No. 850

PRESSURE DIFFERENCE ACROSS WINDOWS IN RELATION TO WIND VELOCITY

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MEMBERS

THE amount of air passing through a window as leakage is dependent upon the pressure difference across the window, and the crack opening. At the present time, there is a considerable mass of data from laboratory research showing what the leakage is for various kinds of windows for any specified pressure difference; but there is little definitely known about what the pressure difference actually is or is likely to be in any given building. In the absence of knowledge regarding this quantity, it is usual to assume a certain wind velocity appropriate to a given locality, and take the leakage as that corresponding thereto, which is equivalent to assuming a certain pressure difference at the window.[3]

Tables showing the relationship between chosen wind velocities and window leakage per foot of crack that may be expected to occur with pressure differences corresponding to those wind velocities, are given on pages 51 to 54 of The Guide 1929 for various types of windows.

The principal object in predetermining window leakage is to enable due allowance to be made in the amount of heating surface for the expected maximum infiltration. This maximum does not mean the leakage that will occur with the highest momentary gust of wind, nor the highest rate for any one hour, but should rather be considered as that which may occur during several hours of the heating season.

It is stated in The Guide that "the heat allowance for infiltration through cracks must be based on the average wind velocity for a given locality." It seems probable that the *average wind velocity,* as the term is used there, does not mean the actual average for all the hours of the heating season. In the case of transmission losses, The Guide suggests 15 mph as an *average wind velocity,* and it is probably implied that a similar value is intended to be used in the calculation of infiltration losses, in the absence of specific data. It is also stated in The Guide that "a further allowance must be made for the

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[3] For standard air density, the formula $p=0.00048M^2$ is used to calculate pressure corresponding to a given wind velocity or vice versa, where p=pressure in inches of water and M=wind velocity in miles per hour.

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direction of the prevailing wind in any locality, which shall be done by adding 15 per cent to the infiltration losses on the sides of the building exposed to the prevailing winds." The tables of The Guide are given in two parts, the values of Part II being 80 per cent of those for Part I (in which leakage as determined from experiments is given), to make allowance for an opposing

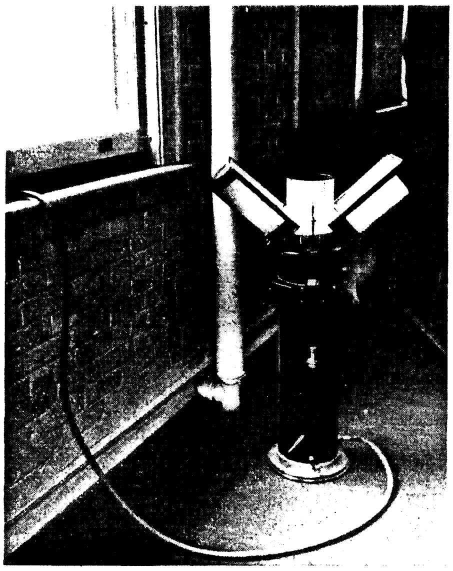


Fig. 1. Recording Gage Used to Measure Pressure Difference Across Windows

pressure built up on the inside as a result of air being forced in by the excess wind pressure on the outside.

In a former paper by the authors,[4] the need for more definite information on the subject of pressure difference across windows was emphasized, and it was suggested that a program of work along this line should be started. It was with this thought in mind that the study described in the present paper has been undertaken. The definite objectives are to attempt to show how the chosen value of wind velocity for The Guide Tables should be rationally determined for a particular case; to ascertain if the factor of 80 per cent of Part II is a reasonable value; and, if possible, to see what is the effect of

[4] The Weathertightness of Rolled Section Steel Windows, Transactions, A. S. H. V. E., 1928, p. 527.

temperature difference. It is to be understood that this study is by no means complete, but is offered at this time rather more in the hope of receiving criticisms and suggestions regarding the mode of procedure in the interpretation of data, than to present final facts and conclusions.

Means of Obtaining Data

A record of pressure difference across two windows in one of the buildings of the University of Michigan was obtained continuously over a period of 45 days, extending from the middle of January to the first of March, 1929. A recording pressure gage with a 24-hour chart was used. A photograph of the gage, known as a hydro-recorder, is shown in Fig. 1. A narrow felt-trimmed board, with a hole through it into which a brass tube was pushed, was slipped under the lower sash, and the crack thus opened at the meeting rail was stopped with another felt-trimmed strip. The brass tube was connected to the gage which was located in the room, and the resulting record showed the excess or deficiency of the outside pressure over that inside. The connection of the gage to the window may be seen in the picture. Fig. 2 shows a part of the record during a period when there was but little wind, and Fig. 3, of a part when the wind was rather high, and from the direction of exposure. The highest momentary pressure difference recorded was 0.88 in. of water, which, in terms of wind velocity, would be about 42 mph.

