Research Paper Engineering

Computer Aided Wind Analysis on R.C.C Folded Plate

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ABSTRACT

Folded plates are a very useful form of structure which has many advantages. Several programs and software are available for the wind analysis of this type of structure. that software and programs methods are simple and essay, but they have the limitations of generality of application and precision. Rigorous methods are involved and some of these become costly due to the use of large-capacity computers. In this research paper Computer programs have been developed to wind analysis of folded plate. by using visual basic program making analysis program of wind analysis of folded plate. It is shown that these programs give acceptable results for the wind load calculation on folded plate structures.

Keywords : software and program, wind analysis, programming by visual basic, programming for wind load analysis

INTRODUCTION

Whenever new software is thought of, the very first question arises is that why to go for a software when software's are already available in the market with extraordinary versatility such as STAAD, SAP, STRUDS, STRAP, consisting design skills of developer. Though such software's are very powerful and user friendly they lack user friendliness in some areas of structural design. Also, such software's are expensive and not affordable by every engineer. One of the reasons behind software making is that to have a procedure or method of one's own which is of the interest, to work over it, and to provides results, outputs as required.

Visual basic (VB) is one of the most powerful GUI (graphical user interface) development tool for developing Windows based applications. It has evolved from one of the oldest programming languages: the BASIC language. But, today it is capable of delivering virtually anything and everything from simple customized applications to complex commercial software packages.

About the folded plate

Folded plates are assemblies of flat plates rigidly connected together along their edges in such a way so as to make the structural system capable of carrying loads without the need for additional supporting beams along mutual edges. There are so many types of folded plate to be used on field like

- Prismatic: if they consist of rectangular plates.
- Pyramidal: when non-rectangular plates.
- Prismoidal, triangular or trapezoidal.

Each plate is assumed to act as a beam in its own plane; this assumption is justified when the ratio of the span "length" of the plate to its height "width" is large enough. But when this ratio is small, the plate behaves as a deep beam.

fig 1. folded plate(Though type)

Wind Load Analysis on folded plate

Wind load are lateral load Whose magnitude depend on velocity of wind. Wind Possessing Kinetic energy to velocity strikes an exposed surface on the building and transmits its energy to the form of wind pressure on the surface of the building in form of wind stresses and hence the displacement of the structure. Higher wind loads produced higher stresses in the materials and demand for large section. Wind loads are discussed in IS: 875(PART III).Here we shall refer only wind load acting on folded plates. For the discussion regarding wind loads "coad" means IS:875 (Part III).

The horizontal wind pressure act on inclined plates of the folded plate and exposed area of the folded plate. Some of the pressure acting on exposed surface of structural wall and column is directly resisted by the bending of the member. The infill wall act as vertical plate supported at the top and bottom by floor beams, thus transferring the loads at slab level. here making the program for analysis of folded plate by using visual basic program.

II. METHODOLOGY OF WIND ANALYSIS ON FOLDED PLATE:

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Wind Pressure on Building

The wind pressure acting on the surface of the building depends on many factors. The method of determining this value is briefly summarized below.

I) Basic Wind Speed (vb) :

Basic wind speed Vb depends on the location of the building. For this purpose the country is divided in to six zones with specified wind speeds ranging from 33 m/s to 55 m/s. Basic wind speed is based on gust velocity averaged over a short time interval of 3 seconds at 10m height from mean ground level in an open terrain and for 50 years retunes periods. Appendix A of code also specifies basic wind speeds for some important cities/tows of country.

The conditions assumed to determine the basic wind speed (Vb) are not same everywhere. There for the basic wind speed is modified by using certain factors as discussed below.

Risk coefficient (k1 Factors) :

The risk coefficient takes in to account the degree of reliability required and the structure, say 5 year for temporary shades,25 year foe structure of minor important and 100 years for important building. Table 1 of the code give the factors K1 dependent on design life of the structure and basic wind speed. Referring to table 1 of the code, it can be seen that K1 increases with the wind speed and design life of the structure. The mean probable design life of general buildings and structures is considered to 50 years for which K1 = 1 for all wind speed. the design classes of structure are as following table (from IS:875(Part III))

Terrain height and structure size factor(k2 factor) :

Three terrain categories are specified by the is code depending on the availability of the obstruction to the flow of wind. Wind force acting on a building will diluted if there are main obstructions avelibale.the building surrounding by many other building. A building standing surrounding in open area will suffering more wind pressure than a building surrounded by the other building, city area the categories of the building area are follows:

1) Category 1: Refers to no obstruction available to the building e.g., sea coasts and flat treeless plains like farm house where other structure if any have height less than 1.5 m.
2) Category 2: Open terrain with well scattered, obstruction of 1.5m to 10 m height, e.g., industrial area.
3) Category 3 : Refers to area of closely spaced building of heights up to 10 m,e.g., building at outskirts of city
4) Category 4: Refers to area with highly closed building of large height e.g.,dense city area

Factor k2 also depends on the dimension of the building under consideration. The structure is classified as class A, class B and class c based on the structure dimensions of the building. If the Length of the building l width is b and height h, than class of the building is determined as:
Class A – maximum of l, b, h< 20 m
Class B – maximum of l,b, h = 2o to 50 m
Class C – maximum of l, b, h >50 m

Depending on terrain category and class of the building, factors K2 are given in table of the code and shall be consulted.

