

RESPONSE OF STRUCTURES TO ATMOSPHERIC TURBULENCE

Computer Programs A9236 and B9236

1. SUMMARY

1.1 Introduction

This Item is one of a group concerned with methods of calculating the loading on and response of structures due to atmospheric turbulence. It provides information on the use of computer programs ESDUpac A9236 and ESDUpac B9236.

ESDUpac A9236 is based on the calculation methods of ESDU 87035¹ and ESDU 88019² for response to the along-wind component of turbulence. ESDUpac B9236 is based on the calculation method of ESDU 89049³ for response to across-wind components of turbulence.

The programs are supplied on disks located in the Wind Engineering Software Volume in two versions. Firstly in a compiled version integrated into the ESDUview PC interface and secondly as a FORTRAN 77 source code listing. In both cases files for several worked examples are included with the programs.

The use of the programs within the ESDUview environment is introduced in Section 2. Setting up input files, running the program and viewing output files can all be carried out within ESDUview.

Use of the source code is outlined in Section 3. In this case the input files must be generated separately, for which instructions are given, and the source code must be compiled in order to run the programs.

Section 4 provides some background to the input data required and interpretation of the output data. Section 4.1 relates the notation used in the output from the programs to that in the corresponding Items. Section 4.2 provides some notes on input required by the programs. Section 4.3 describes briefly the errors trapped by the programs and Section 4.4 describes the output files.

Section 5 presents the worked examples provided with the programs.

1.2 Applicability and Limitations

The programs may be used to calculate the loading on, deflection of, or acceleration of a range of isolated, uniform or non-uniform structures including:

- (i) line-like structures such as chimney stacks, solid or lattice towers and masts, empty or gas-filled suspended pipelines and structural members such as tie rods, any of which may be inclined in a plane normal to the mean wind direction;
- (ii) prismatic and plate-like structures such as buildings and towers and some bridge- and gantry-type structures.

The programs are limited to the calculation of a range of first mode bending responses (see Section 4.2.4). They do not make allowance for aerodynamic or structural coupling between modes.

Further information on the basis of the calculation methods is given in References 1, 2, 3 and 7.

Although program A9236 will calculate responses for any loading component for which the load coefficient is defined, it is most reliable for components which are in or near an along-wind direction because it uses

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turbulence admittance factors derived from tests with along-wind loading only.

Similarly, program B9236 will calculate responses for any loading component for which the load coefficient slope is defined, but is most reliable for components which are in or near an across-wind direction because it uses turbulence admittance factors derived from tests with across-wind loading only.

2. RUNNING ESDUpacs A9236 AND B9236 IN ESDUview

2.1 ESDUview and ESDUpacs

ESDUview is a user-friendly PC interface the purpose of which is to simplify the running of ESDUpac FORTRAN programs. Its facilities include the setting up of the required input file from data entered in response to screen prompts, running of the program and display of the output file. Context-sensitive help is provided for both the interface system and individual programs.

The ESDUview system is in two parts; the core ESDUview program and the Volume disks. Both are provided on 3½" disks in the Wind Engineering Software Volume. The ESDUpac programs A9236 and B9236 are both included on the Volume disk Wind Engineering Volume 3a.

A manual, "Using ESDUview", is provided in the Software Volume describing the installation and use of ESDUview and the facilities it provides.

2.2 Running ESDUpac A9236 or B9236 in ESDUview

Sketch 2.1 shows the main menu form for ESDUpac A9236. The entry of titles and choice of units is made directly on this form. Selection of "Filenames" or one of the options under Data Input presents the appropriate form from those shown in Sketches 2.2 to 2.7. Basic data and selections are entered on these forms and access is provided to further forms on which more detailed data are entered. A similar series of forms is used for ESDUpac B9236.

Sketch 2.1 Main menu form, A9236

When 'Run' is selected on the main form, ESDUview runs a number of checks on the data entered and warns of incorrect or missing data where feasible. If the data are acceptable a final check on filenames is offered and ESDUview then writes the data to an appropriately formatted ASCII input file*, runs the

* This file is always a 'Type 4' input file as described in Section 3 since the simplified files are unnecessary when running in ESDUview.

FORTTRAN program and displays the output file.

Sketch 2.2 Filenames form

Sketch 2.3 Structural selection form

Sketch 2.4 Mass selection form

Sketch 2.5 Modal and loading form

Sketch 2.6 Response selection form

Sketch 2.7 Wind and terrain selection form

The entries on the Main menu form can be accessed in any order but, in the absence of other considerations the user is recommended to follow the order in which they appear.