Two windows were chosen, on the west end of the building, one on the second floor, and one on the fourth. There was free exposure to wind from the west and southwest, as illustrated in Fig. 4. The gage was connected at the second floor window for 28 days continuously, and then moved to the fourth floor, where a record for 17 days was obtained.

Anemometer records of wind velocity and direction as well as thermograph records of temperature were available at the University Observatory. The data of these records were transferred to the pressure difference charts as illustrated in Figs. 2 and 3. For convenient reference, the maximum pressure difference, and the average pressure difference as nearly as it could be determined, were read from the chart curve, and these quantities appear as lines 4 and 5. In this manner, all of the necessary data are synchronized on the pressure difference charts, with the graphic record of the pressure difference in direct view above.

Selecting Wind Velocity in Estimating Infiltration Loss

From Table 1, which is a summary of the wind data over approximately the 45-day period before alluded to, it is seen that the average wind velocity is 7.7 mph over the entire time. It is also seen that the wind is predominantly

Table 1. Summary Wind Data

Item	Direction from which wind came								
	N	NE	E	SE	S	SW	W	NW	Total
1. No. of hours........	97	50	129	85	57	155	179	289	1041
2. Miles of wind.......	569	187	892	509	308	1454	1656	2437	8012
3. Average velocity....	5.9	3.7	6.9	6.0	5.4	9.4	9.3	8.9	7.7
4. Per cent of hours...	9.3	4.8	12.4	8.2	5.5	14.9	17.2	27.7	100.0
5. Per cent of wind....	7.1	2.3	11.1	6.5	3.8	18.1	20.7	30.4	100.0

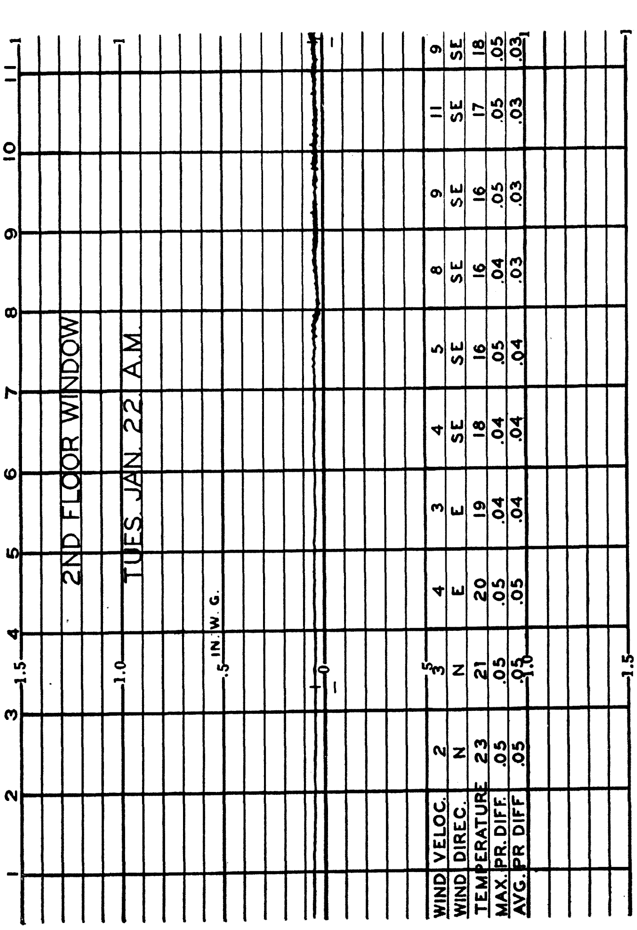


FIG. 2. PORTION OF PRESSURE DIFFERENCE RECORD ACROSS TWO WINDOWS WITH BUT LITTLE WIND VELOCITY

from the SW, W, and NW, nearly 70 per cent of the wind coming from these three directions, and only 30 per cent from the other five.

In order to get at usable maximum values of wind velocity, Table 2 has been prepared, in which the wind is classified as *prevailing* and *non-prevailing*, and the number of hours is shown during which the wind blew at each velocity designated. Separate consideration is given to those hours of the day included between 7 a.m. and 5 p.m., which may be regarded as the ordinary period of occupancy of a building.

