Guide to Using ILLISLAB15 and ILLIGUI Programs

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Contents

Disclaimer

This software is for educational use only and should not be used in design calculations where public safety is a factor.

Both ILLISLAB15 and ILLIGUI are provided as is and with all faults. The author makes no representations or warranties of any kind concerning the safety, suitability, lack of viruses, inaccuracies, typographical errors, or other harmful components of ILLISLAB15 and ILLIGUI. You are solely responsible for the proper use of ILLISLAB15 and ILLIGUI. The programs ILLISLAB15 and ILLIGUI should not be used for actual design calculations and is provided only for educational use.

The aircraft data provided in ILLIGUI may contain errors. It is up to the user to confirm the data is correct. Some aircraft have up to 30 weight variants and it is impossible to know how a particular airline will further modify the airframe. Unless specified otherwise, the data presented as loads and tire pressures is from the heaviest or most common weight variant.

This software has no brain, use yours.

1 Introduction

ILLIGUI was created to facilitate the easy creation of input files for the newly compiled ILLISLAB15 program. ILLIGUI's stand out feature is that it contains a near complete database of commercial aircraft produced by Boeing and Airbus. Another notable feature is the ability to save model setups and load them at later times to make modifications.

ILLISLAB15 is a recompiled version of the slightly modified Ilsl94 Fortran code. Code editing was performed by Dr. M. Scot Breitenfeld and due to his expertise in Fortran, the following modifications include:

- Compilation of 64-bit and 32-bit versions to enhance memory utilization on the desired systems
- Main node array was reconfigured to be any size allowing for the node spacing to be extremely small even for large slab/multiple slab systems
- Several `DO` and `GOTO` statement blocks have been reconfigured to allow for better optimization
- One loop has been reconfigured to prevent a non-initialized variable issue under certain cases
- Recompilation was done with `-O3` to ensure fastest running code

2 Getting Started

There are two primary methods to use the ILLIGUI program: with and without plotting capabilities. In order to plot the results directly from ILLIGUI, the MATLAB runtime files must be installed using the included installer. Note, the installation files can be over 700Mb.

It is possible to use ILLIGUI without the MATLAB runtime but the user must parse and plot the results independently. The MATLAB libraries included in ILLIGUI parse the output from ILLISLAB15 so that the data can easily be imported into Excel, OriginPro, MATLAB, or any other software package needed for visualization.

ILLIGUI also requires the Section31.mdb file to be in the same directory as the ILLIGUI executable. This database contains the aircraft data and is designed to allow for updating of the aircraft data without having to update the ILLIGUI code. Any modifications to the Section31.mdb file will corrupt the database and cause ILLIGUI to not run properly. (Section31 database is not currently functional, please see Known Errors for more details)

2.1 General Setup

Figure 2.1 shows the opening screen for ILLIGUI. The `File Name:` box is where you enter the desired file name for the input/output files. Do not add any extensions. A `.inp/.out` extension will automatically be added to the filename upon creation. The `Project Name:` box is purely for your reference. It will be present in line 2 of the input file as well as near the beginning of the output file. The next three number change boxes will change meaning depending on the subgrade type selected. Please take note of any warnings that may pop up, especially with the first set of subgrade types. The `Max Iterations:` box is currently disabled as it is not used at this time.