It is also possible to save the data to a file which can be reread by ESDUview. Select the File menu from the top menu bar and choose the "Save ESDUpac data" option. A form is presented on which the required file name can be entered. An extension .VWD is recommended to identify such files. This option is also

offered when an ESDUpac is closed.

In the present case, use can be made of the facility to reload data into ESDUview to avoid input of much of the data for calculation of across-wind response if the along-wind response has already been calculated or vice-versa. Assume that program A9236 has been run and the data stored in a file INA9236.VWD. If ESDUpac B9236 is now opened these data can be loaded by using the “Load ESDUpac data” option on the File menu. Each form accessed in ESDUpac B9236 will then show the values entered for A9236 where these are common. The appropriate changes or new entries can be made for, in this case, loading and wind turbulence data and the ESDUpac B9236 can be run.

3. RUNNING ESDUpacs A9236 AND B9236 FROM SOURCE CODE

3.1 Compiling the Source Code

Source code listings for programs A9236 and B9236 in FORTRAN 77 language, together with files for the input and output corresponding to the worked examples in Section 5 are included on the ESDUpac disk for Volume 3a, in directories SOURCE\A9236 and SOURCE\B9236. Also included in those directories are README files which include lists of the files and their sizes.

The source code must be compiled before it can be run. The source code for these programs has been split into four files for each to facilitate compilation on machines with a 64000 byte code limit. The files can be merged before compiling if this limit does not apply. On machines with the limit the files must be compiled separately and then linked. This can be done automatically with the Microsoft Fortran Compiler Version 5 using commands of the form

```
FL /4Yds A9236.FOR A9236X01.FOR A9236X02.FOR A9236X03.FOR , for program A9236
and FL /4Yds B9236.FOR B9236X01.FOR B9236X02.FOR B9236X03.FOR , for program B9236.
```

Executable files A9236.EXE and B9236.EXE will be created and will contain the full executable program code.

The programs read the required input data from an input file which must be assembled separately using an editor. Assembly instructions for these files are given in Section 3.2.

As supplied, the programs are for “directed input”, requiring the name of the input file to be specified at the run command. For MS-DOS, for example, the command line takes the form

```
A9236 <input file name
```

The output file name is included in, and read from, the input file.

3.2 Program Input Files

Assembly instructions for four alternative input data file types* are given in Tables 3.1 to 3.4. The cases represented are outlined in Sections 3.3.1 to 3.3.4 with comments on the assumptions and options built into each case. The program accepts any of these input files without modification.

Each entry should consist of the entry reference number† (enclosed between quotes) followed by the

* The ESDUview interface always produces an input file of Type 4.

† The entry reference numbers used are part of a more comprehensive scheme used in several ESDU Wind Engineering computer programs. Consequently gaps will be found in the sequences used by this program.

appropriate value or values. For example, a height of 150 m would be entered as “S10” 150. Where an entry requires several numbers these should be input as the entry reference number followed by the sequence of numbers with appropriate separators (commas or spaces). The data input sequence ensures that the appropriate number of values will be read in for such entries.

The data required are similar for both programs except in the loading data section, where A9236 requires force coefficients and B9236 requires slopes of force coefficient against incidence curves, and the wind data section where A9236 requires u -component turbulence properties and B9236 requires v - and/or w -component properties.

3.2.1 Program Input File Type 1 (Tables 3.1A and 3.1B)

Uniform vertical cantilever

The structure is represented by a ground-based, uniform, vertical cantilever with a mode shape $(r/H)^{1.5}$. Default values of $46/(H \text{ in metres})$ [equal to $151/(H \text{ in feet})$] for natural frequency and of 0.005 for structural damping ratio are available by input of zero at entries P02 and P03.

Entries P02, P03 and L12 or L17 require two values if both principal axis responses are required, or one value if only one response is required.

The user can select calculation of deflection and acceleration at the top of the structure (input 0 at I01) or of base bending moment (input 1 at I01). First mode responses only are calculated.

The wind data may be input as Type 0, Type 1 or Type 3 of Table 4.6. For response to along-wind turbulence (A9236), the u -component turbulence properties are required. For response to across-wind components (B9236), the v -component turbulence properties are required. In each case the program calculates the wind-speed profile assuming uniform terrain upwind of the site.