From the prevailing directions, the wind had a velocity of 15 mph or more for 73 hours during the month and a half investigated. Counting only the 10 hours per day of ordinary occupancy, the wind had a velocity of 15 mph or more for 25 hours, which is somewhat less than ten twenty-fourths of 73, indicating that most of the higher wind velocities occur at night. If it be assumed that the wind statistics for the other month and a half of the season are like those studied, it could be said that the wind from the prevailing directions has a velocity of 15 mph or more during 50 hours of the time of occupancy of a building. Perhaps this would not be an unreasonable figure upon which to base allowance of heating surface requirements, considering the fact that the periods of high wind velocity will not always occur simultaneously with the periods of lowest temperature. The average speed of the prevailing wind for all those hours during which the velocity is 15 mph or more is found to be about 19 miles. Hence, for this particular case, it would appear that a value of 19, or say 20 mph would represent a reasonable value for wind velocity to be chosen for those sides of a building exposed to the prevailing wind. To obtain more accurate results, wind data for several seasons should be studied in this manner.

Turning now to the non-prevailing winds of Table 2, it is seen that the wind had a velocity of 9 mph or more during 28 hours of the time of occupancy, for the month and a half period, or perhaps 56 hours for the entire season. The average speed of the non-prevailing wind for all those hours during which the velocity is 9 mph or more is found to be about 13 miles.

Having thus determined what is to be considered as the wind velocity, the next objective is to ascertain if possible what is the relation between wind velocity and actual pressure difference, and to find out if the factor of 80 per cent of Part II of THE GUIDE tables is justified.

TABLE 2. PREVAILING AND NON-PREVAILING WINDS

Wind Velocity	Number of Hours			
	Prevailing Wind		Non-Prevailing Wind	
	SW. W. and NW.		N. NE. E. SE. and S.	
	All Hours of Day	7 A. M. to 5 P. M.	All Hours of Day	7 A. M. to 5 P. M.
1. 25 MPH or more	8	5	0	0
2. 20 MPH or more	35	10	0	0
3. 15 MPH or more	73	25	9	1
4. 10 MPH or more	246	78	44	14
5. 9 MPH or more	...	..	69	28

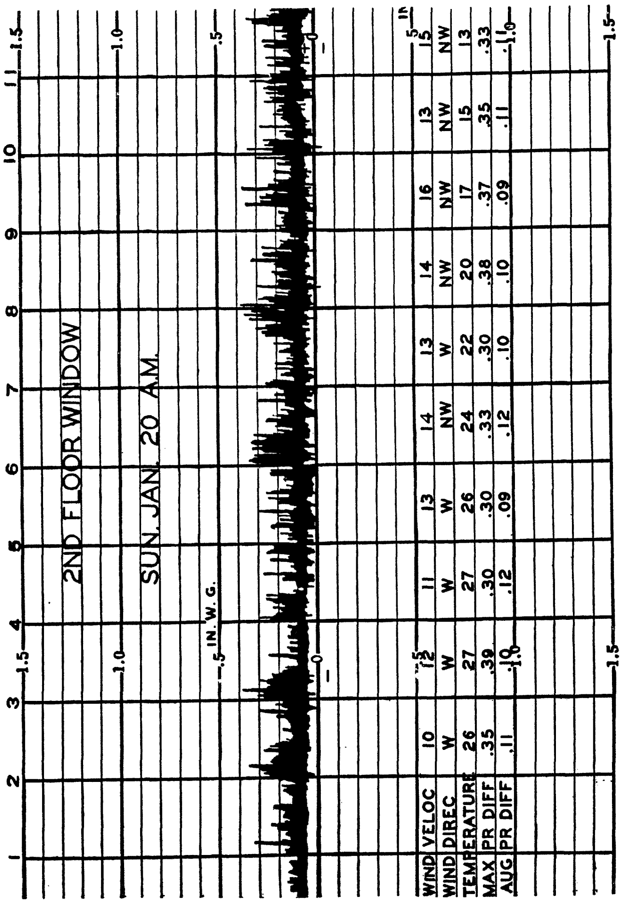


Fig. 3. Portion of Pressure Difference Record Across Two Windows with High Wind Velocity

Relation of Pressure Difference to Wind Velocity

A record of pressure difference across two windows of a chosen building, one on the second floor and one on the fourth floor immediately above (see Fig. 4) was obtained in the manner heretofore described. Owing to the proximity of an adjacent building, the windows were sheltered from a northwest wind, but were fully exposed to the west and southwest. The relation between pressure difference across the second floor window and the wind velocity from the west or southwest (the direction of exposure of the window), is shown by the curve of Fig. 5. Each point represents the average

