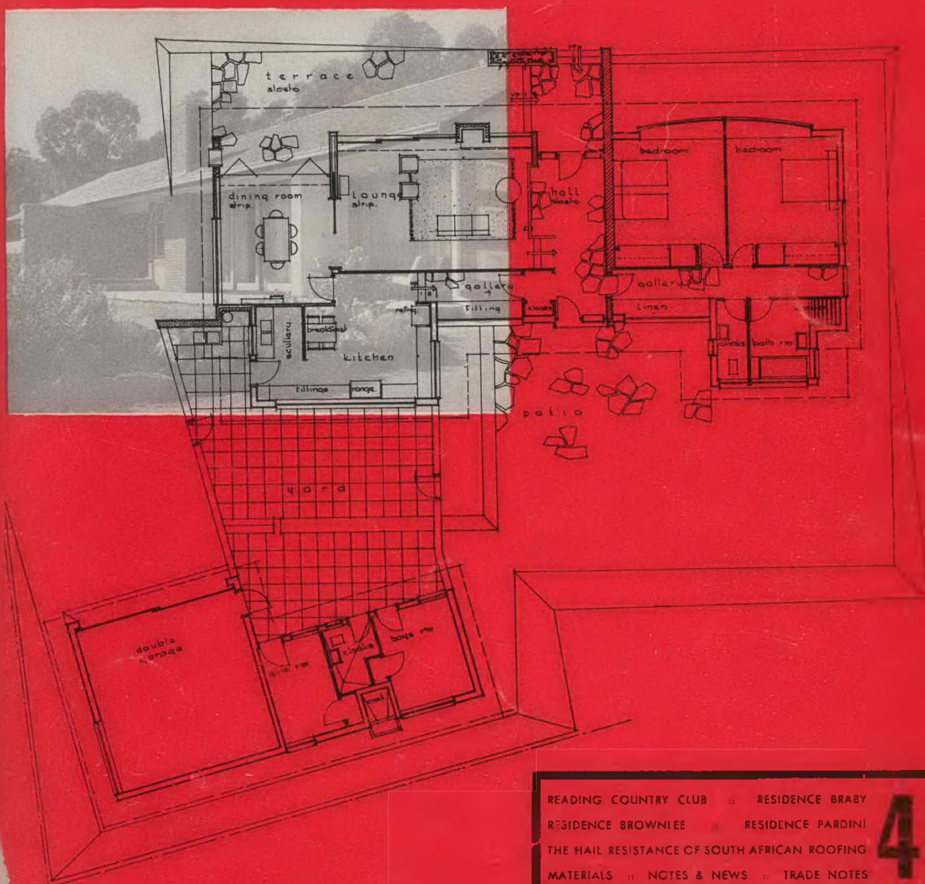
SOUTH AFRICAN ARCHITECTURAL RECORD

APRIL, 1952



READING COUNTRY CLUB :: RESIDENCE BRABY
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4


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JOURNAL OF THE INSTITUTE OF SOUTH AFRICAN ARCHITECTS; THE CAPE, NATAL, ORANGE FREE STATE AND TRANSVAAL PROVINCIAL INSTITUTES AND THE CHAPTER OF SOUTH AFRICAN QUANTITY SURVEYORS

CONTENTS FOR APRIL 1952

EDITOR
W. DUNCAN HOWIE

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UGO TOMASELLI
GILBERT HERBERT

VOLUME 37

4

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READING COUNTRY CLUB, ALBERTON

ARCHITECT: MANFRED HERMER

Early in 1949 a limited competition was held for a new Clubhouse for the Reading Country Club. Six firms of Architects were invited to compete.

The building as erected represents, with some small variations, the design placed first by the Assessor, Mr. N. L. Hanson.

The scheme called for a Clubhouse on a site selected by the Assessor, and on the basis of a programme worked out by him in collaboration with a specially appointed Building Committee of the Club. This site is at the foot of some low hills, but in a fairly elevated position. From it one can overlook the golf course and swimming bath to the east (with Alberton in the distance), the golf course and some hills to the south and nearby hills to the west.

