2022

Platform frame design

Spreadsheet reference

Revisions added

Ref	*Detail*	*Date*
-	Update for version 2	04/02/2022

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CONTENTS

Platform frame design

Refers to version 2 dated Feb 2022

OVERVIEW

Introduction

This is an Excel spread sheet with Visual Basic for Application modules attached to the workbook. It is written as an open architecture document and as such cannot be guaranteed. The user must take full responsibility for the use of the tool and to ensure that the output is accurate and relevant for the project to which it is applied.

The spread sheet has been developed as a tool to make the calculations required when verifying a timber frame design to EN 1995-1-1 rapid and easier. An intuitive linear approach has been taken to the workflow.

Version 2

This version was undertaken to improve the speed of application by separating the design / verification mathematical checks from the printing or documentation production. The broad outline now allows the modules to undertake the data reading, model construction, basic design and verification before document printing occurs. This allows the work to be completed in a matter of seconds rather than minutes.

The structural element types can now be listed, and a quick visual appraisal will alert the designer to problem areas. Adjustments to data and redesign can all be done iteratively before a full print out is attempted.

Printing can now be undertaken in an individual sheet or total batch process. This is now quicker because the calculations are not actually done again but the earlier analysis is accessed for the necessary results and intrinsic values.

Starting Off

The recommended starting position is to copy the original workbook and rename it with a meaningful file name. This ensures the original remains as a fall-back facility in case mistakes are made in the following procedures. Unlike normal applications, that have executable programs separate from the data files, the code is written into the workbook and is carried with the copy into each file. The advantage is that the user has the full capability of the Excel application in addition to the specialist coding required for the verification of timber frame designs.

The renamed copy can be used as copied or all the worksheets except two may be deleted because new sheets will be created as required. The sheets named "***Data***" and "***Tables***" shall not be deleted. The "***Data***" sheet maybe modified as described later but the "***Tables***" sheet will not be touched at all; that sheet is used as a reference for the code modules. The "***Tables***" work sheet has been hidden in this version to make sure that it is not deleted in advertently, but "***Data***" is not hidden and is not protected, to allow you to change it, but do not delete it otherwise the software will not work.

The "***Data***" sheet is the primary description of the design to be checked. A copy of the sketch design may be scanned and inserted into the "***Data***" sheet for reference purposes, to replace that included in the original copy .

Workflow

Start the procedure with a copy of the original file or a previous timber frame file for alteration. The ***Data*** and ***Tables*** sheets shall be left in place, but the other sheets can be deleted. Existing sheets will be reused if they have the same name but will not be touched if reference names are changed. Hence the advice is to delete the sheets that are not used otherwise the workbook will be unwieldy in the future with numerous redundant sheets.

Wind analysis

The spreadsheet does not perform a wind analysis of the structure, but it will require wind forces to be input during the review of the project criteria.

Linear workflow

The ***Data*** sheet should be accessed starting from row 1 and work down the sheet. Nothing should be referred to that is not already described in the rows above on the ***Data*** sheet. The reading module will need a single blank row at the bottom of each list of data entries. This holds true except for the first six rows that refer to the site and project details.

When the data sheet has been updated, the ***RUN*** button should be pressed to activate the coded modules. If an error occurs, correct the ***Data,*** and run the code again.

The code will read the ***Data*** sheet and create a new virtual structural model from the data set, each time it is run. This is used to construct and draw the plans at each level. Specified fixings are analysed, and a calculation sheet is produced for each combination used. The studs used in the walls are reviewed and an estimate is calculated of the reserve vertical compressive strength available after basic wind forces have been allowed for, and the bearing value is calculated, in the verification. The result is carried forward to the wall verification.

The next stage is to calculate the strength of each wall based upon the panels and openings in the wall. The wall strength is used to find the shear centre of the panels that may be different from the centre of action of the wind force on the structure.

