laws of some American cities required a wind pressure allowance as follows:—

New York	.. .. ..	30 lbs.
Philadelphia	.. .. ..	30 „
Pittsburgh	.. .. ..	25 „
Baltimore	.. .. ..	30 „
Cleveland	.. .. ..	30 „
Chicago	.. .. ..	20 „
St. Louis	.. .. ..	30 „
San Francisco	.. .. ..	20 „

Many high buildings had no calculated wind bracing. This practice was not recommended. These wind pressures would be allowed for normally with a factor of safety of four, and the wind considered as a dead load. The American Bridge Co. provided for 20lbs. wind pressure; this was dead load, and with a factor of safety of four. C. C. Schneider, in his specifications, allowed 20lbs. wind pressure as a dead load, with a factor of safety of four for export work. These allowances, in the opinion of many engineers, were too small. From analysis of wind pressures, velocities, etc., this might appear to be the case, but the author was of the opinion that these allowances were sufficient if the building be properly designed.

The author was supplied with the following maximum wind velocities by the Weather Bureau, Flagstaff Hill, on 3/5/13.

It should be borne in mind that these were gusts of wind. 120 miles per hour was the maximum recorded. This might have been the velocity of an eddy in the air. Prof. Kernot, in a paper read before the "Australian Association for the Advancement of Science," showed the great difference between the readings recorded by the different makes of instrument. This variation in reading of the different instruments brought up the subject of which was correct. The experiments of Sir B. Baker, Dr. Stanton, and others, have proved that the pressure in wind was not at all uniform. Small eddy currents might cause great or small local pressures. This was now proved to be one of the causes of the hitherto unaccountable difference of reading of two of the same make of instrument in the same wind. This conclusion, therefore, showed that all instruments with small areas exposed were not at all to be relied upon for finding the correct pressures to be allowed for in as large an area as the walls of a building.

The instrument used at the Sydney Observatory was a Russell anemometer; this had four cups, which had a concave and convex surface acting in opposition. The speed of revolution depended on the difference of resistance of these cups. It was quite possible for one of these cups to be in a current of air of 60 miles per hour and the other at 90 miles per hour, and the reading of the instrument may give 120 miles per hour.

Many experiments had been carried out to ascertain the relation between pressure and velocity. This subject had lately been of great interest to aviators. It was now generally admitted that the pressure varies as the square of the velocity thus:—

$$P = K V^2 \quad \text{where K is a constant.}$$

The value of K depended to some extent on the area of the surface, and numerous experiments have been carried out to ascertain its true value. The author considered the value .003 was a fair allowance to be made for the purposes of estimation of wind pressure. Some experimenters gave slightly less, others more, and no two gave the same. The motion of the air was so irregular that the slightest modification of position or condition gave another reading for the same average velocity.

The author was of the opinion that there were so many assumptions to be made in the instruments, that the absence of uniformity in the air pressure rendered the anemometer readings and the deductions made from them of little value in guiding the engineer what pressure to allow on buildings. 20lbs. per sq. ft. of wind pressure, according to formula, corresponds to 81.6 miles per hour, 30lbs. to 100 miles per hour, 43.2 to 120 miles per hour. This 43.2lbs. per sq. ft. was the calculated wind pressure to suit the maximum wind velocity as indicated by an instrument whose readings were considered to be true, provided the current of air was uniform, which was not the case. We did not propose to put a building on the top of the Observatory tower, the size of a cup of the anemometer, which would have to stand a wind pressure which corresponded to the maximum reading recorded by an instrument on which slight irregularity in wind currents could cause great differences in reading. We wished to establish a wind pressure allowance for a building with the stresses per square inch indicated. The author considered the only information of real importance was actual results of wind on buildings or large areas similarly affected by wind. Sir B. Baker made some experiments on large areas on the site of the Forth Bridge. 20lbs. per sq. ft. covered these readings, but this test was not quite analogous on account of the fact that the gauge was not on the ground as buildings were. To put the gauge near the ground would prevent the wind from rushing round the lower edge, and thus give a smaller reading. To let the wind run round the edge of a surface increased the pressure. It was proved by actual test and experiment that the wind pressure on gable roofs when resting on walls was sometimes almost nothing, and often there was a tendency to lift. The following sketch (Fig. I.) indicated the action of the wind. When there were no walls, the pressure as indicated by Duchemin's formula was approximately right by test. The equivalent of 20lbs. wind pressure was allowed for on all roofs as deduced by Duchemin's formula, to provide for irregular current altitudes and directions. There were an innumerable number of buildings and structures standing which could never resist theoretically a wind pressure of 15lbs. per square foot. If an examination was made of houses, windows, chimneys, signboards, vehicles, etc., they would be found to be unable to withstand the wind pressure. As these structures had stood the wind for very many years, and these were the actual conditions under which the proposed workshop buildings had to stand, it was considered that the wind pressures allowed for, with the stresses permitted, was quite a safe allowance.

