6 assumes that subgrade strain is the critical response being considered. For the criterion of fatigue damage in the HMA layer, w_{eq} is computed from:

$$w_{eq} = w + h \quad (7)$$

where in this case, h is the depth to the critical HMA layer.

Similar to the procedure for Portland cement concrete (PCC) pavements, the subgrade layer is divided into 81 longitudinal strips, and the C/P is computed for each offset. For offset i , $(C/P)_i$ is computed using equation 5, except that the equivalent tire width w_{eq} is substituted for the actual tire footprint width w . Hence, the C/P ratios used in the FAARFIELD program are generally higher for flexible pavements than for rigid pavements.

$$(C/P)_i = \sum_{k=1}^{N_t} P \left[\left(x_i - \frac{w_{eq}}{2} \right) \leq x_k \leq \left(x_i + \frac{w_{eq}}{2} \right) \right] \quad (8)$$

CUMULATIVE DAMAGE FACTOR CALCULATIONS

As in the case of C/P ratio calculations, the pavement surface is divided into 81, 10-inch longitudinal strips for a total pavement width of 810 inches, and the cumulative damage factor (CDF) is computed for each offset. For each offset i , the CDF is calculated as follows:

$$CDF_i = \sum_{A=1}^{\infty} \frac{(C/P)_i^{(A)} \times P_A \times F_{md}}{N_A} \quad (9)$$

where:

- $(C/P)_i^{(A)}$ = coverage-to-pass ratio for offset i and aircraft A (not considering the tandem adjustment)
- P_A = total number of passes of aircraft A in the design period
- m = total number of aircraft in the design mix
- N_A = number of coverages to failure for aircraft A , based on the FAARFIELD failure model

The CDF value for the design is determined by taking the maximum value of CDF_i over all 81 strips i :

$$CDF = \max(CDF_i)$$

An example of a CDF computation can be found in appendix C.

Two points are necessary to consider. First, the CDF calculation assumes that if a point is within the coverage area represented by the equivalent tire width, it experiences the maximum response predicted by the response model for that aircraft. In other words, all nonzero responses less than the calculated maximum response are neglected in the pavement design.

Second, even airplanes with the same gear geometry but with different main gear tracks will have different P/C ratios for a particular 10-inch strip. Depending on how close the gear tracks are to each other, a given airplane gear may generate significant strains yet show little cumulative effect on the maximum CDF. In that case, removing the airplane with the lowest stress or strain may have little effect on the design thickness.

TEST OF ALGORITHM WITH A380-800 AND B777-200 BASELINE AIRPLANES

Two airplanes, designated A380-800ExLib and B777-200 BaselineExLib, were added to the external library with airplane characteristics identical to the corresponding airplanes in the internal library (A380-800 and B777-200, respectively). Data in XML format for the A380-800ExLib and B777-200 BaselineExLib gears are provided in appendix B. FAARFIELD recognizes airplanes with arbitrary gear configurations with the gear code “X.”

To test the ability of the new external library procedure to reproduce gears contained in the FAARFIELD internal airplane library, calculations for the C/P ratio were made for airplanes

A380-800 and B777-200 Baseline using the existing procedure, which were then compared to calculations for airplanes A380-800ExLib and B777-200 BaselineExLib using the new procedure. As shown in figures 6-13, the results were identical for the two pairs of airplanes, demonstrating the correctness of the procedure for both rigid and flexible pavements.

Figure 6 shows the C/P ratio calculation for A380-800 and A380-800ExLib. Figure 7 shows the C/P ratio calculation for B777-200 Baseline and B777-200 BaselineExLib for rigid pavements. Figures 8 through 10 show C/P ratio calculations for A380-800 and A380-800ExLib. Figures 11 through 13 show C/P ratio calculations for B777-200 Baseline and B777-200 BaselineExLib for flexible pavements.

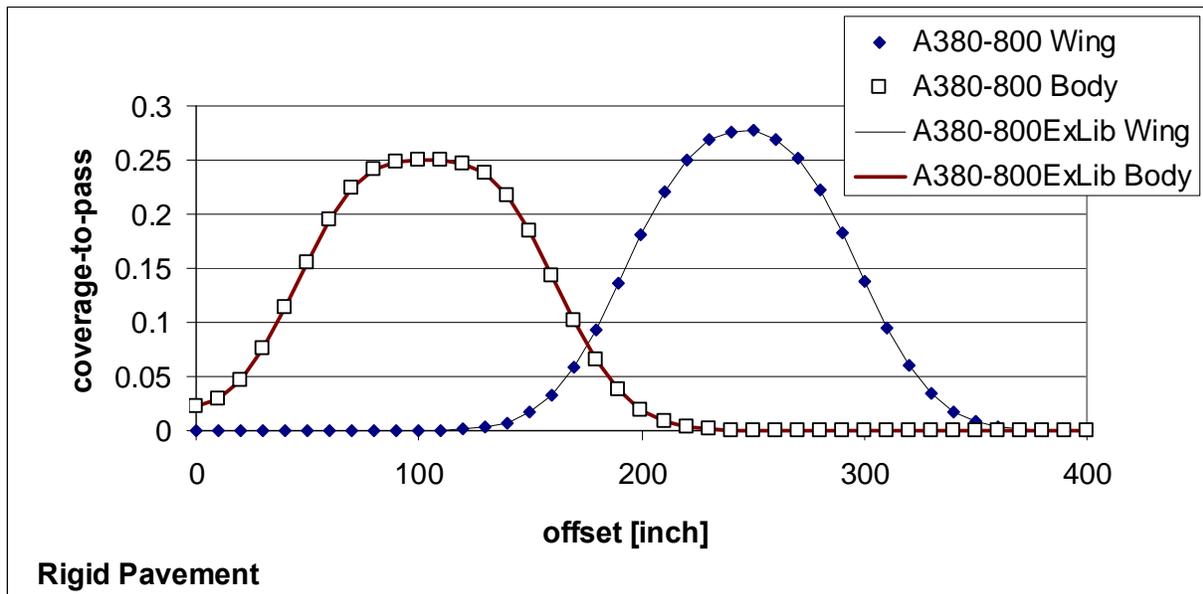


Figure 6. Distribution of C/P Ratio for A380-300 and A380-800ExLib for Rigid Pavements