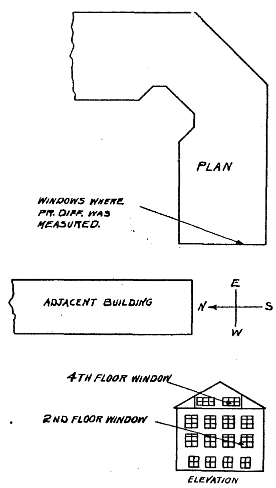
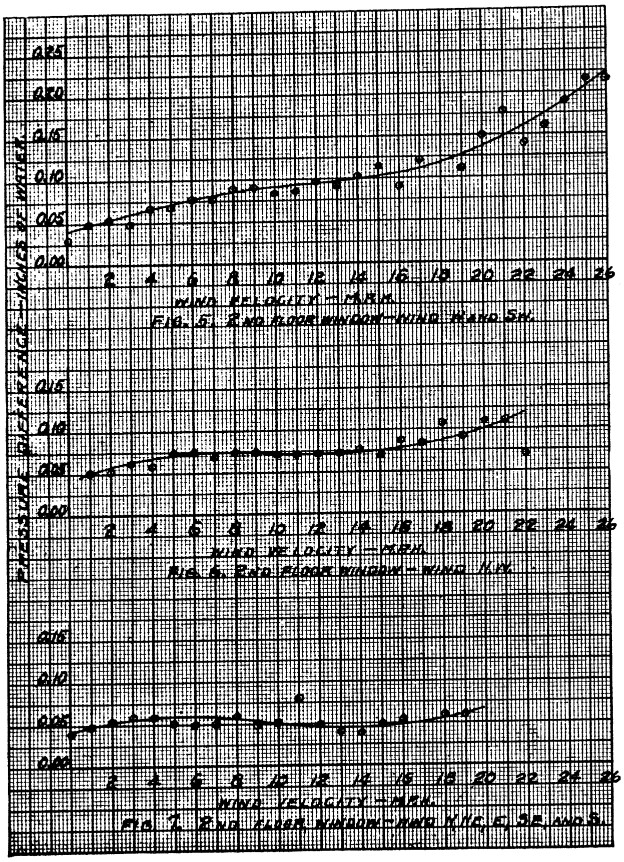


Fig. 4. Showing Location of Windows

of the mean hourly pressure differences for the number of hours during which the wind velocity had the particular value for which the point is plotted. The points lie quite consistently near the smooth curve, except in the region of higher wind velocity, where each one is the average of fewer values than is the case in the region of lower wind velocity.

The curve of Fig. 6 represents the case where the wind came from the northwest, which is considered separately because the window is sheltered in this direction by the adjacent building as shown by Fig. 4. The curve of Fig. 7 shows how the pressure difference on this second floor window is influenced by wind coming from directions other than southwest, west or northwest. The curves of Figs. 8, 9, and 10 present the same kind of picture



FIGS. 5, 6, 7. CURVES SHOWING RELATION BETWEEN PRESSURE DIFFERENCE AND WIND VELOCITY FOR 2ND FLOOR WINDOWS

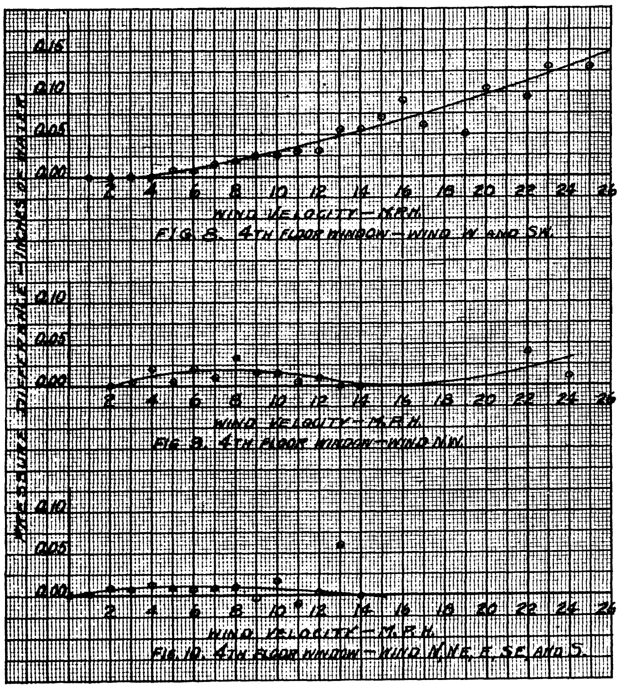
of the relation between pressure differences and wind velocity for the fourth floor window.