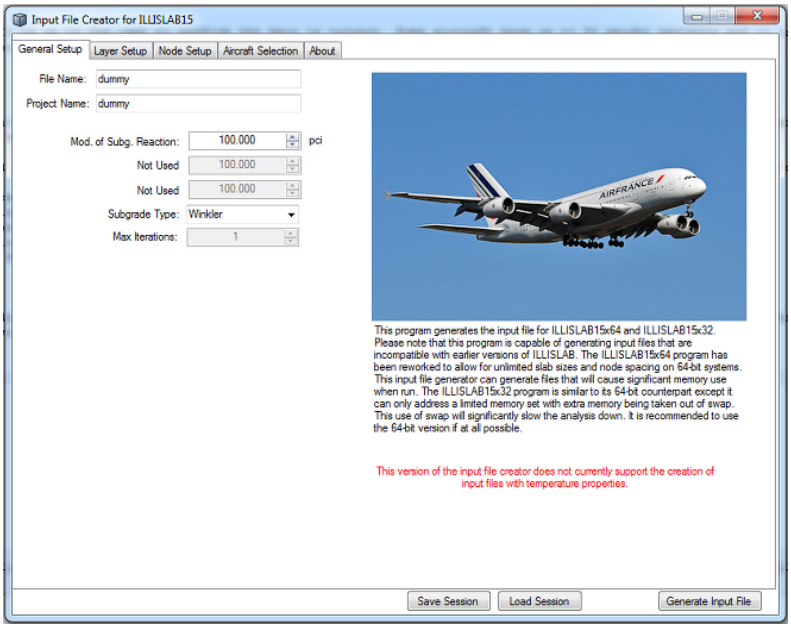

Figure 2.1: Opening screen of ILLIGUI.

2.2 Layer Setup

Figure 2.2 shows the next screen in the input file creation process. Most of the options are self-explanatory. Please note that at this time the temperature modeling capabilities have been disabled. The one property of note is the `Composite Action Factor`. At this time, it is not recommended to choose the Totsky model due to the uncertainty of proper implementation in ILLIGUI.

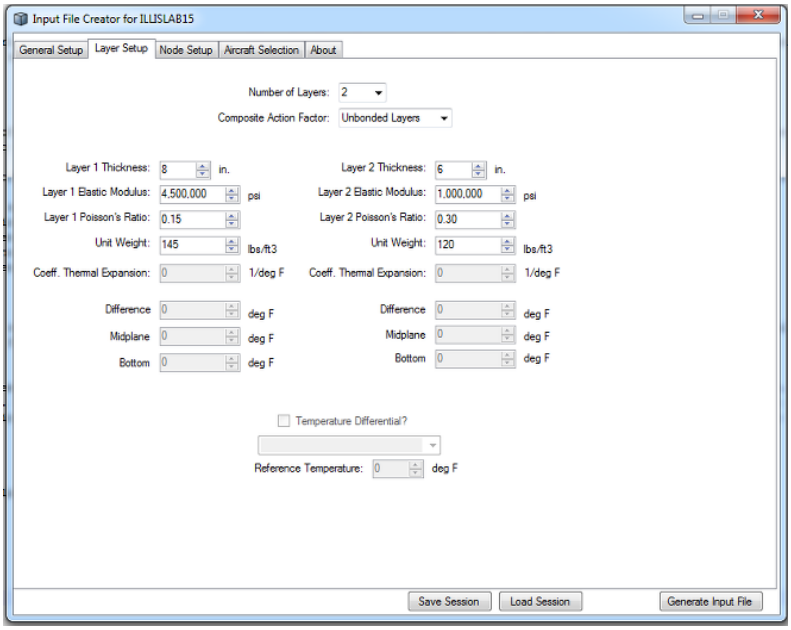

Figure 2.2: Layer setup screen of ILLIGUI.

2.3 Node Setup

Figure 2.3 shows the next screen in the input file creation process. The two inputs for the number of slabs in the X and Y direction are pretty self explanatory. At this time, only uniformly spaced nodes are allowed to be inputted (the `Total X-Nodes per slab:` and `Total Y-Nodes per slab:` boxes). For example, if you had 2 slabs in the X direction and 3 slabs in the Y direction as well as 50 nodes in the X direction and 60 nodes in the Y direction, each of the six slabs modeled would have a total of 3000 nodes (50 nodes by 60 nodes). Keep this in mind with larger slab and node system as the simulation will require large amounts of memory to store all of the calculations.

The length of the X and Y slab should be self-explanatory. There are buttons to activate aggregate interlock in the X and Y directions. You can enter a load transfer efficiency percentage and this will be converted to a stress value using Eq. 2.1. Note that this approximation is only valid for Winkler and Springs subgrade models.