3.2.2 Program Input File Type 2 (Tables 3.2A and 3.2B)

Uniform line-like structure

The structure is represented by a uniform cantilever (mode shape $(r/L)^{1.5}$) (input 0 at P04) or a uniform single-span structure (mode shape $\sin(\pi r/L)$) (input 1 at P04). It may be inclined in the across-wind plane and its lower end may be above ground level.

Calculation of deflection and acceleration, at the tip of a cantilever or at the centre of a single-span structure (input 0 at I01) or of bending moment, at the base of a cantilever or at the centre of a single-span structure (input 1 at I01) can be selected. First mode responses only are calculated.

The wind data may be input as Type 0, Type 1 or Type 3 of Table 4.6, noting that if wind speed and turbulence properties at height h_c are input (Type 3) they should be values at the top for cantilever structures and at mid-span for single-span structures. For response to along-wind turbulence (A9236), the u -component turbulence properties are required. For response to across-wind components (B9236), for vertical structures for only v -component turbulence properties are required, and for horizontal structures only w -component properties, but for inclined structures both v - and w -component properties must be input. The program calculates the wind-speed profile assuming uniform terrain upwind of the site.

3.2.3 Program Input File Type 3 (Table 3.3)

Non-uniform vertical cantilever

The structure is represented by a ground-based, vertical cantilever. The exponent N_1 in the first mode shape can be selected by the user. The mass distribution, structure width and the force coefficients or slopes of the force coefficient curves can vary vertically or can be set constant. Unlike input files of Types 1 and 2, the modal and loading data for OP and OQ directions are input separately.

Calculation of deflection, acceleration, shear force or bending moment at any height can be requested.

The wind data may be input as any of the types in Table 4.6. For response to along-wind turbulence (A9236), the u -component properties are required, for response to across-wind components (B9236), the v -component properties are required. The turbulence properties include the spectral density function, ϕ_{uu} or ϕ_{vv} ; if this is not known, input of 0 prompts the program to calculate a default value.

3.2.4 Program Input File Type 4 (Table 3.4)

General structure, user-generated mode shapes may be included

This is the most general case covered by the program. The structure may be inclined in the across-wind plane and its lower end may be above ground level. With program B9236 only, a horizontal structure, such as a bridge check, may be yawed relative to the oncoming wind. The mass distribution, structure width and force coefficients or slopes of the force coefficient curves can vary along the structure or can be set constant.

The full range of mode shapes in Table 4.3 is available. In addition, the user's own mode shape may be input for either or both directions. If this option is selected, the nearest standard mode shape must also be input to enable the program to calculate the non-dimensional loading factor. The user should take care to choose compatible mode shapes and response functions.

The calculated response depends on the response function selected from Table 4.5.

The wind data may be input as any of the types in Table 4.6. For response to along-wind turbulence (A9236), the u -component turbulence properties are required. For response to across-wind turbulence (B9236), for vertical structures, only v -component turbulence properties are required and for horizontal structures only w -component properties, but for inclined structures both v - and w -component properties must be input.

