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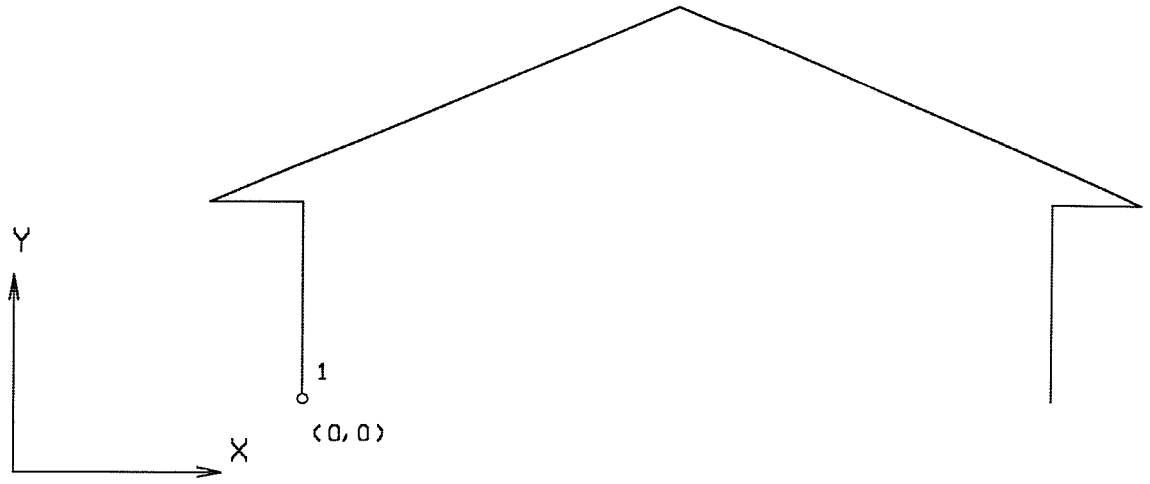
AERODYNAMIC MODELING:



Wind Velocity on left, right and top sides: VxMPH= 45.00 mph

Analysis Methology (*):

Design Reference: Chap. 6, "Introduction to Fluid Mechanics"
by John and Haberman, (c) 1971)

This program analyzes a structure subject to wind forces, considering the air to be inviscid (without viscosity), steady state flow. In reality, more complex behavior will exist, involving thin viscous boundary layers close to the surfaces and turbulent vortexes.

Mass contiuity requires that
$\delta u/\delta x + \delta v/\delta y = 0$
where u=velocity in x direction
and v=velocity in y direction

By introducing a new function, '", called the velocity potential, with characteristics,
$u = \delta\varphi/\delta x$ and $v=\delta\varphi/\delta y$
the continuity equation becomes the Laplace equation:
$\delta^2 \varphi/\delta x^2 + \delta^2 \varphi/\delta y^2 = 0$

The pressure in a flow field is computed for frictionless flow using Euler's equations,
$-g_c/\rho * \delta p/\delta x = u*\delta u/\delta x + v*\delta u/\delta y$
$-g_c/\rho * \delta p/\delta y = u*\delta v/\delta x + v*\delta v/\delta y$
where,
γc = gravitational constant = 32.2 ft/sec^2
ρ = 0.07887 lb/ft^3 for air at 70 deg. F.

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AERODYNAMIC MODELING:

Description of the Iterative Solution Method:
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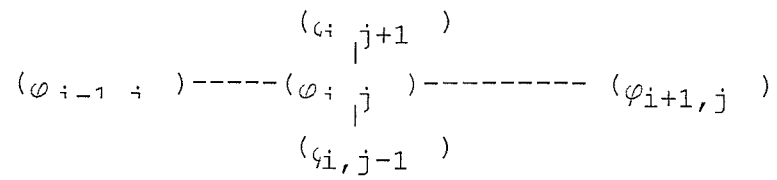
1. The air volume is discretized into uniformly spaced nodes.
2. Known velocity potentials, , are assigned at boundaries(this is called a Dirchlet boundary condition).
3. At other boundaries, the slope /dn is known (this is called a Neumann boundary condition.)
4. A computation molecule is applied to all nodes inside the boundaries:



Computational Molecule

For nodes spaced equidistantly,

$$\varphi_{i,j} = 1/4 * [\varphi_{i-1,j} + \varphi_{i+1,j} + \varphi_{i,j-1} + \varphi_{i,j+1}]$$

Iterating the above, the error between steps for all nodes is computed as,

Error = ABS{(- Previous))/ }

The maximum error printed is the maximum error of all nodes.