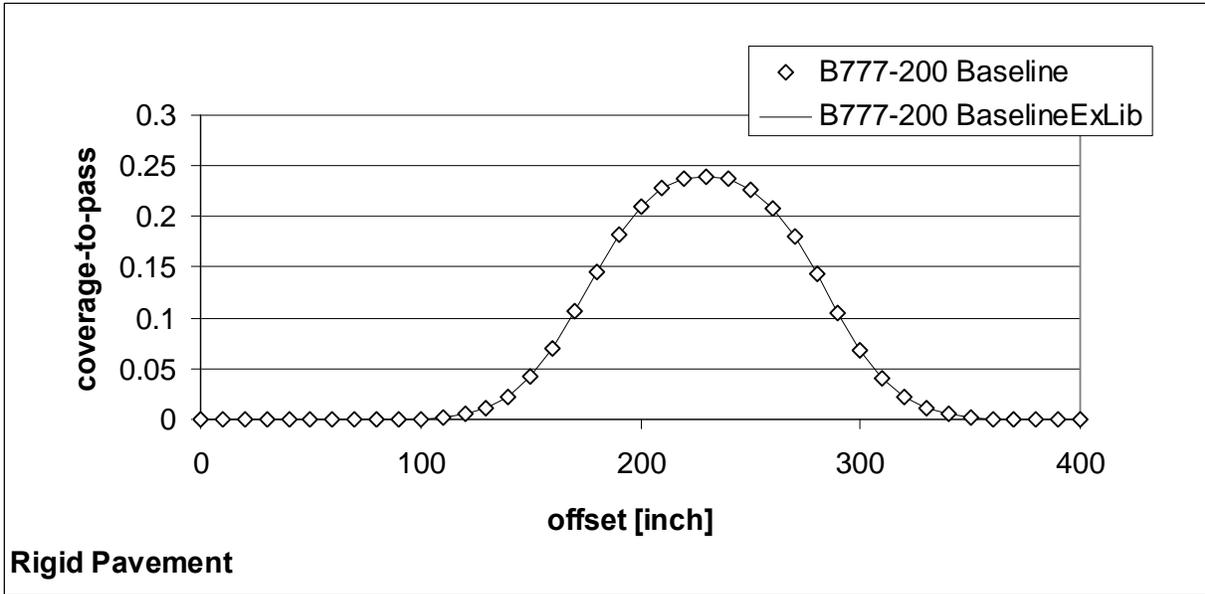


Figure 7. Distribution of C/P Ratio for B777-200 Baseline and B777-200 BaselineExLib for Rigid Pavements

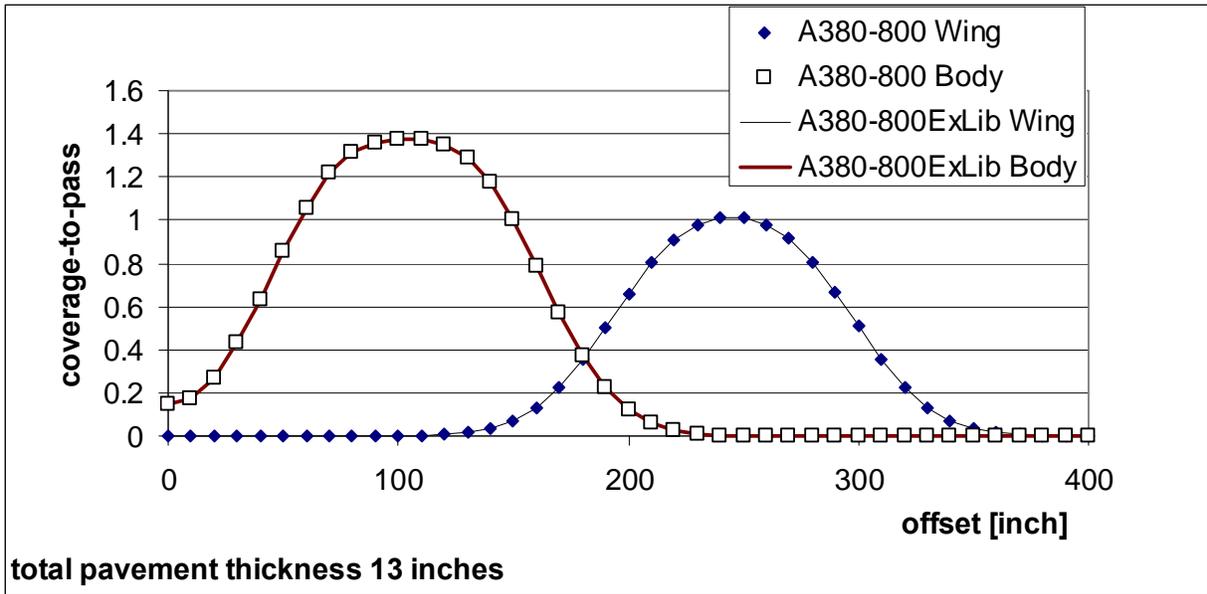


Figure 8. Distribution of C/P Ratio for A380-300 and A380-800ExLib for Flexible Pavements (Pavement thickness = 13 inches)