TABLE 3.1A Program Input File Type 1 for A9236

Input parameter	Units		Input to file	
	SI	British	Entry ref. no.*	Value(s)
Enter file name for input file (up to 8 characters between quotes).	—	—	G01	
Enter file name for output file (up to 8 characters between quotes), enter ' ' to use default name RSA9236.	—	—	G02	
Enter data set or run title. All three lines must be present but can be blank. Line 1 of title (up to 75 characters between quotes). Line 2 of title (up to 75 characters between quotes). Line 3 of title (up to 75 characters between quotes).	— — —	— — —	G03 G04 G05	
Enter 1 to select Program Data File Type 1.	—	—	G06	1
Enter 0 for SI units; enter 1 for British units.	—	—	G07	
Enter overall or reference height of structure, H .	m	ft	S10	
Enter overall or reference cross-sectional dimensions, a and b .	m, m	ft, ft	S15	
Enter overall mass of structure, M (assumed uniformly distributed) [†] .	kg	lb	M01	
Enter number of modes considered in each of 0P and 0Q directions* (0 or 1 only in this program).	—	—	P01	
Enter natural frequency, n_1 , in each direction* to be calculated. (Enter 0 to use program default value [46/ H metres, 151/ H feet].)	Hz	Hz	P02	
Enter structural damping ratio, ζ_s , in each direction* to be calculated. (Enter 0 to use program default value [0.005].)	—	—	P03	
Enter structure force coefficient, C_F , for each direction* to be calculated.	—	—	L12	
Choose required response. Enter 0 for deflection and acceleration at top of structure; enter 1 for base bending moment.	—	—	I01	
Enter type number for choice of wind and terrain data input (Table 4.6). (Enter 0 for default values [$V = 25$ m/s at 10 m height over uniform terrain with $z_0 = 0.03$ m].) (Option 2 or 4 of Table 4.6 not available here.)	—	—	W05	
If entry W05 is 0, the data file is now complete; if entry W05 is 1 or 3, continue below.				
Enter terrain roughness height, z_0 , and displacement height, d , at site.	m, m	ft, ft	W07	
If entry W05 is 1, enter specified height, H_R , and hourly-mean wind speed, V_R . If entry W05 is 3, enter height of top of structure and hourly-mean wind speed, V_{hc} .	m, m/s	ft, ft/s	W21	
If entry W05 is 1, the data file is now complete; if entry W05 is 3, continue below.				
Enter turbulence intensity, I_u , at top of structure.	—	—	W25	
Enter length scale, ^xL_u , at top of structure.	m	ft	W28	
Enter length scale, ^yL_u , at top of structure.	m	ft	W31	
Enter length scale, ^zL_u , at top of structure.	m	ft	W34	

Program Data File Type 1 is now complete.

* In this program, if both response directions are requested, the modal data for both 0P and 0Q directions are entered under P.. reference numbers and loading data for both directions under L12.

† The displacement or acceleration response is proportional to M . In the absence of better estimates a full-scale structure density of about 150 to 300 kg/m³ is typical of modern tall buildings.

TABLE 3.1B Program Input File Type 1 for B9236

Input parameter	Units		Input to file	
	SI	British	Entry ref. no.*	Value(s)
Enter file name for input file (up to 8 characters between quotes).	—	—	G01	
Enter file name for output file (up to 8 characters between quotes), enter ' ' to use default name RSB9236.	—	—	G02	
Enter data set or run title. All three lines must be present but can be blank. Line 1 of title (up to 75 characters between quotes). Line 2 of title (up to 75 characters between quotes). Line 3 of title (up to 75 characters between quotes).	— — —	— — —	G03 G04 G05	
Enter 1 to select Program Data File Type 1.	—	—	G06	1
Enter 0 for SI units; enter 1 for British units.	—	—	G07	
Enter overall or reference height of structure, H .	m	ft	S10	
Enter overall or reference cross-sectional dimensions, a and b .	m, m	ft, ft	S15	
Enter overall mass of structure, M (assumed uniformly distributed) [†] .	kg	lb	M01	
Enter number of modes considered in each of $0P$ and $0Q$ directions* (0 or 1 only in this program).	—	—	P01	
Enter natural frequency, n_1 , in each direction* to be calculated. (Enter 0 to use program default value [46/ H metres, 151/ H feet].)	Hz	Hz	P02	
Enter structural damping ratio, ζ_s , in each direction* to be calculated. (Enter 0 to use program default value [0.005].)	—	—	P03	
Enter slope of structure force coefficient curve, $dC_F/d\phi$, for each direction* to be calculated.	deg ⁻¹	deg ⁻¹	L17	
Choose required response. Enter 0 for deflection and acceleration at top of structure; enter 1 for base bending moment.			I01	
Enter type number for choice of wind and terrain data input (Table 4.6). (Enter 0 for default values [$V = 25$ m/s at 10 m height over uniform terrain with $z_0 = 0.03$ m].) (Option 2 or 4 of Table 4.6 not available here.)	—	—	W05	
If entry W05 is 0, the data file is now complete; if entry W05 is 1 or 3, continue below.				
Enter terrain roughness height, z_0 , and displacement height, d , at site.	m, m	ft, ft	W07	
If entry W05 is 1, enter specified height, H_R , and hourly-mean wind speed, V_R . If entry W05 is 3, enter height of top of structure and hourly-mean wind speed, V_{hc} .	m, m/s	ft, ft/s	W21	
If entry W05 is 1, the data file is now complete; if entry W05 is 3, continue below.				
Enter turbulence intensity, I_v , at top of structure.	—	—	W25	
Enter length scale, ^xL_v , at top of structure.	m	ft	W28	
Enter length scale, ^yL_v , at top of structure.	m	ft	W31	
Enter length scale, ^zL_v , at top of structure.	m	ft	W34	

Program Data File Type 1 is now complete.