The scheme as built creates a screen in the form of a wing of locker rooms on the east side, in order to close off the somewhat unattractive view of Alberton and to confine the view to the golf course and the very pleasant hills on the south and west sides. The fact that the main verandah and public rooms did not face on to the swimming bath was not considered to be a disadvantage, and in practice it has been found that the public rooms and verandah facing as they do over the last hole of the course are in an excellent position and one eminently satisfactory.

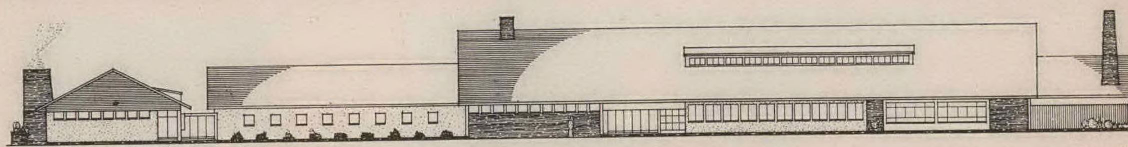
The circulation has proved extremely practicable, and the location of the professional's shop and half-way house in relation to the first and ninth tees is very convenient.

The Assessor's comments on the plans in general, from which the following is a quotation, have proved correct:

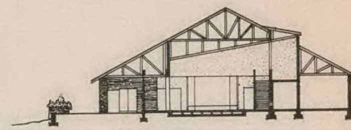
> "Although it is true that the communication corridors are necessarily lengthy, their length has been effectively offset by the centrally placed Entrance Hall. The great length of the South facade enables all the principal accommodation to overlook the south view and the first section of the golf course. At the same time, the Bar Lounge and the Billiard Room are skilfully cut off, as far as the facade is concerned, from the other elements of the scheme.
>
> "The Golf Section is contained in the east wing of the building, and is strategically placed for access to and from the golf course, for quick use by golfers on arrival and for use by swimmers and squash players, as required in the programme. The Children's Change Rooms are also well placed under the same roof."

CONSTRUCTION

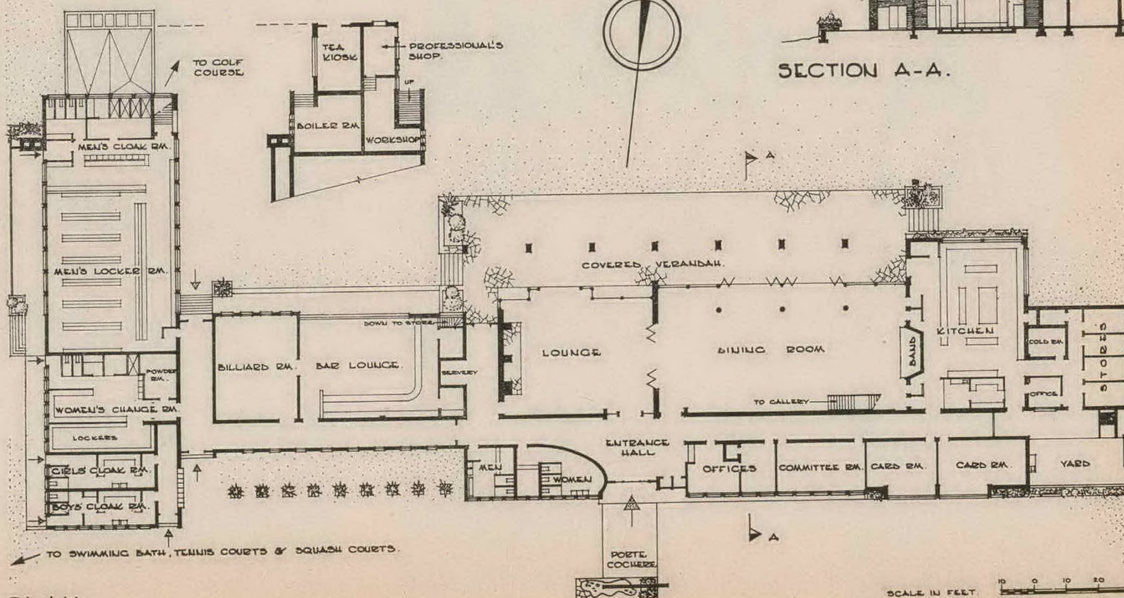
When the foundations of the main structure were being dug it was found that the major portion of the site consisted of a soggy clay which proved quite unsuitable for normal foundations.



NORTH ELEVATION.