The vertical actions at the top of each wall will be modified by the wall configuration. Concentrated actions are checked, if they exceed the stud strength, they are carried through the wall with a warning note attached, and If the action is within the stud capacity the action is disbursed through the solid wall to a grouped distributed action at the base of the wall. In a similar fashion, an opening in the wall will concentrate top loading into a concentrated action on each side of the opening through the stud and cripple studs that frame the opening. A short length of uniform action may or may not occur between the cripple studs depending on the use of the opening for a window or a door. The sections of distributed load are checked against stud strength using the given stud spacing and if the strength is exceeded a warning note is attached to the action. This set of modified actions is then applied to the supporting structure below the wall.

The centre of the wind action is taken as the geometric centre of the elevation in the direction of the wind, that is in two directions at right angles to each other; referenced as ***Wind 0*** and ***Wind 90.*** The strength of each wall is also analysed in the same directions but set in proportion to each relative strength, synonymous with the stiffness, to find the ***Shear centre***. The distance between the ***Shear centre*** and ***Wind centre*** is the lever arm of a couple that introduces an additional force into each wall in proportion to the stiffness. This is shown on the sheet reference ***Wind***.

The next process uses the force on each wall to verify that the wall has enough strength using the procedures detailed in EN 1995-1-1 and other relevant Non-Contradictory Complementary Information [NCCI].

The code modules then proceed to verify other elements included in the ***Data*** sheet.

An additional worksheet has been added to list the results of strength verification around each opening. These are referenced and a list of load actions is shown along with an indication of required strength levels and warning notes whether the proposal would pass verification , if not the area of failure is indicated.

Posts, Lintels and Portals have been added to this version of the workbook. We have also modified the following areas of the coding module:-

1. Allow a variety of foundations and weather faces to show on some details
2. Restructure the use of vector analysis
3. Revised for some parts of PD 6693-1:2019

4. Allow the use of portal frames
5. The introduction of local external loading for brick cladding, water tanks, solar panels etc.

After the presented verification has been reviewed by the user the set of sheets may be checked in the print preview provided by Excel before output on the office printer.

REFERENCE

Project details

Name

This is the name of the project or part to be verified

Times

The date and times, surrounded by closed boxes, are recorded by the software at the top of the Data sheet during and after each run. The Date and start time of the last run, run time, Basic data, Draw Plans, Draw Walls, Draw Beams, Draw Posts, Draw Portals, and Design Check are all recorded in hours: minutes: and seconds.

The buttons for Plans, Walls, Truss or Details have been removed because of the changes in the work flow described above.

Site details

Row seven must be a blank row.

Altitude

Ground level in metres above sea level

Map wind speed

In metres per second

North

Angle between Left-Right latitude of the building and true north in angular degrees.

Location

Description of the building location.

Foundation type

The following options are available, but not all are used at present.

Sleeper

Sleeper walls at 2.40m centres, normally supporting a timber ground floor.

Raft

Concrete slab acting as a spread foundation with thermal insulation and a finishing screed over.

Rising wall

Rising walls from strip foundations under the main load bearing walls; with a floating ground slab

Weather face

This refers to the presence of an outer cladding; the following options are given: -

None

Timber exposed

Masonry

100 Brick or block with 50mm wide cavity

Patent

Patent rain screen with 50mm wide cavity

Roof style

Flat

Notionally flat roof with a small fall for drainage

Duopitch

Roof slopes in two opposite directions with a ridge near the middle.

Monopitch

Roof slopes in one direction with a ridge near one side.

Hipped

Duo pitched roof with a monopitch at one or both ends

Beam

Ad Hoc beams

Roof pitch

Roof angle in degrees measured from the horizontal

Terrain

The style of the surrounding ground either

- Town
- Country

Unit loads

Each row has a unique name in the first column; the list must finish with a blank row

g_k (kN/m²)

Permanent action or loading on this floor type

q_k (kN/m²)

Variable action or loading on this floor type

p_k (kN)

Concentrated action or loading on this floor type

Wind is added to the level where necessary based upon map wind speed, altitude, and height above site level.

Method used

There is a choice of method to be used for the calculation of the diaphragms for wind resistance in the shear walls:-

- Method ‘A’
- Method ‘B’
- BS PD6693

Timber

This list contains the timber types used in the model; the list must finish with a blank row

Timber

Unique reference [Add ‘L’ to right hand of number to indicate use as a lintel material.]