* In this program, if both response directions are requested, the modal data for both $0P$ and $0Q$ directions are entered under P.. reference numbers and loading data for both directions under L17.

[†] The displacement or acceleration response is proportional to M . In the absence of better estimates a full-scale structure density of about 150 to 300 kg/m³ is typical of modern tall buildings.

TABLE 3.2A Program Input File Type 2 for A9236

Input parameter	Units		Input to file	
	SI	British	Entry ref. no.*	Value(s)
Enter file name for input file (up to 8 characters between quotes).	—	—	G01	
Enter file name for output file (up to 8 characters between quotes), enter ' ' to use default name RSA9236.	—	—	G02	
Enter data set or run title. All three lines must be present but can be blank. Line 1 of title (up to 75 characters between quotes). Line 2 of title (up to 75 characters between quotes). Line 3 of title (up to 75 characters between quotes).	— — —	— — —	G03 G04 G05	
Enter 2 to select Program Data File Type 2.	—	—	G06	2
Enter 0 for SI units; enter 1 for British units.	—	—	G07	
Enter overall or reference length of structure, L .	m	ft	S10	
Enter height of base above ground level, h_0 .	m	ft	S11	
Enter inclination of structure from vertical, ψ , (0° to 90°).	degree	degree	S13	
Enter overall or reference cross-sectional dimensions, a and b .	m, m	ft, ft	S15	
Enter total mass of structure, M (assumed uniformly distributed).	kg	lb	M01	
Enter number of modes considered in each of 0P and 0Q directions* (0 or 1 only in this program).	—	—	P01	
Enter natural frequency, n_1 , in each direction* to be calculated.	Hz	Hz	P02	
Enter structural damping ratio, ζ_s , in each direction* to be calculated.	—	—	P03	
Enter 0 if mode shape $(r/L)^{1.5}$ is required; enter 1 if mode shape $\sin(\pi r/L)$ is required; for each direction* to be calculated.	—	—	P04	
Enter structure force coefficient, C_F , for each direction* to be calculated.	—	—	L12	
Choose required response. Enter 0 for deflection and acceleration; enter 1 for bending moment.	—	—	I01	
Enter type number for choice of wind and terrain data input (Table 4.6). (Enter 0 for default values [$V = 25$ m/s at 10 m height over uniform terrain with $z_0 = 0.03$ m].) (Option 2 or 4 of Table 4.6 not available here.)	—	—	W05	
If entry W05 is 0, the data file is now complete; if entry W05 is 1 or 3, continue below.				
Enter terrain roughness height, z_0 , and displacement height, d , at site.	m, m	ft, ft	W07	
If entry 04 is 1, enter specified height, H_R , and hourly-mean wind speed, V_R . If entry 04 is 3, enter at reference height and hourly-mean wind speed, V_{hc} .	m, m/s	ft, ft/s	W21	
If entry W05 is 1, the data file is now complete; if entry W05 is 3, continue with entries W26 to W35.				
Enter turbulence intensity, I_u , and/or I_w , at height h_c (see Section 3.2).	—	—	W26	
Enter length scale, ^xL_u , at height h_c (see Section 3.2).	m	ft	W29	
Enter length scale, ^yL_u , at height h_c (see Section 3.2).	m	ft	W32	
Enter length scale, ^zL_u , at height h_c (see Section 3.2).	m	ft	W35	

Program Data File Type 2 is now complete.

* In this program, if both response directions are requested, the modal data for both 0P and 0Q directions are entered under P.. reference numbers and loading data for both directions under L12.