SECTION A-A.



PLAN.

1. The east side of the building, facing the swimming bath and tennis courts.

2. The men's locker room.

3. The bar lounge. All woodwork is mvuli with the exception of the low cross wall behind the bar which is panelled in olive ash. The ceiling is masonite painted in blue.

The whole of the main block was therefore piled with 9" diameter concrete friction piles to an average depth of approximately 25 feet. Concrete foundations were then laid across the piles to support the brick superstructure.

No concrete was used internally in the superstructure, and when columns of any sort were required specially selected hardened facebricks in a strong cement mortar were used to form piers. This has proved to be good construction since there is little or no sign of cracking throughout the whole building which is of some considerable length.

Only one expansion joint was used, and this was located on the west side of the corridor forming the break between the east wing and the main south wing.

The internal finishes are plaster and paint or tyrolean plaster. The latter was used in a natural cement colour and then painted. A wide variety of delicate colour has been used internally and some walls in slasto assist in maintaining the country atmosphere and contrast well with the roughcast or plain painted walls opposite.

Externally the walls are roughcast and white-washed. The roof is of shingles and the plinth and flower boxes in slasto.

Floors throughout the building vary according to requirements. All the locker sections and the corridors where players have access with spiked shoes have been covered with a heavy rubber matting $\frac{1}{4}$" thick made and laid by Dunlop. The bar lounge has a cork floor. The bar corridor has dark and light quarry tiles laid in a pattern. The billiard room, office and card rooms have asphalte tile floors. The entrance hall and verandah have slasto floors and the lounge and diningroom birch floors laid in 2" strips. The major portion of the diningroom floor is sprung for dancing.

The light fittings in most of the rooms were specially designed by the architect who wished to match the character of the building.

Under the bar lounge is located a large store room. This is of interest from the point of view of the construction of the floor which was built up of hollow terracotta tiles to form

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Photography by Willex.

5

4. Lounge. The floor is birch, and the panelled wall olive ash. The glass display case above is visible from the entrance hall as well as the lounge. The light fitting is mvuli and copper, and suspended from the ceiling by sash cords.

5. The dining room. The large folding doors lead to the lounge. The floor is sprung for dancing.

6. Women's locker room.

7. Verandah. The verandah extends as an open terrace beyond the folding doors on the left which can be closed to afford sitting out space for dancers.

6

collected in a sump from which it is piped over the course. an agricultural drain. The moisture gathering in these tiles is

The scheme in general forms a homogeneous unit with its surroundings, but it is to be regretted that the architect was not consulted in the choice of furnishings.

The kitchen quarters have been planned on a generous scale and have proved adequate for the number of people who have to be catered for. The circulation from the kitchen to the lounge, diningroom and verandahs has proved good in practice and the introduction of a snack preparation room in the bar lounge has considerably improved the service from the bar to the billiard room and verandahs.

The competition originally demanded that the building should not cost more than £50,000. The lowest tender received was £47,750.

During the course of building operations it was decided to build two staff houses in the grounds. These were done in a simple manner, but using the same materials as those in the main clubhouse, thus relating them successfully with the main clubhouse in spite of the considerable distance separating the elements.

7

MAIN CONTRACTORS: W. L. Pretorius & Co. — SUB-CONTRACTORS: Rubber-flooring: Dunlop S.A. Ltd — Hot water installation, sanitary fittings, bar panelling and counter: Cohen & Sons Ltd. — Intercommunication telephone system: Siemens Bros. & Co. (British) Ltd. — Stove: Henwoods Ltd. — Special light fittings: B.G.E. Co. Ltd. — Light fittings: Progress Electric Fittings Co. (Pty.) Ltd. — Sound reproducing equipment: Dowson & Dobson — Structural Engineers: Tandler & Hertz — Painting: H. Evans & Co. (Pty.) Ltd. — Venetian Blinds: Forsyth, Udwin (Pty.) Ltd. — Curtains: Shepherd & Barker — Shingles: K. & L. Timbers — Shingle roofing: R. Fitch — Steel windows: Gratus & Gratus — Refrigeration: J. Liebman — Electrical installation: De Wolf & Rudner — Asphalt, lino and cork flooring: North British Rubber Co. — Dance floor springs: Building Specialists Co. — Sliding window track to lounge: W. S. Thom & Co. — Metal grilles: Walter & E. Markus.