Breadth (mm)

Target breadth in millimetres

Depth (mm)
Target depth in millimetres

SC
Strength class for reference to strength class table where the characteristic values are kept.

Style

Solid

Solid strength graded timber

Glulam

Glue laminated timber

CLT

Cross laminated timber

Paralam

Thin timber flakes glued to form a solid shape like glue laminates

Cladding

This list contains the cladding or sheathing types used in the model; the list must finish with a blank row

Cladding
A unique reference in this list

Name
Describe the material; used as a long name.

Thk (mm)
Thickness of the material in millimetres

Density (kg/m³)
The density of the board material in kilograms per cubic metre. Used to determine the strength characteristics of fasteners.

Material
Current materials permitted

OSB
Oriented strand board; usually type 3.

Hardboard
Tempered hardboard to resist moisture

Particleboard
Particle board with proof that it can be used for this function

Plasterboard
Plasterboard with proof that it can be used for this function

Plywood
Exterior grade plywood

Fastener

This list contains the fasteners used in the model. Detailed values should be checked against actual manufacturer's guarantees; the list must finish with a blank row.

Fastener
A unique reference for this list. 'J' is placed as a post-fix for the fasteners to be used in the joint of frames, and 'S' as a post-fix for the fasteners to be used in fixing the sole plate to the foundation.

Material
Describe the material; used as a long name.

Char Tens (N/mm²)
Characteristic tensile strength of the fastener

Dia (mm)
Diameter of the fastener to be used in calculation.

Length (mm)
Overall length

Pull out (kN)
Pull out value to be used in calculation

Shear (kN)
Shear value to be used in calculation

Head Dia (mm)
Diameter of the head of the fastener

Style
Select from the given list the most appropriate style for the fastener

Bolts
Dowels
Other nails
Round nails
Screws
Square nails

Levels

This list contains the levels used in the model; these represent finite slices through the building model that contain a floor, walls, or roof structure. The list must finish with a blank row.

Levels
A unique reference in this list; start with the lowest and list successively to the highest zone or level

Name
Describe the storey or zone; used as a sheet name.

Site (m)
Height above site ground level to the bottom of the zone

Hz (m)
Height of the zone above the given Site Height to the base of the zone.

Rest On
The reference of the level this zone rests upon (it must be a level already described in this list or '0' if it rests on the foundation).

Unit Load
The reference of the unit load details in the Unit Load list above.

Wind 0
The figures below relate to the wind active at 0° on plan.

Hor (kN)

Total horizontal active wind loads parallel to the plane of the ground on this zone.

Vert (kN)

Total vertical active wind loads perpendicular to the plane of the ground on this zone.

Wind 90

The figures below relate to the wind active at 90° on plan.

Hor (kN)

Total horizontal active wind loads parallel to the plane of the ground on this zone.

Vert (kN)

Total vertical active wind load perpendicular to the plane of the ground on this zone.

Racking

This zone contributes to the stability of the building by resisting the horizontal wind forces; TRUE or FALSE.

Sub Roof

Optional; to label roof areas on lower levels.

List nodes in group, separate by comma, where roof occurs, finish the group with 'O' for Open or 'C' for Closed, and separate groups with a semicolon.

Nodes

This list contains the nodes used in the model; these represent coordinates traced vertically through the building model to act as geometric reference points. The list must finish with a blank row.

Nodes

A unique reference in this list

X (m)

Horizontal distance from a real or fictitious origin on plan.

Y (m)

Vertical distance from a real or fictitious origin on plan.

The space to the right of the nodes list is not read by the program and can be useful for a detail plan that can be scanned and placed here to aid node calculation and wall positioning.

Walls

This list contains all the walls to be included in the building model. The list must finish with a blank row.

It is assumed that the walls are referenced clockwise on the plan from end 1 to end 2, with the external side to the left.

Walls

A unique reference in this list

E1

The reference from the Nodes list to represent the first end of the wall

E2

The reference from the Nodes list to represent the second end of the wall

Lvl

The level reference from the levels list on which this wall shall be placed

Timber

The timber reference from the timber list that shall be used for the studs in this wall.