Generally, this application is designed to model aircraft loads. Thus, the default load type is a selection from the aircraft database. You can change this at anytime. The `Select Symmetry` option has been disabled. The most important and easiest step to mess up is se-

lection of the load reference point. This X and Y coordinate specifies where the load will go in the global coordinate system. For example, in Fig. 2.3, the X,Y coordinate of (0,0) would be the point shown by the checked circle in the lower left of the tire layout diagram. This means the tire will "grow" up and to the right as the footprint is calculated from the load and tire pressure.

You should always perform a check to make sure your gear will not end up outside of the model. This check should be performed after the load, tire pressure, load reference point, and X,Y coordinates have been chosen. Changing any of these values will affect the tire dimensions.

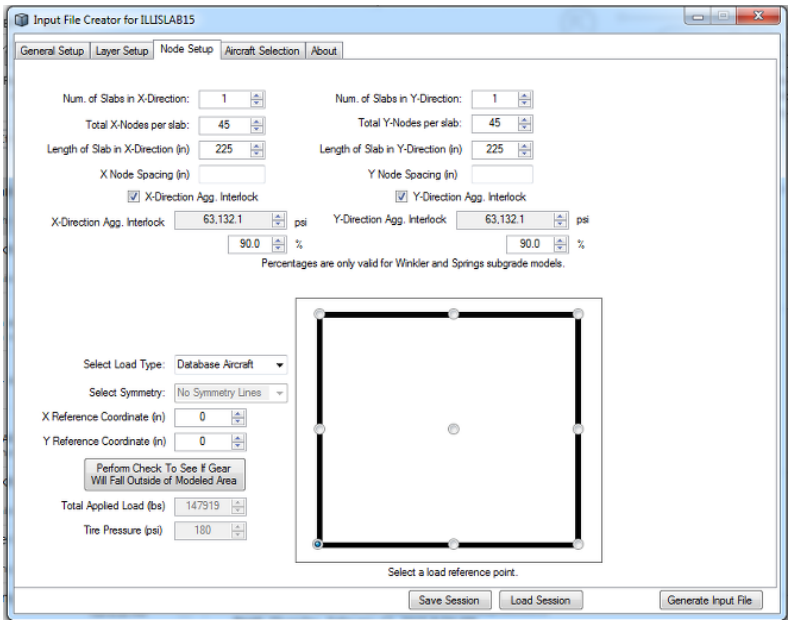

Figure 2.3: Node setup screen of ILLIGUI.

$$A_{x,y} = \left[\frac{\frac{1}{LTE_{x,y}} - 0.01}{0.012} \right]^{\frac{-1}{0.849}} kl_{\text{eff}} \tag{2.1}$$

2.4 Aircraft Selection

(Not currently functional, please see Known Errors section for more details)

Figure 2.4 shows the crowning achievement of this input file generator. Using the data in the Section31.mdb file, the selected aircraft information is displayed. All of the properties that affect the simulation can be altered from their default values. As noted in the various disclaimers, the information presented is accurate but not guaranteed to be error free. Some aircraft versions (e.g. B747-400) have up to 30 different weight variants. Generally, the heaviest weight variant is chosen unless another variant is more commonly deployed. It is up to the user to determine if the weight shown is the desired variant. As long as the `Database Aircraft` option is selected on the Node Setup page, all of the values here will transfer to the Node Setup page.

The A/C Terminology button provides a brief description of some of the terms and the View A/C Info button shows a picture of the selected plane along with a brief description from the manufacturer.