RESIDENCE BRABY

CHICK, BARTHOLOMEW & POOLE: ARCHITECTS

This interesting low cost house is situated on a 2-acre wooded and rocky site on Cowies Hill some nine miles from Durban. It is designed to take full advantage of magnificent panoramic views to the south-east and north-east.

The client's special requirements were that the house be set amongst the existing shrubs and trees and that due regard be given to the orientation of the house to provide warmth in winter and coolness in summer. Provision for future extension was another design requirement.

A split level open scheme was arrived at to take advantage of the sloping site, and careful placing of rooms and fenestration to frame the interesting views was of major importance.

The main entrance door on the west leads directly into the dining recess which has an open view into the living room and through the glazed sliding doors to the views beyond. The lounge opens out onto north and south terraces to provide alternate living during the extremely hot summer months.

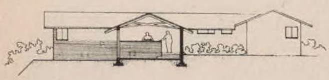
The bedroom section is orientated north and is cut off from the living and service zone to give complete privacy. To provide a suitable break from the prevailing south-west winds necessitated careful though somewhat obstrusive placing of the outbuildings, and while the split pole screen adjoining the entrance court is most attractive it might have been desirable to arrange a more organised and screened yard area. Further protection against the prevailing winds was provided by the low slung roof.

The use of exposed roof trusses has been exploited by the designers to give added height to the living room and dining room. The bungalow was erected in 1948 for the cost of £3,500

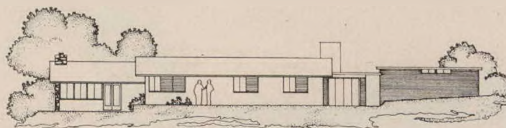
RESIDENCE BRABY

ARCHITECTS: CHICK, BARTHOLOMEW & POOLE

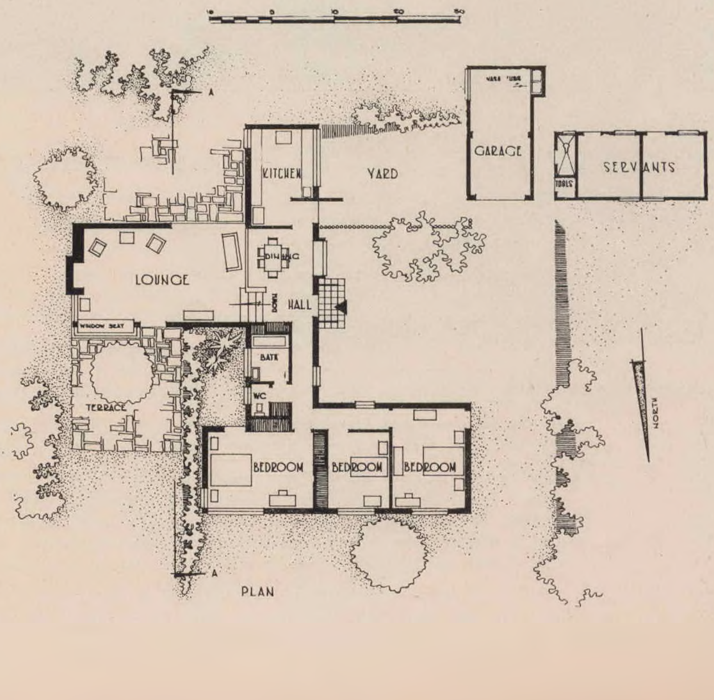
Exterior view of lounge sliding doors from south east.



SECTION AA



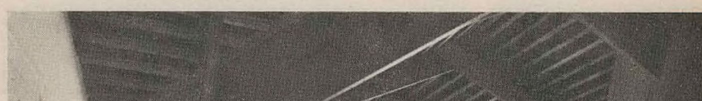
NORTH ELEVATION



PLAN

Exterior view of entrance porch on west elevation.

Interior view of lounge from dining recess.



ARCHITECT: H. C. PINFOLD
GARDEN LAYOUT: SUZANNE PIJPER
CONTRACTOR: A. GLENVILLE MORRISON

This house was designed at the time of Building Control which imposed the limit of 2,000 sq. ft. of floor area. Into this area had to be packed a lounge of fair dimensions, a dining space, a study, three bedrooms and the usual auxiliaries.