5. After solving for all velocity potentials, velocities are computed:

$$u_{i,j} = (\varphi_{i+1,j} - \varphi_{i-1,j})/(2*DX)$$
$$v_{i,j} = (\varphi_{i,j+1} - \varphi_{i,j-1})/(2*DY)$$

6. After solving velocities, pressures are computed by numerically integrating p in Euler's equations.

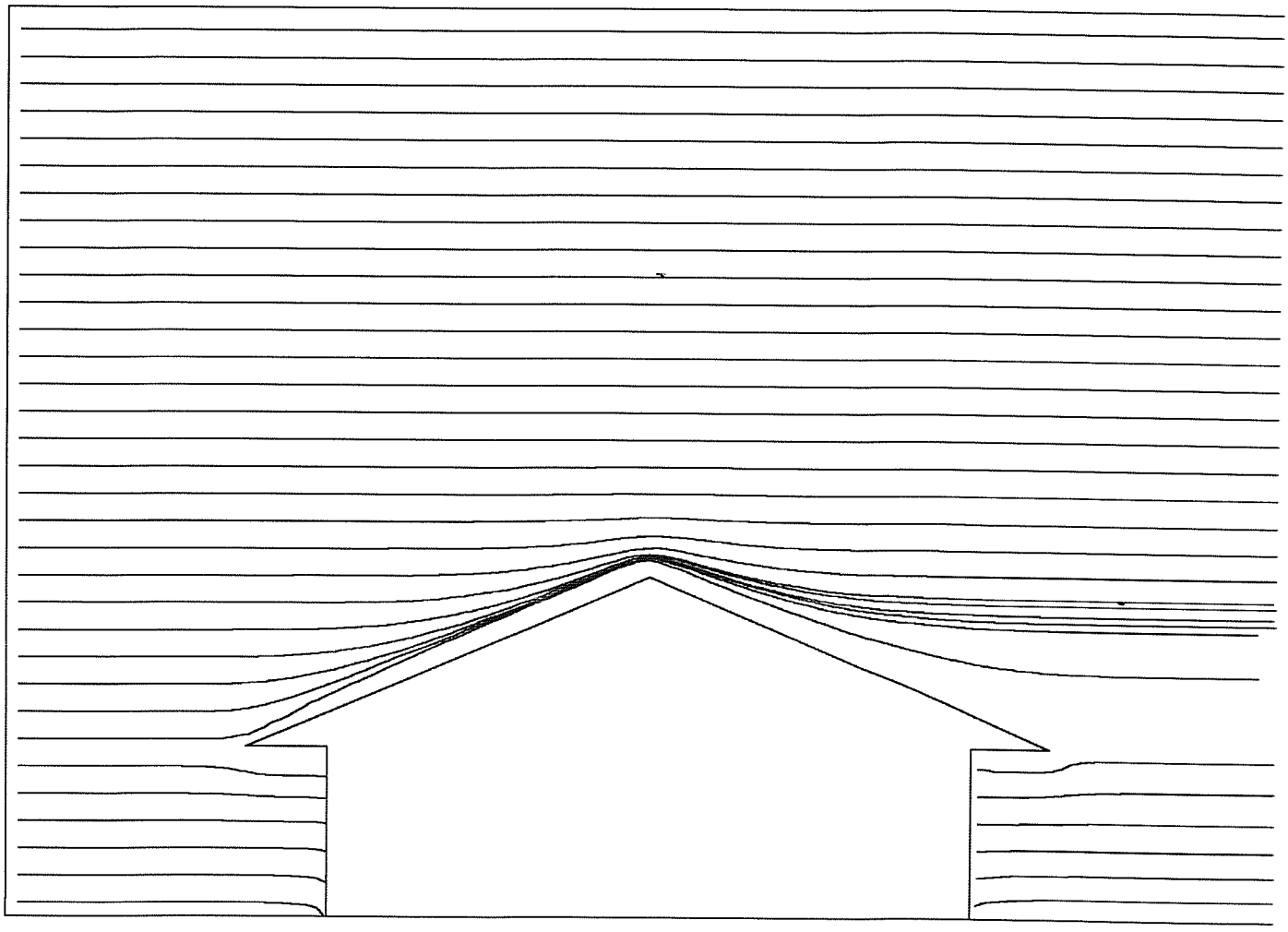
(* Note: This program is a visualization tool only, not intended to be used to replace design pressures prescribed by design codes.)