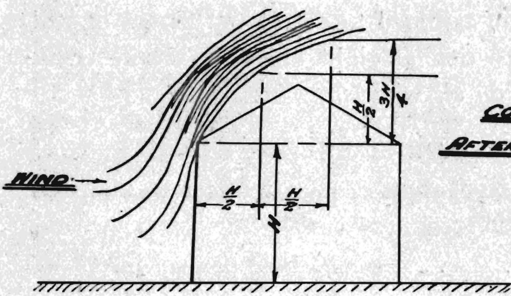

FIG. I.

Prof. Kernot, as a result of his investigations, "as a reliable guide," gave the following:—

"Plane surfaces of not less than 300 sq. ft. in area are subject to a maximum wind pressure of not more than 20lbs. per sq. ft., and smaller surfaces to a pressure of not more than 30lbs. per sq. ft. in exposed positions. In sheltered positions half the above values may be taken, and intermediate cases may be dealt with according to judgment."

Factors of safety of not less than two for stability and three for strength should be used.

This would be taking the wind as a dead load. While the author was not allowing quite as low a relative value for wind, yet he had no proof that Prof. Kernot was not safe, but there was abundant proof that the allowances of 30lbs. per square foot and higher were excessive.

Live Load.— For structures carrying travelling machinery, such as cranes, conveyors, etc., maximum loads should be allowed for in conjunction with dead load, wind load, and after-mentioned loadings.

In the case of travelling cranes, 3/20ths of the maximum wheel pressures were assumed to act at the surface of contact along the length of the track. This loading was assumed to be absorbed within 50ft. of its point of application.

In the case of a travelling crane 3/20ths of weight of truck, and load was assumed to act at top flange of rail in a horizontal direction at right angles to crane track evenly distributed on all wheels.

STRESSES.

Structural Steel.—The stress per sq. inch was not to exceed—

Tension	=	10 tons per sq. in.
Compression ..	=	10 ,, ,, ,, ,,
Shear	=	10 ,, ,, ,, ,,
Bearing	=	10 ,, ,, ,, ,,

Rivet Steel.—The stress per sq. in. was not to exceed—

Tension	=	8 tons per sq. in.
Compression ..	=	8 ,, ,, ,, ,,
Shear	=	8 ,, ,, ,, ,,
Bearing	=	8 ,, ,, ,, ,,

Foundations.—Pressure was not to exceed the following:—

Soft Clay .. .. 1 ton per sq. ft.

Ordinary Clay and Dry Sand mixed

with Clay	2 tons per sq. ft
Dry Sand and Dry Clay	3 „ „ „ „
Hard Clay and Firm Coarse Sand ..	4 „ „ „ „
Firm Coarse Sand and Gravel ..	6 „ „ „ „
Concrete, 4 — 2 — 1	25 „ „ „ „
Grip of Concrete on Steel embedded in it	=100 lbs. per sq. in.
Modulus of rupture of Oregon	= 5 tons „ „ „

COVERING.

The covering was 24 gauge galvanized corrugated iron, side lapped, 1½ corrugations on both roof and walls, with not less than 6in. end lap on roof and 4in. end lap on walls. Sheets were screwed down with 1¾in. galvanized roofing screws, No. 12 gauge, and lead washers.

24 gauge iron was considered the best. Lighter gauges were too frail, and heavier too dear. As regards length of life of the various gauges, with regard to corrosion, there was little difference in them, as the thickness of the galvanizing was the determining factor. Once the galvanized coat was removed from the iron, the time taken to rust the iron away was small, and the difference of time for the various gauges was small.

In Balmain, there was galvanized iron on roofs of 24 gauge quite good after 32 years' service, but on workshop buildings a definite length of life could not be given, owing to the large number of different conditions that affected it. One case might last seven years or less, another 40 years.