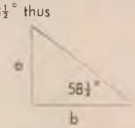
The site of one acre extent was covered with young gums and wattles which, had they been left, would have made gardening quite impossible. The site had therefore to be completely tree-dozed and will suffer for some years to come by its rather empty bleakness which tends to draw an unwanted degree of attention to the house. This is accentuated by the fact that the house itself stands on the brow of the slope and so dominates the yet young and diminutive growth of the garden.

The problem is straightforward. East-facing bedrooms and north-facing living quarters. This type of articulated wing planning was exploited by Mr. Bryer in his house for F. Klennerman in Abbotsford to good effect.

Perhaps the most interesting feature of the house is the use of a consistent system of proportion, namely the golden section which relates pairs of dimensions by the ratio

$$\frac{a}{b} = \frac{a + b}{a}$$

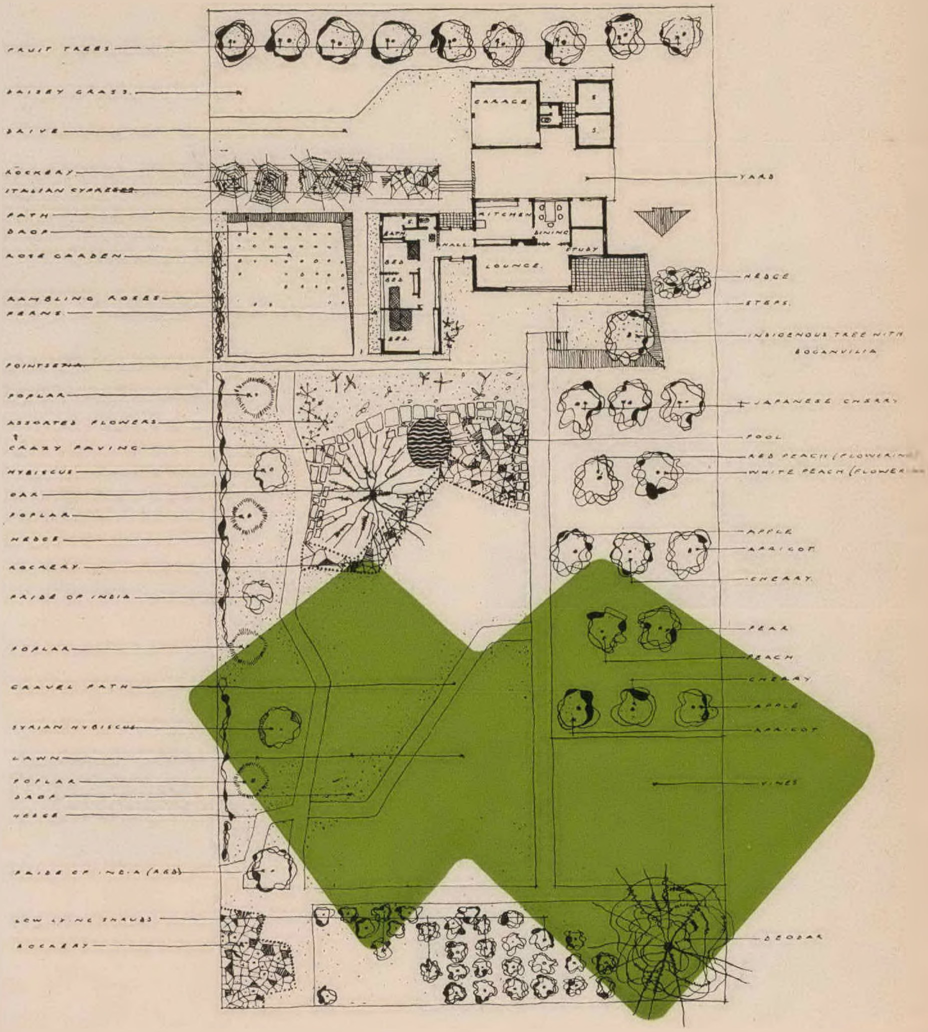
where a is the longer and b the shorter of the dimensions. Where these two dimensions are made the "Opposite" and the "Adjacent" sides of a right angle triangle they give rise to an angle of 58½° thus



and a and b are related by a ratio of 1.618. This relationship

RESIDENCE BROWNLEE-SENDERWOOD

ARCHITECT : H. C. PINFOLD



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1. View of lounge windows from terrace.
2. View of interior lounge looking towards fireplace and entrance hall.