AERODYNAMIC MODELING:

SHAPE DEFINITION TABLE:

Shape No.	Description	X (ft)	Y (ft)	R (ft)
1	Solid Polygon	0.000	0.000	
		0.000	10.000	
		-5.000	10.000	
		20.000	20.000	
		45.000	10.000	
		40.000	10.000	
		40.000	0.000	

AERODYNAMIC MODELING:



Node spacing: DX= .533 ft, DY= .533 ft
Results after 21 interations:
Maximum error = 0.00276

Discussion of How to Interpret Results:

The boundaries have been discretized using an orthogonal node spacing. Inclined boundaries will therefore be represented by a step-like node spacing - not a smooth line. It will be observed that velocities along inclined boundaries are typically uneven. The user will need to recognize that the uneven velocities are a consequence of a model's step-like node spacing, not the actual boundary. The user may need to evaluate how to convert the models's pressures into actual pressures on an inclined boundary, perhaps by using a weighted average and smoothing results.

It is also not uncommon for the solution to predict very high velocities and pressures, particularly at sharp corners. The user will need to evaluate results to determine if some of the solutions are unrealistic.

AERODYNAMIC MODELING:

Velocities and Pressures along boundaries:

Node	X (ft)	Y (ft)	Velocities (mph) X-Direc.	Y-Direc.	Resultant	Pressure (psf)
1	0.00	.27	0.0	0.0	0.0	0.0
2	0.00	.80	2.2	-2.0	2.9	5.3
3	0.00	1.33	2.1	-1.6	2.7	5.3
4	0.00	1.87	2.1	-1.3	2.5	5.3
5	0.00	2.40	2.1	-1.0	2.3	5.3
6	0.00	2.93	2.1	-.7	2.2	5.3
7	0.00	3.47	2.1	-.5	2.1	5.3
8	0.00	4.00	2.0	-.4	2.1	5.3
9	0.00	4.53	2.0	-.3	2.1	5.3
10	0.00	5.07	2.0	-.2	2.0	5.3
11	0.00	5.60	2.0	-.2	2.0	5.3
12	0.00	6.13	2.0	-.2	2.0	5.3
13	0.00	6.67	2.0	-.2	2.0	5.3
14	0.00	7.20	2.0	-.2	2.0	5.3
15	0.00	7.73	2.0	-.2	2.1	5.3
16	0.00	8.27	2.1	-.1	2.1	5.3
17	0.00	8.80	2.1	-0.0	2.1	5.3
18	0.00	9.33	2.1	2.0	2.9	2.2
19	0.00	9.87	0.0	0.0	0.0	0.0
20	-.53	9.87	2.1	2.0	2.9	2.2
21	-1.07	9.87	6.2	2.0	6.5	2.1
22	-1.60	9.87	14.3	1.9	14.4	1.9
23	-2.13	9.87	22.0	1.7	22.0	1.3
24	-2.67	9.87	29.1	1.4	29.1	.4
25	-3.20	9.87	35.5	1.2	35.5	-.8
26	-3.73	9.87	41.8	.9	41.8	-2.4
27	-4.27	9.87	50.0	.7	50.0	-7.8
28	-4.80	9.87	13.5	4.8	14.3	2.9
29	-5.33	9.87	27.3	-10.7	29.3	4.8
30	-4.80	9.87	13.5	4.8	14.3	0.0
31	-4.27	10.40	26.2	9.8	28.0	3.2
32	-3.73	10.40	20.3	7.4	21.6	1.3
33	-3.20	10.93	37.6	14.3	40.2	1.9
34	-2.67	10.93	28.3	10.5	30.2	2.2
35	-2.13	10.93	21.2	7.6	22.5	1.0
36	-1.60	11.47	30.9	11.4	32.9	2.4
37	-1.07	11.47	22.9	8.2	24.3	-.1
38	-.53	12.00	40.0	15.0	42.7	1.6
39	0.00	12.00	29.5	10.8	31.5	1.8