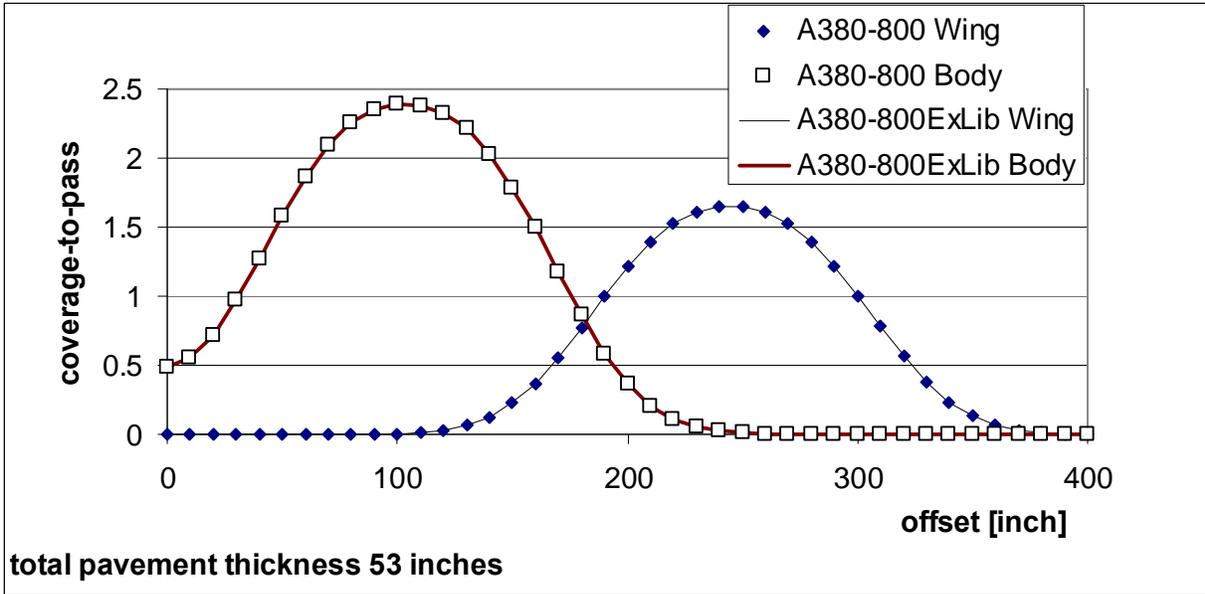


Figure 9. Distribution of C/P Ratio for A380-300 and A380-800ExLib for Flexible Pavements (Pavement thickness = 53 inches)

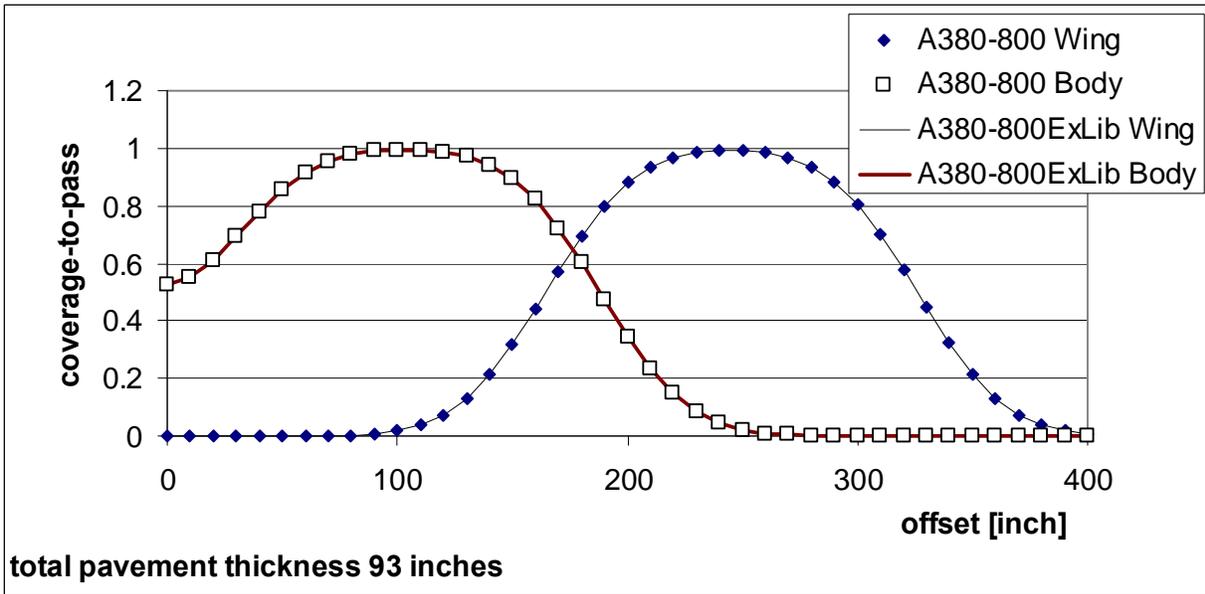


Figure 10. Distribution of C/P Ratio for A380-300 and A380-800ExLib for Flexible Pavements (Pavement thickness = 93 inches)

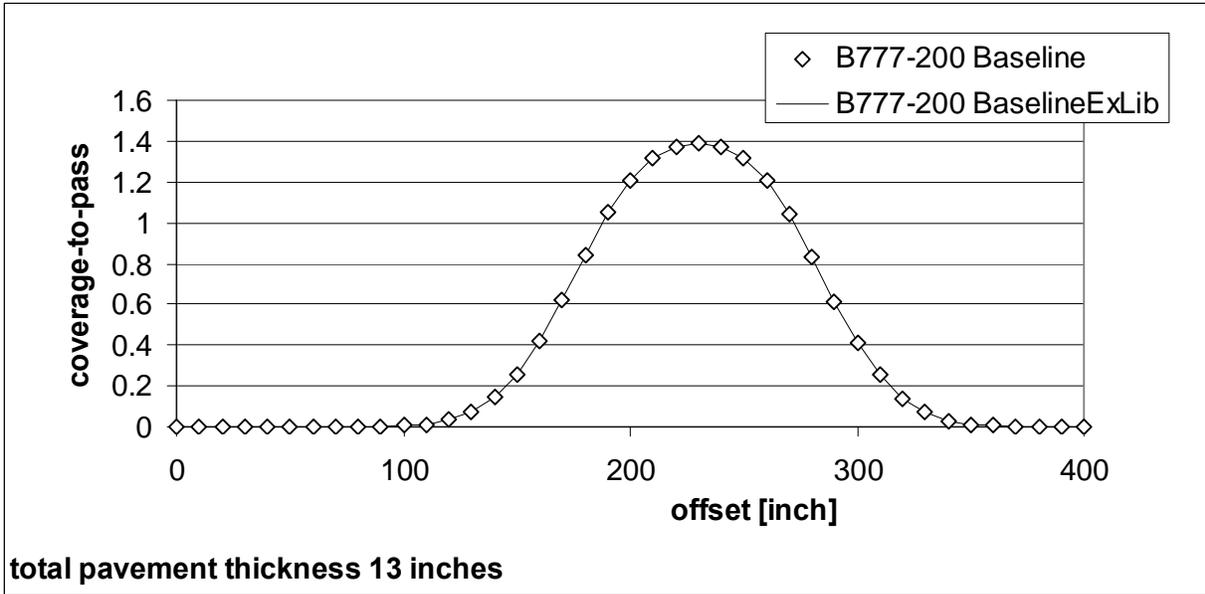


Figure 11. Distribution of C/P Ratio for B777-200 Baseline and B777-200 BaselineExLib (Pavement thickness = 13 inches)