It might have been expected, with winds coming over or around the building, from directions other than southwest, west or northwest, that there would have been a tendency to form a slight vacuum at the leeward end in which the windows were located, and thus materially reduce the excess of outside pressure over inside pressure, or even reverse the direction of excess at the upper window. This same effect might even be expected in some degree when the wind came from the northwest, blowing over or around the adjacent building (see Fig. 4). The curves of Figs. 6, 7, 9, and 10, do indeed suggest this very thing, as all of them show a slight drop after the wind attains a velocity of about 8 mph. None of the curves reveal an excess of pressure inside, over that outside at the upper window, as would be anticipated by the theory of effect of temperature difference. However, there is a reason to account for this situation, which will be explained.

Since the principal object of this part of the study is to examine the pressure difference over windows exposed to the wind, attention will now be directed only to the curves of Figs 5 and 8, and these may be considered to represent what would occur at any window about the building when the unobstructed wind blew against it. The pressure differences at the windows at the two levels investigated are compared in Fig. 11, where *A* is the curve of Fig. 5 (second floor window), and *B* is the curve of Fig. 8 (fourth floor window). Curve *C* of Fig. 11 is the computed wind pressure drawn in for reference. It is seen that the curves for the two windows are more or less parallel, *A* being displaced above *B* by an average amount of 0.053 in. of water. Using the average temperatures that prevailed and the height between the windows, which is about 28 ft, the head caused by temperature difference is calculated to be 0.041 in. of water, which should express the amount by which the pressure difference at the lower window is greater than that at the upper, and pretty well accounts for the actual difference of 0.053 in. between the curves. If it were not for the upward bulge in the curve *A* between wind velocities of zero and about 14 mph, for which no reason seems to be evident, it is probable that the difference between the curves *A* and *B* would be almost exactly accounted for by the effect of temperature.

It would be anticipated that with little or no wind, the temperature difference would produce a negative effect at the upper window—that is, the inside pressure would be greater than the outside, and outflow would occur there. This would be evidenced by the curve *B* of Fig. 11 coming below the base line at low wind velocities, which it does not do. It is believed that the presence of gravity flues in the rooms in which the windows are located accounts for the apparent departure from theory. The gravity flue on the second floor drew air from that room, and thus tended to increase the excess of outside pressure. At the same time the loss of air here reduced the amount that would have otherwise naturally ascended to the fourth floor by way of open stairs in other parts of the building, and so relieved the interior pressure on the fourth floor windows. Also the gravity flues in the fourth floor room provided an escape for air which further relieved the inside pressure there, with the net result that there was no excess of inside pressure over that outside on the fourth floor windows. It is probably merely accidental that the pressure difference at the fourth floor happened to be exactly zero with no wind.

In Fig 12, curve D is the mean of curves A and B, of Fig. 11—that is, it represents the average of the pressure differences observed at the second and fourth floor windows. Curve C is again the pressure computed from the wind velocity. The ratio of the average pressure difference to the wind pressure is



FIGS. 8, 9, 10. CURVES SHOWING RELATION BETWEEN PRESSURE DIFFERENCE AND WIND VELOCITY FOR 4TH FLOOR WINDOWS

represented by curve E, and this is the relation that is the principal objective of this part of the study. Up to a velocity of 11 mph, the pressure difference exceeds the wind pressure, as a result of the temperature effect. Above 11 mph, the pressure difference is less than the wind pressure, and it is interesting to note that curve E seems to approach and become constant at about the value of one-half, in the region of high wind velocities. This is just what

would be expected to happen in a building, when the wind pressure becomes so great as to submerge the temperature effect, and where the total leakage area for inflow on the windward faces about equals the total area for outflow on the leeward faces. The inside pressure would have to build up automatically to a value equal to half the wind pressure, so that the head available to force the air out would be equal to the head available to force an equal amount of air in.

Having chosen a value of 20 mph for wind velocity as a basis upon which to determine infiltration in the calculation of heating surface requirements for rooms on exposed sides of the building, curve E of Fig. 12 would indicate that the actual pressure difference across the windows is about 0.55 of the pressure computed from this wind velocity, which means that the leakage is about 75 per cent of the amount corresponding to the pressure computed from the wind velocity, since leakage quantity is approximately proportional to the square root of the pressure difference. In other words, the factor to be applied in Part II of the tables of THE GUIDE 1929, to allow for building up of inside pressure should be about 75 per cent in this case.

It will be recalled that the usable maximum wind velocity for sides of the building exposed to the non-prevailing winds was chosen as 13 mph. This is near the value of 15 miles, which is probably the intent of THE GUIDE to suggest for use in connection with the less severe exposures. Referring to Fig. 12, it is seen that for 15 mph, the ratio of actual average pressure difference at the two windows, to the calculated wind pressure, is 0.67, which means that the leakage is about 82 per cent of the amount corresponding to the pressure computed from the wind velocity.