Number

Number of studs used at each location; if left blank, one is assumed.

Shear Wall

If this is left blank then wind shear will be taken by this wall; if shear should not be considered then type 'No'.

Spc0 (mm)

The spacing of the studs in this wall. The standard spacing is 600mm but the spacing may be related to truss, joist spacing, requirements for supporting cladding material, or reduced spacing to increase load carrying capacity.

Style

Either 'Ext' for external, 'Int' for internal wall style, 'Par' for a party or separating wall

Clad 1

Reference from the Cladding list for the external or first face of the wall

Clad 2

Reference from the Cladding list for the internal or second face of the wall

Fix1

Reference from the Fastener list for fixing the external or first face cladding of the wall

Fix2

Reference from the Fastener list for fixing the internal or second face cladding of the wall

Spc1 (mm)

Spacing of the Fix1 fastener on the perimeter of the sheathing; internal spacing on the panels taken as twice this value

Spc2 (mm)

Spacing of the Fix2 fastener on the perimeter of the sheathing; internal spacing on the panels taken as twice this value

Top shape

Leave blank if wall top is flat and level. Otherwise use a list of vectors i.e., Y(X;Angle)() in groups of two enclosed in round brackets. Y starts the wall height and changes as X * Sine(Angle)

Rest on

The wall reference that this wall rests upon from the wall list above. The reference wall must of course be a wall that is physically below the subject wall on a level below. The list may spread over several columns if the wall rests on several below.

Panels

This list contains all the panels to be included in the building model. The list must finish with a blank row.

Panels

A unique reference in this list

Wall

The reference, taken from the 'Walls' list, to the wall this panel is to be part of in the building model.

X (m)

The dimension at which the panel should start measured from End1 along the length of the wall referenced above.

Y (m)

The dimension at which the base of the panel should start measured from bottom of the referenced wall in a vertical direction.

L (m)

The panel length from point 'X' along the length of the wall, referenced above, toward End2.

H (m)

The panel height from point 'Y' along the height of the wall, referenced above, toward the top.

Top

Leave blank and the panel will follow the wall top if tall enough, otherwise use the same syntax as for the wall if the panel is to follow a different path; details the shape of the panel top if not horizontal

Opes

This list contains all the openings to be included in the building model. The list must finish with a blank row.

Opes

A unique reference in this list

Wall or Level

The reference, taken from the 'Walls' list or the 'Levels' list, to the wall or level this opening is to be part of in the building model.

X (m)

The dimension at which the opening should start measured from End1 along the length of the wall referenced above; or from the site origin if a level reference is used.

Y (m)

The dimension at which the top of the opening should start measured from bottom of the referenced wall in a vertical direction; or from the site origin if a level reference is used.

L (m)

The opening length from point 'X' along the length of the wall or level referenced above toward End2.

H (m)

The opening height from point 'Y' down the height of the wall, referenced above, toward the bottom. A door opening would have the same height 'H' as the top 'Y'. If the reference is to a level then H is the length of the opening from 'Y' toward the origin of 'Y'

NumLin

The number of standard lintels to be used for this opening. If left blank the normal one number is assumed, if 0 is shown then there is no lintel and loads over the opening must be taken by the fixings of sheathing to studs or the top rail.

NumCr

The number of standard studs to be used as cripple studs supporting the lintel on each side of this opening. If left blank the normal one number is assumed, if 0 is shown then there is no cripple stud to support the lintel and loads over the opening must be taken by the fixings of sheathing to studs or the top rail.

Posts

This list contains all the posts or columns to be included in the building model. The list must finish with a blank row.

Posts

A unique reference in this list; a prefix of "P" is expected.

OnIn

The Wall reference that the post is to on the line of or within. If the post is to be free standing, then it may be the only element in a wall or one of several similar posts along the wall, as for a line of columns in open space.

X (m)

The dimension at which the post should be measured from End1 along the length of the wall referenced above.

Tim

The timber reference to be used in the post taken from the list of timbers given above.

No.

The number of timber elements to be used in the post.

Portals

This list contains all the portals to be included in the building model. The list must finish with a blank row.