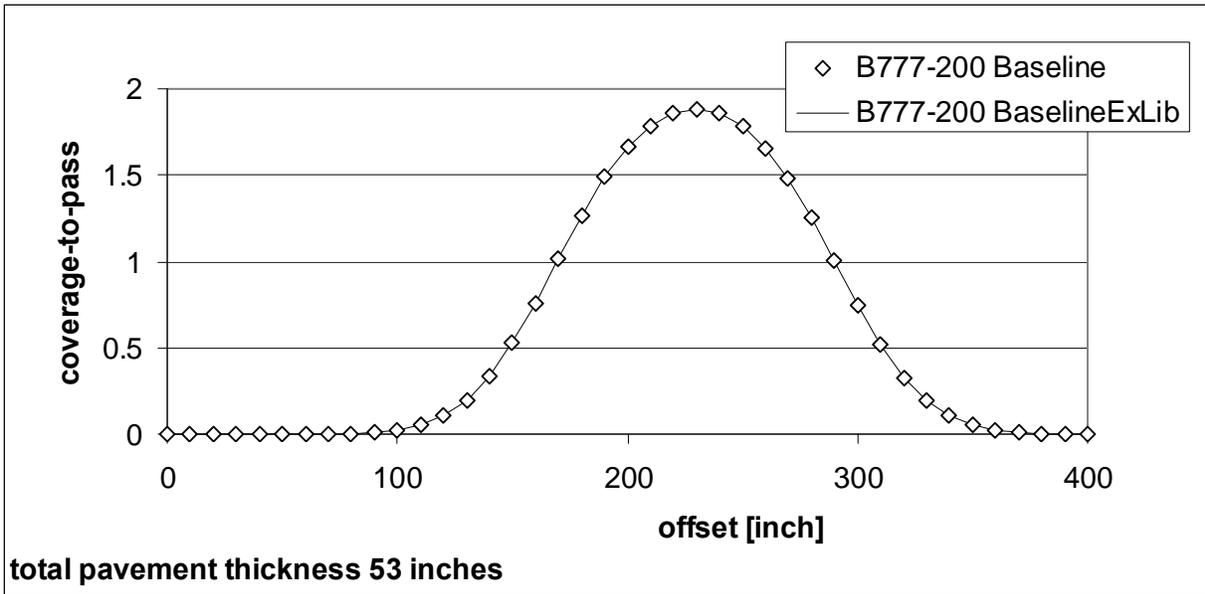


Figure 12. Distribution of C/P Ratio for B777-200 Baseline and B777-200 BaselineExLib (Pavement thickness = 53 inches)

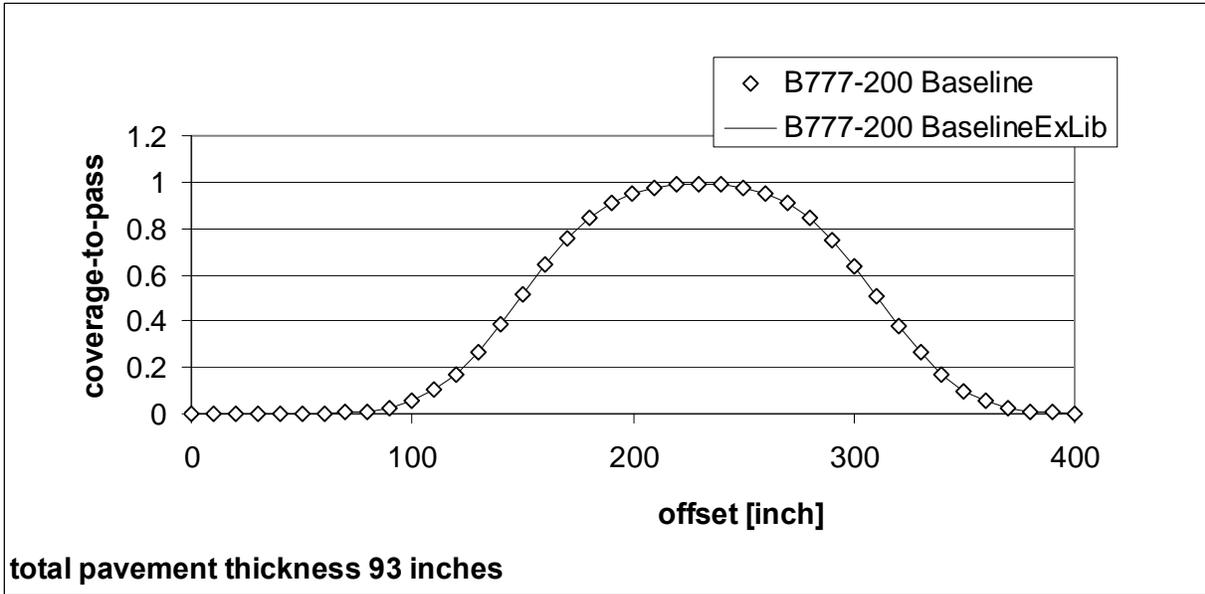


Figure 13. Distribution of C/P Ratio for B777-200 Baseline and B777-200 BaselineExLib (Pavement thickness = 93 inches)

NEW XML SCHEMA FOR AIRPLANES IN THE FAARFIELD EXTERNAL LIBRARY

Appendix A contains a new XML schema for the FAARFIELD external airplane library, and appendix B contains an example of an external library file in XML format. Information about XML including the current specification can be found online in reference 3. Figure 14 shows wheel coordinates and evaluation points for the A380-800 airplane.