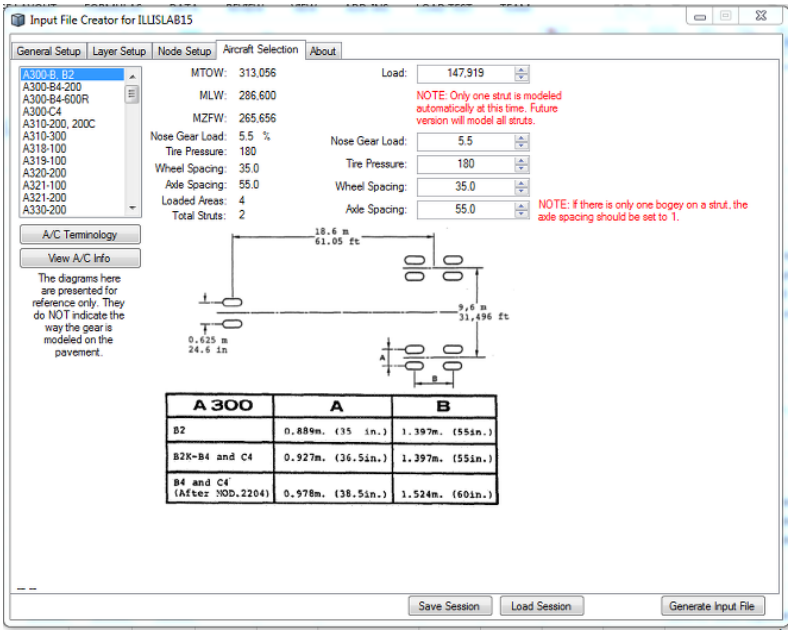

Figure 2.4: A/C selection setup screen of ILLIGUI.

2.5 Generate Input File

2.5.1 Creating the Input File

Clicking the `Generate Input File` button will immediately generate an input file with the file name specified in the `General Setup`

tab. This file will be created in the same directory as the ILLIGUI program and will overwrite any file with the same name without warning.

2.5.2 Generating the Output File

ILLIGUI will automatically pass the generated input file to the ILLISLAB15 executable. If the executable runs successfully an output file with the file name specified and the extension `.out` will be created in the same directory.

2.5.3 Analyzing the Output File

A successfully generated output file will be passed to the MATLAB functions included in the program. These functions read in the unformatted data in the `.out` file and convert it to 2 different arrays containing all relevant node information. These arrays are saved in a MATLAB environment variable (`.mat`) and also in comma-delimited ASCII format. These can be opened and imported through MATLAB or a number of other softwares.

The final stage will generate a heatmap of the relevant variable's values at each node. Ensure that a variable is selected, as a graph will still be generated even if no selection is made.

2.6 Save/Load Session

These buttons allow you to save the current state of ILLIGUI or load an existing state to quickly continue your work. It also aids in troubleshooting as the saved sessions can be opened by any version of ILLIGUI. These saved sessions cannot be used as input files for ILLISLAB15.

2.7 Output File Format

The files generated by MATLAB contain arrays with all relevant node data. The column headers are the same for the `.mat` and `.txt` files. DRSF.txt contains comma-delimited ASCII data and corresponds with the MATLAB variable "nodeLocDRSF". The column headers for the array contained in both files are:

Node Number, X Coordinate, Y Coordinate, Deflection, X Rotation, Y Rotation, Subgrade Stress, and Subgrade Force

For the 3-Dimensional array contained in NDS.txt and the "NDSArray" variable the column headers are:

Node Number, Depth, X-Stress, Y-Stress, XY-Stress, Major Principal Stress, Minor Principal Stress

NDS.txt is comma separated and in ASCII format. The array will contain node data for 2 or 4 different depths, this is represented in the text file by placing the uppermost layer in the first 7 columns and subsequent layers in following columns.

3 Running ILLISLAB15

ILLISLAB15 is a console application that can only be run from the command line. It is required to keep ILLISLAB15 in the same folder as ILLIGUI so that the generated input files from ILLIGUI will be immediately and readily accessible to ILLISLAB15.