The advantage of the heavier gauges was in the fact that they could be walked on less carefully. Walking on the lighter gauges caused local buckling, and when workmen climbed about on roofs for electric wiring or other purposes, it was advisable that planking be laid. If it was found after some years that the lead washers under the screws turn up, these could be strengthened by the addition of a galvanized iron washer at the back of the lead one. Special conical washers made of lead were able to be obtained on the market. It should not be allowed that the screws be driven in with a hammer, as the hole through the iron became enlarged by the process, but they could be first started with the hammer and then screwed home in oregon. Hardwood must always be bored. Galvanized iron, when curved or bullnosed for 1½in. laps, should have one-half the number of sheets ordered "hollow" curved, and the other half "dome" curved.

Sheets should not be curved smaller than a 12in. radius. In ordinary bullnosed iron the best way to fix the curve was to state the length of the straight iron that was curved and the radius of curvature, thus:—

> x, y′—o″ sheets G gauge galv. corr. iron, with
> a′—b″ dome (or hollow), bullnosed one end,
> to c′—d″ radius.

The length of sheets obtainable in 24 gauge and approximate number of sheets per ton and per case was as follows:—

	Lengths in feet.						
	5	6	7	8	9	10	12
Gauge—							
24 per ton ..	160	140	120	102	94	32	71
24 per case..	83	70	60	51	45	41	35

Sheets when side lapped 1½ corrugations take 8 sheets to 15 feet, and the number of screws to 100 feet run of purlin for end laps was 187, and for intermediate purlins 134.

60	1¾in.	Roofing Screws	go to the lb.
70		Lead Washers	,, ,, ,, ,,
96		Galv. Iron ,,	,, ,, ,, ,,
48	2in.	Roofing Screws	,, ,, ,, ,,

For end lap joint, 3.12lbs. screws and 2.67lbs. washers per 100ft. run of purlin.

In intermediate purlin, 2.23lbs. screws and 1.91lbs. washers.

Corrugated iron, when packed, should never be left out in the rain, especially in a flat position, as the rain settled in the sheets and sweated them. Galvanized iron thus left in the rain for a very short period is reduced in value about 30/- per ton.

It was always advisable to use the longer lengths where possible to save lapping, but the price per ton for long sheets was a little more than for short.

Ridge Capping. — Ridge capping was obtainable in 6′—0″ lengths. 24 gauge, 18in. girth, was recommended, screwed down with the lap arrangement of screwing mentioned before.

GUTTERING.

Guttering was to be made of 24 gauge. The largest stock guttering obtainable was 6in., and down pipe maximum size was 6in. diameter. It was sometimes considered preferable to specially make a bigger size guttering, and thus avoid a large number of down pipes. The following arrangement was considered by the author to be as cheap as any (see Fig. 2) :—

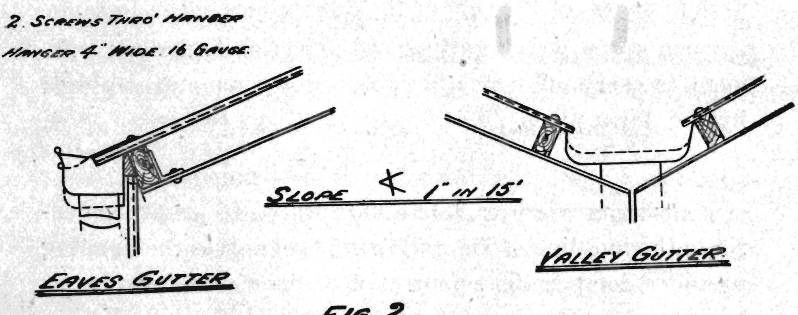

FIG. 2.

The guttering and down pipes should be large enough to carry off the water in the heaviest storms. The maximum rate of rainfall in Sydney is 1006 points per hour. Valley gutters were used between two roofs. The guttering should be all riveted and soldered together, and have a slope to the down pipe of 1in. in 15ft. 0in. at least. 72 sq. ft. of roofing could supply one cubic ft. of water per minute.

The approximate capacity of down pipes for carrying off water was as follows:—

Diam. of Pipe in inches.	Height of Water in Gutter.	Capacity in cubic ft. per min.
3	2	9.4
3	3	11.6
3	4	13.4
4	2	16.9
4	3	20.9
4	4	24.1
5	2	26.3
5	3	32.5
5	4	37.5
6	2	38
6	3	46.9
6	4	54.2

Glazed earthenware drain pipes contained a sectional area in excess of the sum of the down pipes led in to same.

Open storm water gutters had a section and slope sufficient to carry off water in excess of the amount supplied by the down pipes.

VENTILATION.

Ventilators were provided and located to properly ventilate the building. The following table gives the opening provided for per 100 square feet of floor area for various heights of buildings:—