Height	Terrain Category 1 Class			Terrain Category 2 Class			Terrain Category 3 Class			Terrain Category 4 Class		
m	A	B	C	A	B	C	A	B	C	A	B	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
10	1·05	1·03	0·99	1·00	0·98	0·93	0·91	0·88	0·82	0·80	0·76	0·67
15	1·09	1·07	1·03	1·05	1·02	0·97	0·97	0·94	0·87	0·80	0·76	0·67
20	1·12	1·10	1·06	1·07	1·05	1·00	1·01	0·98	0·91	0·80	0·76	0·67
30	1·15	1·13	1·09	1·12	1·10	1·04	1·06	1·03	0·96	0·97	0·93	0·83
50	1·20	1·18	1·16	1·17	1·15	1·10	1·12	1·09	1·02	1·10	1·05	0·95
100	1·26	1·24	1·20	1·24	1·22	1·17	1·20	1·17	1·10	1·20	1·15	1·05
150	1·30	1·28	1·24	1·28	1·25	1·21	1·24	1·21	1·15	1·24	1·20	1·10
200	1·32	1·30	1·26	1·30	1·28	1·24	1·27	1·24	1·18	1·27	1·22	1·13
250	1·34	1·32	1·28	1·32	1·31	1·26	1·29	1·26	1·20	1·28	1·24	1·16
300	1·35	1·34	1·30	1·34	1·32	1·28	1·31	1·28	1·22	1·30	1·26	1·17
350	1·37	1·35	1·31	1·36	1·34	1·29	1·32	1·30	1·24	1·31	1·27	1·19
400	1·38	1·36	1·32	1·37	1·35	1·30	1·34	1·31	1·25	1·32	1·28	1·20
450	1·39	1·37	1·33	1·38	1·36	1·31	1·35	1·32	1·26	1·33	1·29	1·21
500	1·40	1·38	1·34	1·39	1·37	1·32	1·36	1·33	1·28	1·34	1·30	1·22

Table: Terrain, height and structure size factor (K2 factor)

Topography factor (k3 factor)

wind motion depends on topography of the area .for the example, the wind motion will be accelerated near the summits of the hills or crests of cliffs and decelerated near the roof and cliffs. If the upward ground slope θ ≤ 3, value of k3 shall be taken as 1.0 for θ > 3, the value of k3 lies between 1.0 to 1.36 foe θ>3, the method to determined below;

If ground slope is more than 3 at that time below equation to be used

K3 = 1 + C.S
Where,
"C" as following value

Slope	C
$3° < \theta < 17°$	$1{\cdot}2\left(\frac{z}{L}\right)$
$> 17°$	0·36

And value of "s" to calculated in accordance with height, H above mean ground level and the distance from the summit or crest to the effective length, Le

The all the notation are given in below fig,

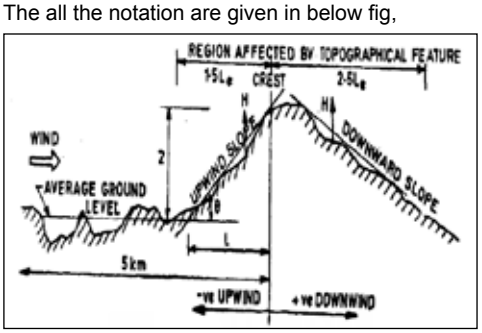
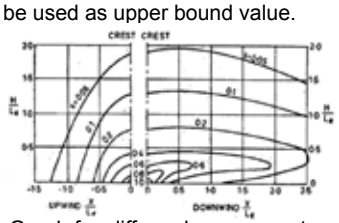


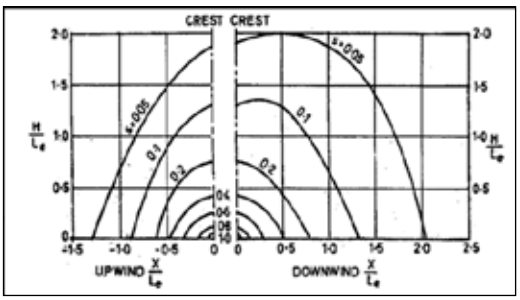
fig 2. general notation

The factor s,should be determind from
1)Graph 1 for cliffs and escarpments
2)Graph 2 for hill and ridge,

Where the downwind slop of a hill or ridge is greater than 3,there will be large regions od redued accelearation of even shelter and it is not possiba; to give genral design rules to cater for these circumstances,value of s from below graph may be used as upper bound value.