AERODYNAMIC MODELING:

Velocities and Pressures along boundaries:

Node	X (ft)	Y (ft)	Velocities (mph) X-Direc.	Y-Direc.	Resultant	Pressure (psf)
40	.53	12.00	22.0	7.8	23.3	.6
41	1.07	12.53	31.5	11.6	33.5	2.3
42	1.60	12.53	23.2	8.3	24.7	-.3
43	2.13	13.07	40.3	15.1	43.0	1.5
44	2.67	13.07	29.7	10.9	31.6	1.7
45	3.20	13.07	22.0	7.8	23.4	.5
46	3.73	13.60	31.5	11.6	33.6	2.3
47	4.27	13.60	23.3	8.3	24.7	-.3
48	4.80	14.13	40.3	15.1	43.1	1.5
49	5.33	14.13	29.7	10.9	31.6	1.7
50	5.87	14.13	22.0	7.8	23.4	.5
51	6.40	14.67	31.5	11.6	33.6	2.3
52	6.93	14.67	23.3	8.3	24.7	-.3
53	7.47	15.20	40.3	15.1	43.1	1.5
54	8.00	15.20	29.7	10.9	31.6	1.7
55	8.53	15.20	22.0	7.8	23.4	.5
56	9.07	15.73	31.5	11.6	33.6	2.3
57	9.60	15.73	23.3	8.3	24.7	-.3
58	10.13	16.27	40.3	15.1	43.1	1.5
59	10.67	16.27	29.7	10.9	31.6	1.7
60	11.20	16.27	22.0	7.8	23.4	.5
61	11.73	16.80	31.5	11.6	33.6	2.3
62	12.27	16.80	23.3	8.3	24.7	-.3
63	12.80	17.33	40.3	15.1	43.1	1.5
64	13.33	17.33	29.7	10.9	31.6	1.7
65	13.87	17.33	22.0	7.8	23.4	.5
66	14.40	17.87	31.5	11.6	33.6	2.3
67	14.93	17.87	23.3	8.3	24.7	-.3
68	15.47	18.40	40.4	15.2	43.1	1.5
69	16.00	18.40	29.8	10.9	31.8	1.7
70	16.53	18.40	22.2	7.9	23.6	.4
71	17.07	18.93	32.4	12.0	34.5	2.1
72	17.60	18.93	24.2	8.8	25.7	-1.0
73	18.13	19.47	44.9	17.2	48.1	.1
74	18.67	19.47	35.6	13.6	38.1	.2
75	19.20	19.47	28.2	10.8	30.2	-6.3
76	19.73	20.00	81.4	32.2	87.6	.9
77	20.27	20.00	29.1	-11.2	31.2	-0.0
78	20.27	20.00	29.1	-11.2	31.2	0.0
79	20.80	19.47	29.1	-11.2	31.2	-0.0

AERODYNAMIC MODELING:

Velocities and Pressures along boundaries:

Node	X (ft)	Y (ft)	Velocities (mph) X-Direc.	Y-Direc.	Resultant	Pressure (psf)
80	21.33	19.47	36.5	-14.1	39.2	-.5
81	21.87	19.47	25.4	-9.3	27.0	-.3
82	22.40	18.93	25.4	-9.3	27.0	-.3
83	22.93	18.93	23.3	-8.4	24.8	-.3
84	23.47	18.40	23.3	-8.4	24.8	-.3
85	24.00	18.40	30.6	-11.3	32.6	-.9
86	24.53	18.40	24.2	-8.7	25.7	-.3
87	25.07	17.87	24.2	-8.7	25.7	-.3
88	25.60	17.87	23.0	-8.2	24.4	-.3
89	26.13	17.33	23.0	-8.2	24.4	-.3
90	26.67	17.33	30.3	-11.1	32.2	-.9
91	27.20	17.33	24.1	-8.6	25.6	-.3
92	27.73	16.80	24.1	-8.6	25.6	-.3
93	28.27	16.80	23.0	-8.2	24.4	-.3
94	28.80	16.27	23.0	-8.2	24.4	-.3
95	29.33	16.27	30.2	-11.1	32.2	-.9
96	29.87	16.27	24.1	-8.6	25.6	-.3
97	30.40	15.73	24.1	-8.6	25.6	-.3
98	30.93	15.73	23.0	-8.2	24.4	-.3
99	31.47	15.20	23.0	-8.2	24.4	-.3
100	32.00	15.20	30.2	-11.1	32.2	-.9
101	32.53	15.20	24.1	-8.6	25.6	-.3
102	33.07	14.67	24.1	-8.6	25.6	-.3
103	33.60	14.67	23.0	-8.2	24.4	-.3
104	34.13	14.13	23.0	-8.2	24.4	-.3
105	34.67	14.13	30.2	-11.1	32.2	-.9
106	35.20	14.13	24.1	-8.6	25.6	-.3
107	35.73	13.60	24.1	-8.6	25.6	-.3
108	36.27	13.60	23.0	-8.2	24.4	-.3
109	36.80	13.07	23.0	-8.2	24.4	-.3
110	37.33	13.07	30.2	-11.1	32.2	-.9
111	37.87	13.07	24.1	-8.6	25.6	-.3
112	38.40	12.53	24.1	-8.6	25.6	-.3
113	38.93	12.53	23.0	-8.2	24.4	-.3
114	39.47	12.00	23.0	-8.2	24.4	-.3
115	40.00	12.00	30.2	-11.1	32.1	-.9
116	40.53	12.00	23.9	-8.6	25.4	-.3
117	41.07	11.47	23.9	-8.6	25.4	-.3
118	41.60	11.47	22.3	-8.0	23.7	-.2
119	42.13	10.93	22.3	-8.0	23.7	-.2

AERODYNAMIC MODELING:

Velocities and Pressures along boundaries:

Node	X (ft)	Y (ft)	Velocities (mph) X-Direc.	Y-Direc.	Resultant	Pressure (psf)
120	42.67	10.93	29.1	-10.7	31.0	-.8
121	43.20	10.93	21.1	-7.7	22.5	-.1
122	43.73	10.40	21.1	-7.7	22.5	-.1
123	44.27	10.40	32.9	18.4	37.7	4.2
124	44.80	9.87	32.9	18.4	37.7	4.2
125	45.33	9.87	19.6	4.5	20.1	2.3
126	44.80	9.87	32.9	18.4	37.7	0.0
127	44.27	9.87	44.7	-.9	44.7	-7.1
128	43.73	9.87	39.3	-1.0	39.3	-5.0
129	43.20	9.87	34.4	-1.2	34.5	-3.7
130	42.67	9.87	29.2	-1.4	29.3	-2.6
131	42.13	9.87	23.4	-1.6	23.5	-1.7
132	41.60	9.87	16.9	-1.8	17.0	-.9
133	41.07	9.87	9.7	-1.9	9.9	-.3
134	40.53	9.87	5.9	-2.0	6.2	-.1
135	40.00	9.87	0.0	0.0	0.0	0.0
136	39.47	9.87	0.0	0.0	0.0	0.0
137	40.00	9.87	0.0	0.0	0.0	0.0
138	40.00	9.33	5.9	-2.0	6.2	-.1
139	40.00	8.80	5.9	0.0	5.9	-0.0
140	40.00	8.27	5.9	0.0	5.9	-0.0
141	40.00	7.73	5.9	0.0	5.9	-0.0
142	40.00	7.20	5.9	0.0	5.9	-0.0
143	40.00	6.67	5.9	0.0	5.9	-0.0
144	40.00	6.13	5.9	0.0	5.9	-0.0
145	40.00	5.60	5.8	.1	5.8	-0.0
146	40.00	5.07	5.8	.2	5.8	-0.0
147	40.00	4.53	5.8	.3	5.8	-0.0
148	40.00	4.00	5.8	.4	5.9	-0.0
149	40.00	3.47	5.9	.5	5.9	-0.0
150	40.00	2.93	5.9	.7	5.9	-0.0
151	40.00	2.40	5.9	1.0	6.0	-.0
152	40.00	1.87	5.9	1.3	6.0	-.0
153	40.00	1.33	6.0	1.6	6.2	-0.0
154	40.00	.80	6.0	2.0	6.3	-0.0