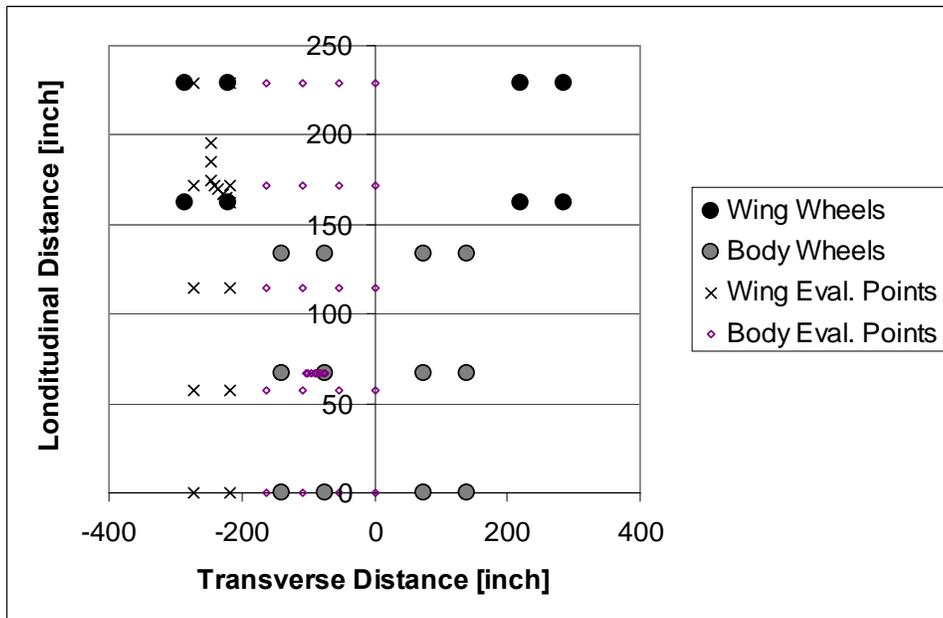


Figure 14. Gear Configurations and Evaluation Points for A380-800 Airplane

Evaluation points are used in layered elastic analysis (LEA) and are mainly relevant for flexible pavement case. They do not apply to rigid pavements where the structure is analyzed by means of the finite element method. However, evaluation points must still be included in the FAARFIELD external airplane file for the rigid pavement case because the preliminary phase of rigid pavement design in FAARFIELD uses LEA.

An external library airplane with an arbitrary gear configuration must be coded “X” to be recognized properly by FAARFIELD. The user has the ability to specify up to two wheel groups. The wheel coordinates need to be specified only on one side of the airplane. As shown in the example provided in appendix A, the wheel coordinates on the other side of the airplane are defined automatically by the program, assuming the gear is reflected on the centerline. A complete user’s guide for the modified external library, including procedures for defining code X airplanes, is provided in appendix D.

CONCLUSIONS

Recent modifications to the Federal Aviation Administration Rigid and Flexible Iterative Elastic Layered Design (FAARFIELD) program support user-defined aircraft gear configurations consisting of up to two wheel groups. Arbitrary gear configurations designated by letter code “X” in the Extensible Markup Language (XML) external library need not conform to any of the existing standard gear types. A general method of computing the pass-to-coverage (P/C) ratio in FAARFIELD, which applies to arbitrary gear geometries, is described. It is demonstrated that the P/C ratios computed for specific multiple-wheel gears (Airbus A380-800 and Boeing B777) defined using the new external library procedure are identical to those for the same airplanes in the internal library.

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2. Kawa, I., Hayhoe, G.F., and Brill, D.R., “Modifications to Pass-to-Coverage Ratio Computation in the FAA’s FAARFIELD Design Procedure,” *2nd International Conference on Transport Infrastructures*, São Paulo, Brazil, August 2010.
3. The World Wide Web Consortium (W3C), Extensible Markup Language (XML) web site, <http://www.w3.org/XML/> (last visited September 21,2012).

APPENDIX A—THE EXTENSIBLE MARKUP LANGUAGE SCHEMA FOR THE
FAARFIELD EXTERNAL AIRPLANE LIBRARY

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APPENDIX B—THE FAARFIELD AIRPLANE EXTERNAL LIBRARY

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<EVPTX>-163.05</EVPTX>
<EVPTY>229.35</EVPTY>
  </Evaluation_Points>
  </WheelGroupInfo>
  </AirplaneInfo>
- <AirplaneInfo>
  <Name>B777-200 BaselineExLib</Name>
  <GrossWt>547000</GrossWt>
  <MGpcnt>0.95</MGpcnt>
  <CP>182.00</CP>
  <Gear>X</Gear>
  <IGear>13</IGear>
  <NWheelGroups>1</NWheelGroups>

```

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- <Wheel_Coordinates>
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  <TX>202.25</TX>
  <TY>0.00</TY>
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  <TY>0.00</TY>
  <TX>202.25</TX>
  <TY>57.00</TY>
  <TX>257.25</TX>
  <TY>57.00</TY>
  </Wheel_Coordinates>
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- <Evaluation_Points>
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  <EVPTX>-218.75</EVPTX>
  <EVPTY>0.00</EVPTY>
  <EVPTX>-213.25</EVPTX>
  <EVPTY>0.00</EVPTY>
  <EVPTX>-207.75</EVPTX>
  <EVPTY>0.00</EVPTY>
  <EVPTX>-202.25</EVPTX>
  <EVPTY>0.00</EVPTY>
  </Evaluation_Points>
</WheelGroupInfo>
</AirplaneInfo>
</FAAAirplaneLibrary>
```