From this study, it appears that the factor of 80 per cent, as applied in Part II of the tables of THE GUIDE 1929, is well chosen, probably erring, if at all, on the side of being too large. However, it is indicated that the practice of allowing an additional 15 per cent in leakage loss for the sides of a building exposed to the prevailing wind may not provide an adequate margin of heating surface on those sides. For example, if 15 mph be taken as the wind velocity upon which to figure infiltration on the less exposed sides, the leakage per foot of sash crack of a double hung weatherstripped wood window is 11.7 cu ft per hour. It has been shown that a reasonable value to be taken for wind velocity from prevailing directions is 20 mph, for which the leakage is 22.9. Thus in the case studied the leakage of windows under the more extreme conditions on the more exposed sides, is nearly twice as much as that on the less exposed sides, instead of only 15 per cent greater. If this is true of infiltration loss, it is also true of transmission loss, although probably in a different ratio. In other words, in the determination of heating surface to take care of the most severe situations, it is probable that there should be a greater differential than 15 per cent in the allowances for infiltration and transmission loss between the windward sides of a building and the sides of lesser exposure.

DISTRIBUTION OF LEAKAGE AT WINDOWS AT DIFFERENT LEVELS

Referring to Fig. 11, it is seen that the pressure difference at the second floor window is considerably greater than it is for the fourth floor, which, as previously explained, is practically accounted for by the temperature difference effect. Converting the pressure difference at 20 mph into corresponding wind velocity, and then going to THE GUIDE table, it is found that the leakage at the second floor for a double hung weatherstripped wood window is about 17.5 cu ft per hour per foot of sash crack, and that at the fourth floor about 12.8 cu ft which calls for 0.025 sq ft more radiation per foot of crack on the second floor than on the fourth. With eight windows of say 50 ft of sash crack each, including transoms, the total difference in radiation would amount to 10.0 sq ft. Considering windows of poorer construction, and taking frame leakage into account, the total difference in radiation between the floors for rooms at the one end of the building (Fig. 4) might easily run to 40 or 50 sq ft. The difference in heating surface requirements between lower and upper floors is thus seen to be of considerable amount even in the case of three or four story buildings. It would of course be greater still in taller buildings, although it is reduced when there is not free communication between stories by way of open staircases or other means.

In connection with the matter of extra allowance in square feet of radiation to take care of maximum infiltration, it is to be emphasized that this is not a measure of heat loss by infiltration, but is rather an allowance in capacity to meet an extreme or emergency situation. Infiltration goes on to some extent continually, so long as there is either a temperature difference or a wind, but not at the maximum rate. The column of the tables in THE GUIDE 1929 headed *Heat Loss* is likely to be misinterpreted to mean a continual drain from the heating system of the Btu rate per degree temperature difference indicated, which is not the case.

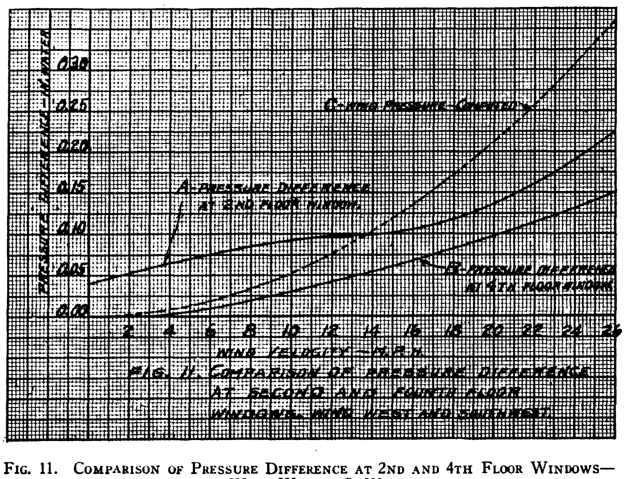


FIG. 11. COMPARISON OF PRESSURE DIFFERENCE AT 2ND AND 4TH FLOOR WINDOWS—WIND W. AND S. W.