The portal is typically used as additional structural stiffness in a wall particularly when there are large openings in a wall line or additional stiffness is required in a structural frame.

Portals

A unique reference in this list; a prefix of "Po" is expected.

Wall

The Wall reference that the portal is to be the line of or within. If the portal is to be free standing, then it may be the only element in a wall, as for a portal in open space.

X (m)

The dimension at which the port should be positioned from End1 along the length of the wall referenced above.

L (m)

The length of the opening or distance between the centres of the legs of the portal.

Fx (kN)

The ultimate force the portal can resist at its top while the deflection of the legs does not exceed height/300.

Beams

This list contains all the spanning members to be included in the building model. The list must finish with a blank row.

Beams

A unique reference in this list; prefix the reference as follows: -

The first character should be:-

- B for a beam
- T for a truss
- E for roof extension
    - EG for a gable
    - EV for a valley
    - ED for Dutch hip
    - EH for a plain hip
- Set the style to Gable or Valley

Style

Flat

Default for a beam but can also be used for a parallel chord truss

Duopitch

Truss style

Monopitch

Beam or Truss. [*Not yet covered in the details section*]

Hipped
Truss. [Not yet covered in the details section]Beam

Beam
Normal beam

Gable or Valley

W1
The reference, taken from the 'Walls' or 'Beams' list, to indicate this member is to bear upon at End1 in the building model. If the bearing is on a wall, then prefix the reference with 'W'. The bearing must be detailed in a row above this row.

W1 item
For use if there are more than one of copy of W1, then enter the one you are referencing. The original is index 0; 9 is the nineth copy of W1.

W2
The reference, taken from the 'Walls' or 'Beams' list, to indicate this member is to bear upon at End2 in the building model. If the bearing is on a wall, then prefix the reference with 'W'. The bearing must be detailed in a row above this row.

W2 item
For use if there are more than one of copy of W2, then enter the one you are referencing. The original is index 0; 9 is the nineth copy of W2.

Lvl
The level from the levels list on which this member shall be placed

X (m)
The distance from End1 of wall W1 that the first member should be placed; the member will be placed perpendicular in plan to the direction of W1 towards an intersection point with W2

Ex1
The extension distance that End1 of this member is from the point 'X' above

Ex2
The extension distance that End2 of this member is from the intersection point with W2 detailed above

Bg1
Bearing length in metres.

Bg2
Bearing length in metres.

Hos (m)
Optional, Height over support W1; to control truss depth

Thk(m)
Thickness of this member on plan

Sp (m)
Spacing of the members from point 'X' along the length of 'W1'

L (m)
Length over which the members are placed from point 'X' along the length of 'W1'

Main
The timber reference from the timber list that shall be used for the main chords in this member, or the material used if it is a beam.

Web
The timber reference from the timber list that shall be used for the webs in this member if it is a truss.

Num
The number to be used together as a single member.

Load
Optional, only need to insert load description if different from level, point to unit load list item. Allows for a local change in design actions otherwise normal for the rest of the building level.

W1On
When the spread of beams or trusses go beyond one W1 reference; list the other supports separate with a semicolon.

W2On
When the spread of beams or trusses go beyond one W2 reference; list the other supports separate with a semicolon.

Groups

These are groups of beams or trusses that will be used repeatedly but calculated once only.

Groups
Unique reference in this list

Origin
The reference node used in the original beam/truss pattern or group.

Members
Reference list of members in that original group; separate with 'comas' [A, B, C]

Copy
Specification for each copy of this group; a list of lists. Each copy has a reference node to replace the origin for this copy, followed by the angular rotation in degrees for this copy. I.e. N, 99;

For example, several copies would read as N1, 15; N2, 45; N3, 60 etc

The program will work out where the new bearing points are on the frame and use the calculated forces from the original versions in the resulting verification.

Loads

These are optional extra or external loads that can be placed on the framework and will be considered as the load chase down and verification procedures take place.

Finish with a blank row.

Loads
Unique reference in this list

Describe
Brief description for this load source.

Style
'U' or 'P' are currently the only valid values in this field.