APPENDIX C—ILLUSTRATIVE CODE FROM FAARFIELD FOR CUMULATIVE DAMAGE FACTOR CALCULATION (VISUAL BASIC 2005)

```

OFFSET = 0.0!
For IOFF = 1 To NOFF
    System.Windows.Forms.Application.DoEvents()

    GearACType = AC(LI).libIGear
    GearLoadType = AC(LI).libGear

    If GearLoadType = "WFBF" Then
        GearACType = DualTandemMainGear
        If IGearLoads = 1 Then GearLoadType = "WF" ' Wing dual-tandem.
        If IGearLoads = 2 Then GearLoadType = "BF" ' Body dual-tandem.
    End If
    If GearLoadType = "WFBN" Then
        GearACType = DualTandemMainGear
        If IGearLoads = 1 Then GearLoadType = "WF" ' Wing dual-tandem.
        If IGearLoads = 2 Then GearLoadType = "BN" ' Body triple-dual-tandem.
    End If

    Call CoverageToPassFlexible(IA, GearACType, IGearLoads, _
        GearLoadType, OFFSET, CovToPass, Depth)

    ACCDF = CSng(Reps(IA) * CovToPass / NtoFail) ' Aircraft CDF.
    If ACCDF > ACCDFmax Then ACCDFmax = ACCDF

    If IGearLoads = 1 Then
        lclCDF(IA, IOFF) = ACCDF
        CtoP(IA, IOFF) = CovToPass
    Else
        ' Sum CDF over gears for multiple gear aircraft.
        lclCDF(IA, IOFF) = lclCDF(IA, IOFF) + ACCDF
        ' Report maximum CtoP for multiple gear aircraft.
        If CovToPass > CtoP(IA, IOFF) Then CtoP(IA, IOFF) = CovToPass
    End If

    If lclCDF(IA, IOFF) > jobCDFacrftMaxtable(ISect, IA) Then _
        jobCDFacrftMaxtable(ISect, IA) = lclCDF(IA, IOFF)
    If jobCtoPtable(ISect, IA) < CtoP(IA, IOFF) Then _
        jobCtoPtable(ISect, IA) = CtoP(IA, IOFF)
    ' Note: CtoP(IA, IOFF) is used only for printing when required.

    CDFFlexVal(IOFF) = CDFFlexVal(IOFF) + ACCDF

    OFFSET = OFFSET + OFFSETINC
Next IOFF

```

APPENDIX D—USERS’ GUIDE FOR THE FAARFIELD EXTERNAL LIBRARY

The file *FAAairplaneLibrary.xml* contains the Federal Aviation Administration (FAA) Rigid and Flexible Iterative Elastic Layered Design (FAARFIELD) external airplane library in Extensible Markup Library (XML) format. The FAARFIELD user can add, delete, or modify airplanes in *FAAairplaneLibrary.xml* by modifying the XML content of this file.

Table D-1 lists existing letter gear designations and corresponding numerical codes for various common gear types in FAARFIELD. To this list should be added the “X” designation, which pertains to an arbitrary or a user-defined gear configuration. The “X” type may consist of up to two wheel groups, and within a wheel group the individual tires need not conform to a pattern.

Table D-2 contains sample XML code for a gear configuration of type “X” consisting of two wheel groups that are offset in both the x and y dimensions (A380-800 BaselineExLib, figures D-1 and D-2). The XML fields are annotated in table D-2. Figure D-1 graphically presents the data entered by the user in table D-2. The wheel coordinates need to be specified only on one side of the airplane. The wheel coordinates on the other side of the airplane are automatically generated by the program, assuming that the gear is reflected on the centerline. Figure D-2 shows the gear configuration of the A380-800ExLib airplane as displayed by the FAARFIELD program in the View Gear window.

The user still has the option of using a gear definition conforming to one of the existing letter designations shown in table D-1. In the case where the gear to be added is a common type (a dual-tandem (2D) airplane, for example), it is usually easier to apply the appropriate letter code from table D-1 rather than use the “X” designation. Table D-3 contains sample XML code for a gear configuration of type “N” (B777-200 BaselineExLib, figures D-3 and D-4). The XML fields are annotated in table D-3. Figure D-3 graphically shows the gear data provided by the user in table D-3. The user must specify wheel locations in gear local coordinates. Figure D-4 shows the gear configuration of the B777-200 BaselineExLib airplane as displayed by the FAARFIELD program in the View Gear Window.

The “X” designation is subject to the following restrictions: (1) airplane wheels must have the same load and tire pressure, (2) currently, the number of wheel groups is limited to 2, and (3) data must be entered in U.S. units.

Table D-1. Existing FAARFIELD Gear Designations

	Letter Gear Designation	Numerical Gear Designation
Single wheel	B	2
Single wheel in tandem	E	2
Dual wheel	D	3
Dual tandem	F	3
Triple dual tandem	N	3

Table D-2. Example of XML Data for A380-800 BaselineExLib Airplane

- <FAAAirplaneLibrary>	
- <AirplaneInfo>	
<Name> A380-800ExLib </Name>	Airplane name
<GrossWt> 1239000 </GrossWt>	Gross weight in lb
<MGpcnt> 0.95 </MGpcnt>	Percent of load on main gears
<CP> 194.00 </CP>	Tire pressure in psi
<Gear> X </Gear>	Gear designation
<IGear> 13 </IGear>	Gear designation
<NWheelGroups> 2 </NWheelGroups>	Number of wheel groups
- <WheelGroupInfo>	
<NTires> 4 </NTires>	Number of tires
- <Wheel_Coordinates>	
<TX> -271.75 </TX> <TY> 229.35 </TY>	} Wheel coordinates for wheel group 1
<TX> -271.75 </TX> <TY> 162.45 </TY>	
<TX> -218.65 </TX> <TY> 162.45 </TY>	
<TX> -218.65 </TX> <TY> 229.35 </TY>	
</Wheel_Coordinates>	
<NEVPTS> 18 </NEVPTS>	Number of evaluation points
- <Evaluation_Points>	
<EVPTX> -218.65 </EVPTX>	} Evaluation point coordinates for wheel group 1
<EVPTY> 162.45 </EVPTY>	
. . .	
<EVPTX> -271.75 </EVPTX>	}
<EVPTY> 229.35 </EVPTY>	
</Evaluation_Points>	
<NTires> 6 </NTires>	Number of tires
- <Wheel_Coordinates>	
<TX> -133.70 </TX> <TY> 133.80 </TY>	} Wheel coordinates for wheel group 2
<TX> -134.10 </TX> <TY> 66.90 </TY>	
<TX> -133.70 </TX> <TY> 0.00 </TY>	
<TX> -73.50 </TX> <TY> 0.00 </TY>	
<TX> -73.10 </TX> <TY> 66.90 </TY>	
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</Wheel_Coordinates>	
<NEVPTS> 28 </NEVPTS>	Number of evaluation points
- <Evaluation_Points>	
<EVPTX> -73.10 </EVPTX>	} Evaluation point coordinates for wheel group 2
<EVPTY> 66.90 </EVPTY>	
. . .	
<EVPTX> -163.05 </EVPTX>	}
<EVPTY> 229.35 </EVPTY>	
</Evaluation_Points>	
</WheelGroupInfo>	
</AirplaneInfo>	
</FAAAirplaneLibrary>	