Graph for cliffs and escarpments



Graph for hill and ridge,

Design wind speed (Vz)

Design wind speed is given by following equation:
Vz = Vb K1 K2 K3
Where,
Vz = Design of wind speed
K1 = Risk coefficient
K2 = Terrain, height and structure Size factor
K3 = Topography factor

Design Wind Pressure
The Design wind pressure at any height above mean ground level shall be obtained by the equation:

$Pz = 0.6\ Vz^2$

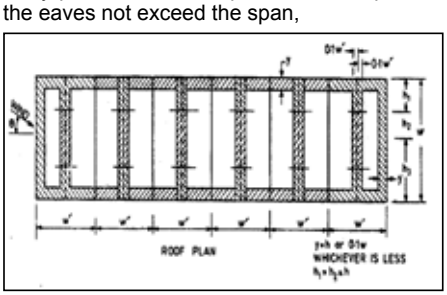
Where,
Pz = Design wind pressure in N/m^2 at height Z
Vz = Design Wind speed in m/s.

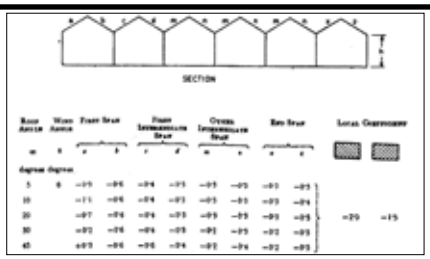
Wind loads on Building
The loads on the given surface are determined as the product of the net pressure acting on the surface and surface area. The net pressure is the algebraic sum of the external and internal wind pressure acting on surface. the pressure coefficient given by the code to determined the pressure on the surface. The external pressure coefficient Cpe and internal confident Cpi are given in code. The external coefficient is depending on the dimension, roof angle and shape of the building, the internal pressure coefficient Cpi depend on permeability of the structure. The net effect was found by algebraic addition. The wind force F acting on the surface is given by

F = (Cpe – Cpi) . A . Pz
Where, Cpe = external pressure coefficient
Cpi = internal pressure coefficient
A = surface area of the structure element
Pz = Design Wind pressure

Internal Pressure Coefficient Cpi for folded plate
If the opening and permeability in wall is in Between the 5 to 20 % of area than coefficient foe internal pressure is consider ± 0.5 and if it is more than 20% than it will be taken ± 0.7 foe the internal pressure coeffient.

External Pressure Coefficient Cpe for Folded plate
For, Pitched and saw-tooth of Multiplan structure(Folded plate),the external average pressure coefficient and pressure concentration coefficient shall be given in below table respectively provided that all span shall be equal and the height to the eaves not exceed the span,





External pressure coefficient [Cpe] for multiple span (When θ =0)

But wind angle is 90 and wind are acting to the perpendicular direction at that time value of Cpe as to be consider like

Roof Angle on degrees	Wind Angle θ degrees	Distance h_1	h_2	h_3
Up to 45	90	−0·8	−0·6	−0·2

External pressure coefficient [Cpe] for multiple span (when θ = 90)

select the all criteria and put in wind load equation and find out the wind load at each plate of folded plate.

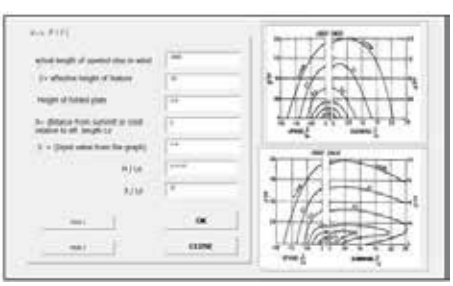
Programming for Wind Analysis
following spread sheet is for input data sheet input the require data like

1) Location of structure [City wise]
2) Life duration of the building
3) Terrain Category
4) Class depend on size of building
5) Height of Structure In Meter
6) upward ground slop(θ)
if value θ is less than 3 or more than 3. than open the next spreadsheet

Spreadsheet 1 for preliminary data input

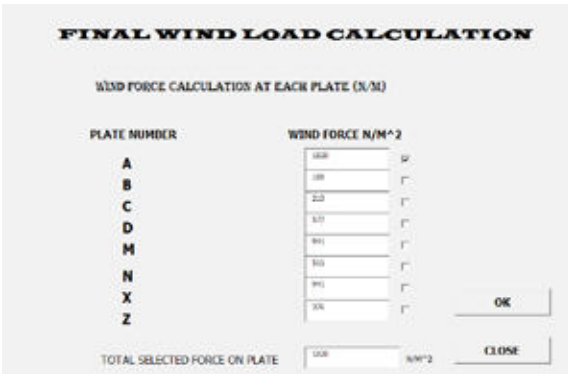
input data as per required in spreadsheet

1) Angle of Roof
2) Angle of Wind
3) % Of Opening in Wall
4)L=actual length of upwind slop in wind direction
5)Z= effective height of feature
6) Height of folded plate
from the use of above data find out value of “s” is input from the graph calculate which are shown in graph of hill and cliff.



Spreadsheet 2 for θ data input

after data input click on ok button than after program will be run and final wind load calculated at each plate of folded plate.



Spreadsheet 3 for final wind load output

CONCLUSION

The present author's work satisfies the requirements of wind analysis of folded plate to the extent possible in comparison with other availed literature and standard codes of practice. In comparisons with other analytical method for calculation of wind load on folded plate. and the final result of wind load on each plate From the wind analysis by visual basic programming of folded plate i got the satisfactory result and it is voided with other sources as well as from literature review so it may be give satisfactory result for field work.

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