- U takes the service loads as kN/m over the length L from point X
- P takes the service loads as kN for a point load at X; L is left blank or ignored.

Support
Reference for the Wall, Beam, or Truss that supports this load or action.

X (m)

The distance from End1 of support the load or action should be placed.

L (m)

The length from the point X along the supporting element towards end 2.

Gk (kN or kN/m)

The total value of the characteristic permanent action on the length L.

Qk (kN or kN/m)

The total value of the characteristic variable action on the length L.

Wk (kN or kN/m)

The total value of the characteristic wind action on the length L.

Action Chase Down

This procedure endeavours to follow or audit the actions, forces, or loads in a vertical fashion from the top of the structure to the foundation. Each action or load has position, style, and force. A wall can be loaded from the top and laterally from the side. The lateral loads should be converted to vertical equivalents as with the forces in tie downs, fasteners and straps, the top can support actions that occur at that level and from structural elements above taking bearing or support from the subject wall.

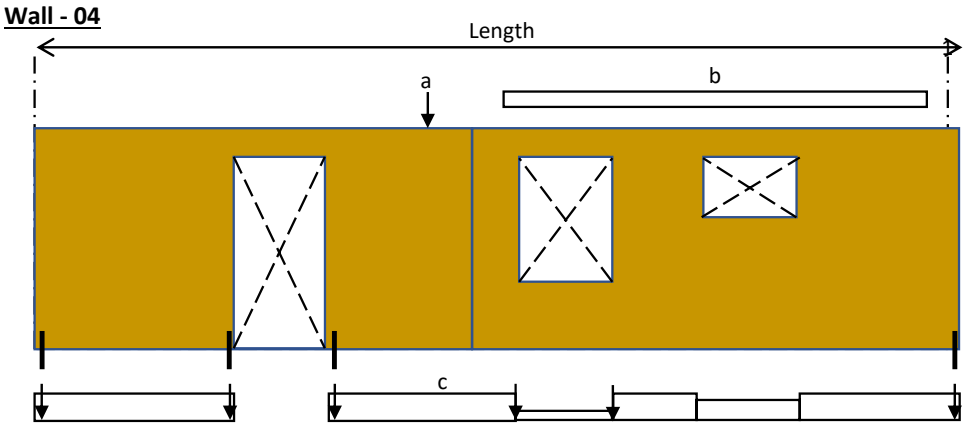

Figure 1 ;Action Chase Down

a – *Concentrated force or array of forces*
[Beam reaction, Column load, or array of joist or rafter reactions]
b – *Collection of forces from structural element above*
[As for **a***]*
c – *Actions modified by geometry of the wall*
[As for **a** *but carried on structure below]*

Procedure

The residual vertical strength, RVS, in the standard wall stud has been calculated earlier considering the wind laterally bending the stud and the bearing stress on the side grain at the head and bottom rails.

Starting at the highest level make a collection, Top Loads, of the actions directly in top of the wall plus the loads from walls or structural elements taking support from the subject wall.

Divide the wall up into plain lengths and lengths with openings

The Top Loads on Plain lengths of wall
If a concentrated load, then
if load is less than RVS then
Add load to distributed load over this length
Else keep as concentrated load
Else Distributed load then

Add the total load over this length
if distributed load > RVS then
Increase size or number of standard studs
The Top Loads on Open lengths of wall
If a concentrated load, then
Calculate the Left-hand RL and Right-hand RR reactions at edge of opening
Add them to current values
Else Distributed load then
Calculate the Left-hand RL and Right-hand RR reactions at edge of opening
Add them to current values
Check if reaction load > RVS then
Increase size or number of cripple studs
Add a distributed load for the self-weight of the wall under the opening

Verification pages produced with this version

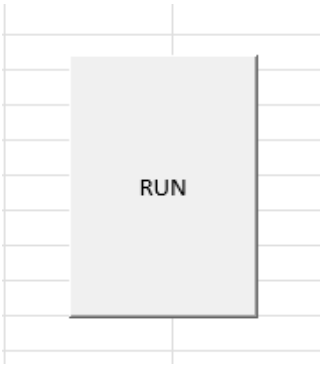

Figure 2: Run button

When the run button is pressed, located near the top of the Data sheet, the calculation modules are engaged that:-

- Read the Data sheet
- Read the strength classes
- Make the tree of elements
- Make beam loads
- Check the studs
- Transfer the forces
- Design the fixings
- Design each beam
- Verify each wall
- Design the wind load at each level
- Check the walls after wind load allocation
- Check the lintels at each opening
- Design each post
- Design each portal

A dialog box then appears that will give access to the results of the design and verification just completed.