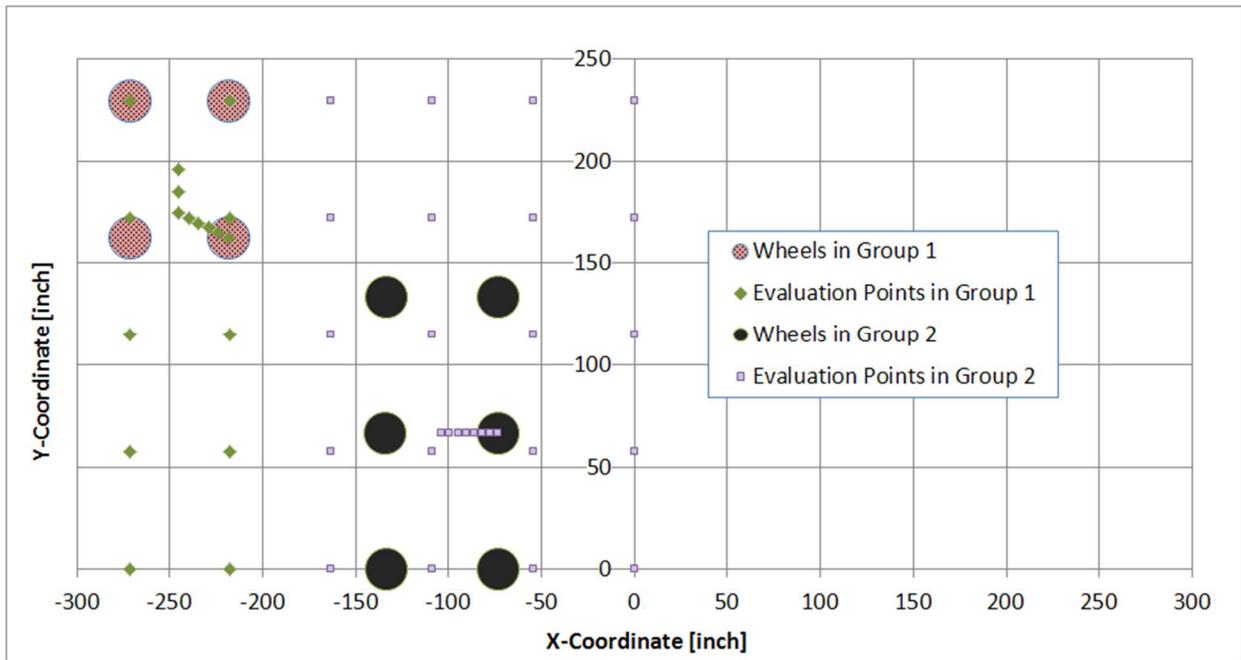


Figure D-1. The A380-800ExLib Gear Configuration in Airplane Coordinates

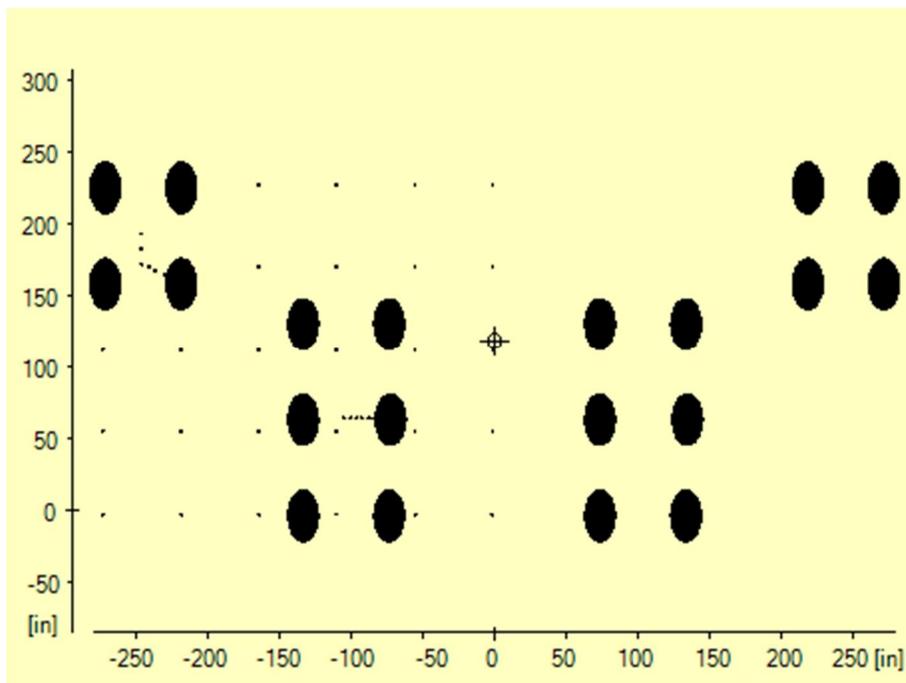


Figure D-2. The A380-800ExLib Gear Configuration in Airplane Coordinates as Displayed by FAARFIELD