TABLE 3.2B Program Input File Type 2 for B9236

Input parameter	Units		Input to file	
	SI	British	Entry ref. no.*	Value(s)
Enter file name for input file (up to 8 characters between quotes).	–	–	G01	
Enter file name for output file (up to 8 characters between quotes), enter ' ' to use default name RSB9236.	–	–	G02	
Enter data set or run title. All three lines must be present but can be blank. Line 1 of title (up to 75 characters between quotes).	–	–	G03	
Line 2 of title (up to 75 characters between quotes).	–	–	G04	
Line 3 of title (up to 75 characters between quotes).	–	–	G05	
Enter 2 to select Program Data File Type 2.	–	–	G06	2
Enter 0 for SI units; enter 1 for British units.	–	–	G07	
Enter overall or reference length of structure, L .	m	ft	S10	
Enter height of base above ground level, h_0 .	m	ft	S11	
Enter inclination of structure from vertical, ψ , (0° to 90°).	degree	degree	S13	
Enter overall or reference cross-sectional dimensions, a and b .	m, m	ft, ft	S15	
Enter total mass of structure, M (assumed uniformly distributed).	kg	lb	M01	
Enter number of modes considered in each of 0P and 0Q directions* (0 or 1 only in this program).	–	–	P01	
Enter natural frequency, n_1 , in each direction* to be calculated.	Hz	Hz	P02	
Enter structural damping ratio, ζ_s , in each direction* to be calculated.	–	–	P03	
Enter 0 if mode shape $(r/L)^{1.5}$ is required; enter 1 if mode shape $\sin(\pi r/L)$ is required, for each direction* to be calculated.	–	–	P04	
Enter slope of structure force coefficient curve, $dC_F/d\phi$, for each direction* to be calculated.	deg ⁻¹	deg ⁻¹	L17	
Choose required response. Enter 0 for deflection and acceleration; enter 1 for bending moment.	–	–	I01	
Enter type number for choice of wind and terrain data input (Table 4.6). (Enter 0 for default values [$V = 25$ m/s at 10 m height over uniform terrain with $z_0 = 0.03$ m].) (Option 2 or 4 of Table 4.6 not available here.)	–	–	W05	
If entry W05 is 0, the data file is now complete; if entry W05 is 1 or 3, continue below.				
Enter terrain roughness height, z_0 , and displacement height, d , at site.	m, m	ft, ft	W07	
If entry 04 is 1, enter specified height, H_R , and hourly-mean wind speed, V_R , If entry 04 is 3, enter at reference height and hourly-mean wind speed, V_{hc} .	m, m/s	ft, ft/s	W21	
If entry W05 is 1, the data file is now complete; if entry W05 is 3, continue with entries W26 to W35.				
Enter turbulence intensity(ies)*, I_v , and/or I_w , at height h_c (see Section 3.2).	–	–	W26	
Enter length scale(s)*, ^xL_v , and/or ^xL_w , at height h_c (see Section 3.2).	m	ft	W29	
Enter length scale(s)*, ^yL_v , and/or ^yL_w , at height h_c (see Section 3.2).	m	ft	W32	
Enter length scale(s)*, ^zL_v , and/or ^zL_w , at height h_c (see Section 3.2).	m	ft	W35	

Program Data File Type 2 is now complete.

* In this program, if both response directions are requested, the modal data for both 0P and 0Q directions are entered under P. reference numbers and loading data for both directions under L17. If required, turbulence properties for both v and w components are entered under the same reference number.

TABLE 3.3 Program Data File Type 3

Input parameter	Units		Input to file	
	SI	British	Entry ref. no.	Value(s)
GENERAL DATA, A9236 and B9236				
Enter file name for input file (up to 8 characters between quotes).	—	—	G01	
Enter file name for output file (up to 8 characters, between quotes), enter ' ' to use default name RSA9236 or RSB9236.	—	—	G02	
Enter data set or run title. All three lines must be present but can be blank. Line 1 of title (up to 75 characters between quotes). Line 2 of title (up to 75 characters between quotes). Line 3 of title (up to 75 characters between quotes).	— — —	— — —	G03 G04 G05	
Enter 3 to select Program Data File Type 3.	—	—	G06	3
Enter 0 for SI units; enter 1 for British units.	—	—	G07	
STRUCTURAL DATA, A9236 and B9236				
Enter overall or reference height of structure, H .	m	ft	S10	
Enter overall or reference cross-sectional dimensions, a and b .	m, m	ft, ft	S15	
Enter type reference number for loaded area distribution (Table 4.1), enter 0 if structure is completely uniform.	—	—	S16	
If entry S16 is 0, go to entry M01, otherwise continue with entry S17.				
If entry S16 is 1 or 3, enter number of distributed load sections.	—	—	S17	
If entry S16 is 2 or 4, enter number of distributed load sections and number of point load reference areas.	—	—		
If entry S16 is 5, enter number of point-load reference areas.	—	—		
If entry S16 is 1 or 2, enter required number of pairs of [location of end of section (from $r/L = 0$) and width of that section].	—, m	—, ft	S18	
If entry S16 is 3 or 4, enter required number of sets of [location of end of section (from $r/L = 0$) and width at each end of that section].	—, m, m	—, ft, ft		
If entry S16 is 5, no entry is required.	—	—		
If entry S16 is 1 or 3, no entry is required.	—	—	—	
If entry S16 is 2, 4 or 5, enter required number of pairs of [location of point load reference area (from $r/L = 0$) and its area].	—, m ²	—, ft ²	S19	
Enter type reference number for mass distribution (Table 4.2), enter 0 if completely uniform.	—	—	M02	
If entry M02 is 0, go to entry P01, otherwise continue with entry M03.				
If entry M02 is 1, enter number of uniformly-distributed mass sections.	—	—	M03	
If entry M02 is 2, enter number of uniformly-distributed mass sections and number of lumped masses.	—	—		
If entry M02 is 3, enter number of lumped masses.	—	—		
If entry M02 is 1 or 2, enter required number of pairs of [location of end of section (from $r/L = 0$) and mass/unit length for that section].	—, kg/m	—, lb/ft	M04	
If entry M02 is 3 no entry required.	—	—		
If entry M02 is 1, no entry required.	—	—	—	
If entry M02 is 2 or 3, enter required number of pairs of [location of lumped mass (from $r/L = 0$) and its mass].	—, kg	—, lb	M05	