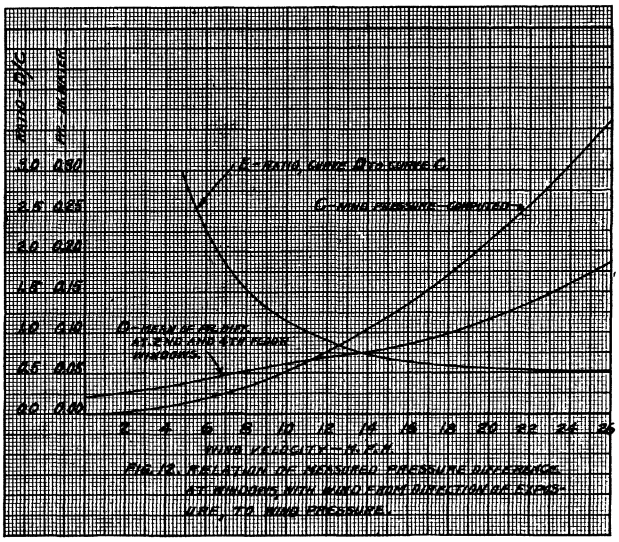


FIG. 12. RELATION OF MEASURED PRESSURE DIFFERENCE AT WINDOWS, WITH WIND FROM DIRECTION OF EXPOSURE, TO WIND PRESSURE

In conclusion it may be said that the study described and developed in this paper throws some light upon the relation of actual pressure difference across windows to wind pressure, for one particular case. It is indicated that something definite may be derived from a study of this kind. It is further plainly shown that temperature effect, even in buildings of moderate height, may be a factor of sufficient importance to require a different allotment of heating capacity as between lower and upper floors. A study of Weather Bureau records and a general agreement as to the interpretation of data therefrom are highly important in order to better define what shall be considered as the wind velocity upon which to determine window leakage.

DISCUSSION

S. H. GIVELBER: Is there any relation between the pressure differences and the effect they have on the temperature in the room?

C. G. SEGELER: I would like to question something that Professor Emswiler has stated or perhaps point out a source of possible difference of opinion on this particular paper. Professor Emswiler has very carefully selected data for 45 days on both wind direction and velocity. Would the conclusions drawn be the same if the data had only been collected on such days as might be termed maximum heating days, that is, days on which the given heating system was taxed to the utmost? It would seem to me that the information that is ultimately going to be necessary in deciding such a point is what wind velocity to use in estimating the radiation required for a given building. I feel that it is possible (on this I am not informed; I would like to hear from Professor Emswiler) that the maximum day conditions might be different from those taken over a 45-day period. That is to say, the higher winds might not coincide with the coldest days. That would alter the picture presented.

G. L. LARSON: This paper represents a very important study and I hope that the authors will follow it up with further tests. In laboratory tests, certain pressures are created on the two sides of a wall, or window, and the leakage due to these pressure differences can be very accurately measured. But before a designer can intelligently use the results of these laboratory tests, he must know something about the actual pressure differences that actually exist in practice. This paper throws considerable light on this point, but more research on this subject is necessary. I hope the authors will continue the excellent work that they have started.

The relation between existing winds and outside temperature was mentioned by the last speaker. I think the general practice of THE GUIDE is to assume a certain outside temperature, say —10 or —20 F, depending on the locality, and at the same time to apply a wind velocity of 15 mph. I believe this is wrong because this procedure superimposes two peaks upon each other, and they do not exist together.

I have in mind the records of the heating plant at the University of Wisconsin, where the heating plant is connected to some 93 buildings. The record from this many buildings should give a good average of what is taking place in such a group. The maximum heating load last year occurred on the day when it was four degrees above zero, although it was as much as 25 below several days. At 25 below, or at 20 below, or at 15 below, we ordinarily have practically no wind; the atmosphere is *dead;* but on a day around zero or a little bit above, we have our heaviest winds. So it is questionable whether we should design for —25 F and at the same time add losses due to a wind which is traveling at 15 mph. At least in our section of the country, these peaks do not exist together.

I would like to ask the authors if they tried out different types of tubes to get the static pressure on the outside of a window. I imagine that there might be found considerable difference in the readings depending upon the kind of tube used.

MARGARET INGELS: I believe mention was made that there were gravity exhaust flues in the room. I would like to know if there was any figure taken to find out if the difference in temperature indoors and outdoors caused a variation of air to flow through the gravity exhaust making different pressures build up inside the room.

MR. NICHOLLS: Professor Emswiler speaks of the prevailing winds from the west and southwest. What kind of temperature do you get from that direction as a rule?

PROFESSOR EMSWILER: We usually get our coldest temperatures from the northwest.

MR. NICHOLLS: What were they from the south and the southwest?

PROFESSOR EMSWILER: The average perhaps was 20 F.

MR. NICHOLLS: I think you will find that they have a good deal of guessing to do yet when it comes to that. You have to use a factor of wind velocity with your temperature and after you have that worked down to a rational equation, you have to guess what kind of a building you have to heat. Perhaps you will get it some day; I doubt it!