The current version of ILLIGUI automatically passes the generated input file to the ILLISLAB15 application. To run this application manually, please see the documentation below:

First, you will need to open the command prompt. In Windows 7 and 8 you can type in `Command Prompt` into the search bar. You will then need to change the directory to the one that contains ILLISLAB15 and your input file. You can use the `cd` command for this. For example:

```
cd C:\Users\Default\Documents\Slabs
```

This will change the directory to the Slabs folder, where for purposes of this example, the ILLISLAB15x32 executable and input file test1.inp. Once in the correct folder type the following command:

```
ILLISLAB15x32.exe < test1.inp > test1.out
```

The file `test1.out` is created upon execution and can be named anything. However, it is best to name it the same as the input file so that the two will always be paired. ILLISLAB15 has very little in the way of exception handling. It is up to the user to look at the output to determine if something went wrong and the perform a reasonableness check on the final values.

4 Known Errors/Bugs

4.1 Aircraft Database not Functional (The 'Microsoft.Jet.OLEDB.4.0/12.0' provider is not registered on the local machine.)

This occurs due to a driver issue with Microsoft Access. The Section31 database cannot be accessed by any x64 application as the default Microsoft Office driver is 32-bit. ILLIGUI must be compiled on the x64 platform to be compatible with required MATLAB libraries. This error is not critical, and pressing `Continue` will allow the application to proceed.

4.2 Application Cannot Process Output Files for Slab Systems Larger Than 999 inches

The portion of the ILLISLAB15 output file which matches node numbers and locations displays all 4-digit numbers as "***". Thus, the MATLAB functions fail when attempting to import these systems.

4.3 MATLAB Analysis is Extremely Time-Consuming

Larger slab systems, especially those with 2 layers, can take upwards of 45 seconds to process. The data from the ILLISLAB15 output file is not consistently formatted and contains text interspersed at unpredictable locations. The MATLAB functions are required to do significant reformatting and data cleaning, resulting in long wait times. Future directions include optimization of this process and the option to generate multiple graphs with the same output file.

4.4 Application Does Not Close Properly

This occurs when ILLIGUI is started and the aircraft selection is never changed. Upon trying to exit the program without ever selecting a different aircraft, you will get an unhandled string exception error. This is nonsense because the author has handled string

exception errors. You can either hit Continue or Quit. This error does not affect the operation of the program and is only a nuisance. Upon trying to exit the program a second time, it will successfully terminate.

This has been fixed since Version 2.0.0

4.5 Application Does Not Generate Correct Input File

This occurs when ILLIGUI tries to generate an input file for a one slab system. This will be fixed in future versions. The solution is not to use one slab systems.

This has been fixed since Version 0.9.984

4.6 Single Axle Case Does Not Generate Correct Coordinates

This occurs when the single axle load type is selected either through the menu or via selection of certain aircraft.

This has been fixed since Version 1.0.4

5 ILLIGUI Change Log

Version 0.9.501

Initial release version.

Version 0.9.902

Added unit labels

Added X,Y direction indicators

Added 4Gb 64-bit warning message due to possible segfaults

Version 0.9.957

Fixed thickness input boxes not displaying decimal values

Version 0.9.959

Fixed issue with single load area not allowing for a change in tire pressure

Version 0.9.984

Fixed issue when trying to generate input file with agg. interlock in singleton slab directions

Version 1.0.4

Fixed coordinate generation for single axle cases

Added memory display to alert user to model size and available memory

Version 1.0.7

Fixed issue with single load area not being square

Version 1.1.2

Fixed issue with single axle area not be calculated correctly in the Y-direction

Added ability to change X/Y load ratio for tire footprints

Version 1.1.9

Fixed issue of LTE not always updating when layer properties were changed

Version 1.2.4

Fixed issue of a cast error in modulo operation for calculating node coordinates. This caused some nodes to not be duplicated.

Version 2.0.0

Integrated automatic output generation of output files.

Fixed initialization error that caused application to close improperly.

Integrated initial MATLAB libraries to allow analysis visualization of output data.

Version 2.0.4

Fixed errors in MATLAB text import that would cause failure in large slab systems.

Added variable selection and depth options that updated according to system type.

Added warning about aircraft database non-functionality.

6 ILLISLAB15 Change Log

Version 15.1.0

Initial release version.

Version 15.2.0

Reconfigured several arrays and `GOTO` statements

Updated `TITLEPG` subroutine