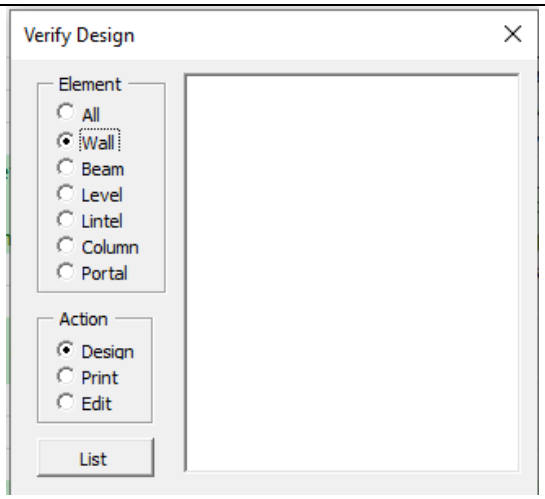

Figure 3: Dialog for access to results

The dialog box is termed 'Modal', it prevents access to the printed pages, but it does give one access to the results as required by the user as follows.

The dialog has four areas Labelled 'Element', 'Action', 'List', and a list box shown blank in Figure 3. The 'Element' options only appear if there are such elements in the structure. When the element option is selected the available actions for that element will be visible. In some instances when an element option is selected a list of the elements will be presented in the list box.

If the element, say 'Beam' is selected all of the actions Design, Print, Edit and List would be available. A list of the beams and trusses will appear in the list box. First select the action required then select the beam reference one has an interest in and the action for that beam will be completed. If the list of beams is required, then it is not necessary to select a particular beam because the outline results for all the beams would be listed to the screen.

Stud, fixing, and wind results are generated as part of the module run at the beginning. When one requires a complete set of the printed pages one can select the 'All' option and a message will appear on the screen reminding you that all but the Table and Data sheets will be deleted before the entire set of documents are printed to the screen thus completing the work book. One has the option to cancel this action.

When one has finished with the dialog box left clip on the 'X' at the top right corner and the workbook will be accessible to make a visual check of the complete set before printing out as one requires for the project.

SOME OF THE PRINTED PAGES AVAILABLE.

Plan level

A plan is produced for each level described in the Data sheet. It includes the wall, beam, and truss position at that level.

Stud Verification

This will take each stud reference, internal/external, and spacing combination at each level where walls have been required and checks the available vertical load resistance on each.

Fixing Verification

The fixings are grouped for each combination of stud, fastening, cladding, and location. The combination is verified to find the total design lateral shear or pull-out capacity for later panel and diaphragm verification.

Wind Actions

The wind and shear centres are calculated for each wind level. These calculations are used to allocate wind design actions to each wall depending upon the wall strength.

Walls

Each wall is shown and verified for compliance with EN 1995 considering the given openings, panels, posts, actions, and portals. The load audit is included in these pages.

Details

Beams and trusses are verified for compliance with EN 1995 on this sheet.

Beams

Each beam has its loading specified and the ultimate loads are calculated before the element is verified to EN 1995. An indication of pass and failure are given after each check.

Trusses

Each truss is shown along with dimensions and loading that may be used with other programmes to verify compliance with the Eurocode requirements.

Posts

All the required posts are listed on this sheet. Each post is verified taking account of its location and given loading.

Lintels

All the lintels are itemised with a list of the given loads the design moment, reactions, and deflection with an indication of pass or failure of the verification. An indication of where the failure occurred is indicated where necessary. The detailed verification is not given; but a print out using the beam calculation if required.

Portals

The portals are listed on this sheet but are not verified, however there is enough information given to ensure verification could be made using other relevant software or by hand calculation.