TABLE 3.3 Program Data File Type 3 (Continued)

Input parameter	Units		Input to file	
	SI	British	Entry ref. no.	Value(s)
MODAL DATA, A9236 and B9236.				
Enter number of modes considered in <i>OP</i> direction (0 or 1 only in this program).	–	–	P01	
If entry P01 is 0, go to entry Q01, otherwise continue with entry P02.				
Enter natural frequency, n_1 , in <i>OP</i> direction.	Hz	Hz	P02	
Enter structural damping ratio, ζ_{s1} , in <i>OP</i> direction.	–	–	P03	
Enter exponent, N_1 , for first-mode shape, $(r/L)^{N_1}$, in <i>OP</i> direction.	–	–	P06	
Enter number of modes considered in <i>OQ</i> direction. (0 or 1 only in this program).	–	–	Q01	
If entry Q01 is 0, go to entry L10 (for A9236) or L15 (for B9236).				
Enter natural frequency, n_1 , in <i>OQ</i> direction.	Hz	Hz	Q02	
Enter structural damping ratio, ζ_{s1} , in <i>OQ</i> direction.	–	–	Q03	
Enter exponent, N_1 , for first-mode shape, $(r/L)^{N_1}$, in <i>OQ</i> direction.	–	–	Q06	
LOADING DATA, A9236 (for B9236 go to entry L15)				
If entry P01 is 0, go to entry of data for <i>OQ</i> direction.				
Enter type number for load coefficient distribution (Table 4.4) for <i>OP</i> direction, enter 0 if completely uniform.	–	–	L10	
If entry L10 is 0 or 5, no entry is required.	–	–	–	
If entry L10 is 1 or 2, enter number of distributed-load sections for <i>OP</i> direction.	–	–	L11	
If entry L10 is 0, enter load coefficient for <i>OP</i> direction.	–	–	L12	
If entry L10 is 1 or 2, enter required number of pairs of [location of end of section (from $r/L = 0$) and load coefficient for that section].	–, –	–, –		
If entry L10 is 5, no entry is required.	–	–	–	
If entry L10 is 0 or 1, no entry is required.	–	–	–	
If entry L10 is 2 or 5, enter required number of values of load coefficient for point loads in same order as reference areas input in entry S19.	–	–	L13	
If entry Q01 is 0, go to entry I01, otherwise continue below.				
Enter type number for load coefficient distribution (Table 4.4) for <i>OQ</i> direction, enter 0 if completely uniform.	–	–	L30	
If entry L30 is 0 or 5, no entry is required.	–	–	–	
If entry L30 is 1 or 2, enter number of distributed-load sections for <i>OQ</i> direction.	–	–	L31	
If entry L30 is 0, enter load coefficient for <i>OQ</i> direction.	–	–	L32	
If entry L30 is 1 or 2, enter required number of pairs of [location of end of section (from $r/L = 0$) and load coefficient for that section].	–, –	–, –		
If entry L30 is 5, no entry is required.	–	–	–	
If entry L30 is 0 or 1, no entry is required.	–	–	–	
If entry L30 is 2 or 5, enter required number of values of load coefficient for point loads in same order as reference areas input in entry S19.	–	–	L33	