S. R. LEWIS: There is in Chicago a 21-story cooperative apartment. Through some mistake the north end of this building, having 21 duplicate apartments, was short of radiation. It was necessary to add radiators. Our observations of the conditions were taken in the second story and the twenty-first, where the complaints originated, but since all of the apartments were exactly alike throughout the 21 stories, I recommended the additional radiation to all of them. When the radiation was shipped and the steamfitters started to work putting them in, just before I left to come to this meeting, the owners of the apartments through the central zone of the building refused to permit the radiators to be added. They said, "We are all right." I suspect it is the infiltration due to the height of the building in the lower part and the exfiltration in the upper part that causes the complaints of shortage of radiation.

L. A. HARDING: I think this is a very excellent paper. There were originally two major problems to be solved in reference to infiltration. The first one was to determine the amount of leakage through a crack with a certain pressure difference. That has apparently been satisfactorily solved by these gentlemen and others. The second problem, that of correlating the wind velocity as reported by the Weather Bureau to actual infiltration or pressure difference, remains unsolved. The Research Laboratory is attempting to solve this part of the problem, that is to correlate the wind velocity as reported by the Weather Bureau to actual wind velocity over the surface of building walls. I think you will be very much interested in the paper that our director of research, Mr. Houghten, will be able to present next year along this line. There exists at present, no standard in reference to the distance from the wall surface where the velocity of the air movement is to be measured in order to arrive at surface coefficients to be employed in heat transmission problems relative to building construction.

MR. NICHOLS: I think it is going to be extremely difficult to arrive at any thing satisfactory by the method of observation merely of wind velocities. If it is possible to establish some kind of a laboratory so that condensation experiments can be made, under observation of all these conditions, I think a factor can be derived which will have to do with the wind pressure recorded by the Weather Bureau.

PROFESSOR EMSWILER: In answer to the first question, whether or not there was any relation between pressure difference and temperature in the room, the situation was this: The temperature in the room was held essentially constant by the thermostatic control that operated in connection with the building. If there was more infiltration, that is more cold air coming in, it was compensated for by the thermostatic control. Hence there was, therefore, no necessary relationship as far as that was concerned.

Now, with respect to Mr. Segeler's question, whether the results of such a study as this ought to be based upon conditions prevailing during a single day of maximum or extreme conditions, or whether it should be based, as we have suggested here, upon a total of several hours during which the wind velocity was up to or above a certain selected level, that is an important question. If you consider the situation from the standpoint of performance, it would seem that you would have to base it upon some such arbitrary factor or time, as we have chosen. If you would want to examine an actual system that is already in operation, then it would be perfectly logical, of course, to observe during that day when the extremes prevailed.

In answer to Professor Larson's question, we have a record of the outside temperature along with wind velocity, but there seemed to be no obvious relation between the two. Of course, with the lower temperature and the same velocity, the inertia or impact effect of the wind is greater. The amount of infiltration, however, is not different with the lower temperature and therefore higher density, but, of course, the weight of air is somewhat different. We did not think this would make a great deal of difference.

The tube used was simply pushed through a hole in the wood strip under the sash, the end of the tube being flush with the outside surface of the board, so that it collected, so to speak, the dynamic pressure that was produced by the wind. It did not of itself produce or result in any localized static pressure as a result of the wind blowing across it, or at same angle to it. It simply, as I see it, collected the static pressure that existed at the exterior of this window due to the dynamic effect of the wind blowing, together with any natural static pressure that prevailed there.

In answer to Miss Ingels' question, we took no measurements of the quantity of air flowing through the gravity flues. We simply took a record of pressure differences as they existed in the two rooms and, these gravity flues would readily account for the displacement of those two pressure difference curves in relation to the wind. They would account for the fact that at zero velocity we found no vacuum on the outside with respect to that inside.

Again, referring to Mr. Nicholl's question, there has already been done a very extensive amount of laboratory work in the determination of the amount of infiltration that will take place through openings or cracks in windows and doors, with certain specified pressure differences applying, and curves and tables present the relation between the quantity of infiltration and the pressure differences. However, I do not see how in any way you could in the laboratory decide upon the question as to what wind velocity you were going to use in applying or making use of the tabular values resulting from the laboratory experiments. It seems to me that must be obtained from statistical data with respect to the observatory records.

MR. NICHOLLS: You have to do some intelligent guessing, you mean?

PROFESSOR EMSWILER: Mr. Lewis and Mr. Harding presented very interesting phases of this same question and I am sure that we all look forward with anticipation to the results that are available when they have been finished. However, the only record which we were interested in was the pressure difference across the window. We are continuing this experiment and possibly may have some more to present at some later time.