Table D-3. Example of XML Data for B777-200 BaselineExLib Airplane

- <FAAAirplaneLibrary>	
- <AirplaneInfo>	
<Name> B777-200 BaselineExLib </Name>	Airplane name
<GrossWt> 547000 </GrossWt>	Gross weight in lb
<MGpcnt> 0.475 </MGpcnt>	Percent of load on main gears
<CP> 182.00 </CP>	Tire pressure in psi
<Gear> N </Gear>	Gear designation
<IGear> 3 </IGear>	Gear designation
<TT> 55.00 </TT>	Dual wheel distance
<TS> 404.50 </TS>	Inner-wheel gear distance
<TG> 0.00 </TG>	
 57.00 	Dual tandem distance
<NWheelGroups> 1 </NWheelGroups>	Number of wheel groups
- <WheelGroupInfo>	
<NTires> 6 </NTires>	Number of tires
- <Wheel_Coordinates>	
<TX> -27.50 </TX> <TY> 0.00 </TY>	} Wheel coordinates
<TX> 27.50 </TX> <TY> 0.00 </TY>	
<TX> -27.50 </TX> <TY> 57.00 </TY>	
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</Wheel_Coordinates>	
<NEVPTS> 6 </NEVPTS>	Number of evaluation points
- <Evaluation_Points>	
<EVPTX> 27.50 </EVPTX> <EVPTY> 57.00 </EVPTY>	} Evaluation point coordinates
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</AirplaneInfo>	
</FAAAirplaneLibrary>	

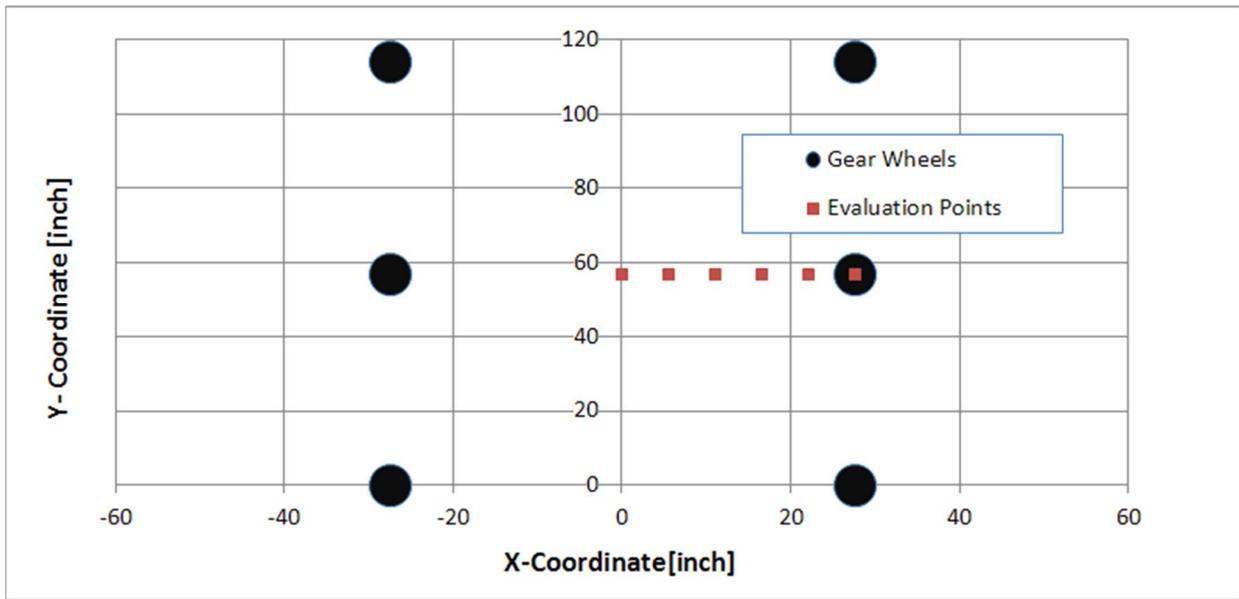


Figure D-3. The B777-200 BaselineExLib Gear Configuration in Local Coordinates

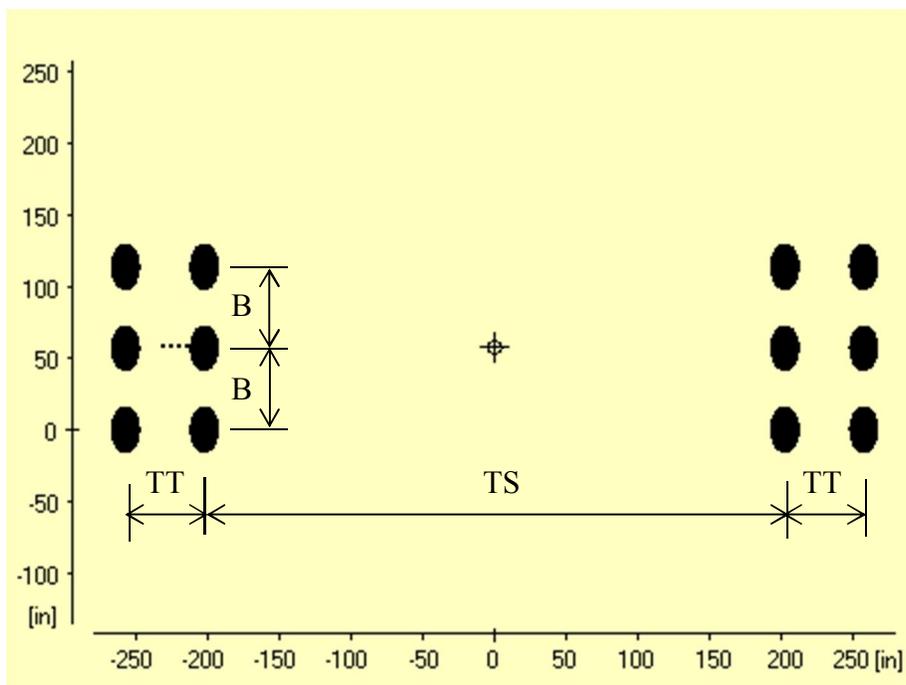


Figure D-4. The B777-200 BaselineExLib Gear Configuration in Airplane Coordinates as Displayed by FAARFIELD