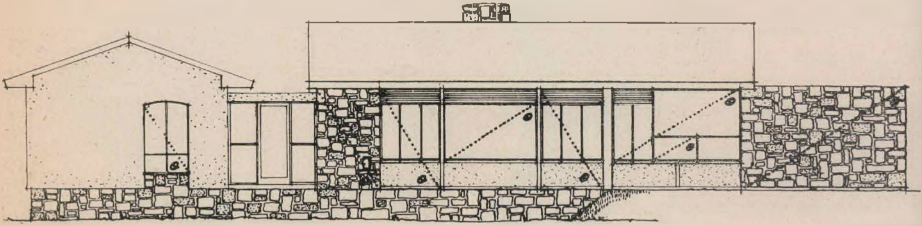
Exterior photography by Derrick Bridge.
Interior photography by Aldo Tomaselli.

or number has many significant implications in plane geometry, in musical harmony and in the rate of biological growth. Adopted as a law of the universe by Pythagorians and used as a means of architectural proportion by the Egyptian, the Greek, the Roman, the Mediaeval and the Renaissance architects it does seem to lend a significant unity to the objects that it governs

In the present century it has been used extensively by Lutyens and Le Corbusier

The dotted lines on the drawn elevation on page — indicate how the angle of 58½° (θ) has been used to proportion the various surfaces involved.

The visual result in fact has been an apparent increase of scale not altogether desirable in domestic work This may be due to the use of a proportion system but may on the other hand be occasioned by the bareness of the site already mentioned together with the rather generous use of stone whose texture is too heavy for the context. A further visual lesson of this house has been, in the author's opinion, a tendency to put too much "architecture" into a small building. Changes of material and complexity of detail can very soon make a house appear self-conscious. Perhaps the next step in our domestic architecture lies in a striving for a greater simplicity in terms of form, texture and colour.



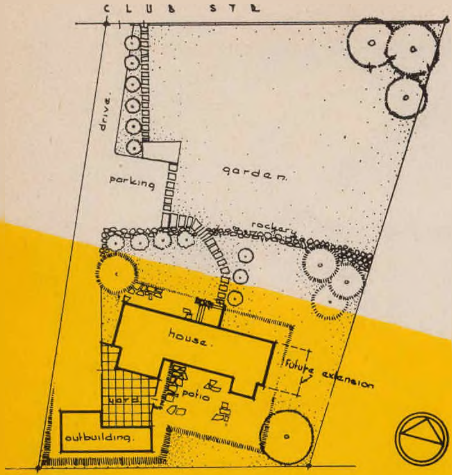
$\theta = 58\frac{1}{2}°$

NORTH ELEVATION.

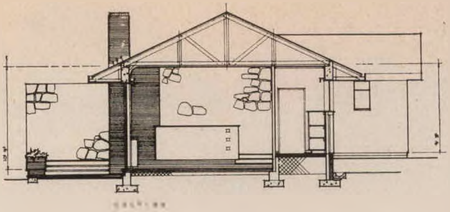
RESIDENCE PARDINI, LINKSFIELD

ARCHITECT: UGO TOMASELLI

View of lounge terrace from north west.



SITE PLAN



RESIDENCE: V. PARDINI

ARCHITECT: U. TOMASELLI

The site: A $\frac{3}{4}$ acre north-facing, north-sloping site with magnificent views over tall trees was purchased in Linksfield, Johannesburg, overlooking distant northern suburbs and local golf courses.

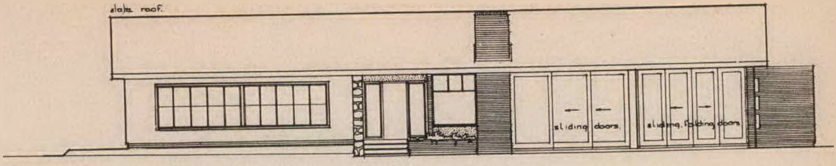
Programme: A contemporary home for a family with two children, with a leaning towards contemporary living. Special client's requirement was that a curved bay window be incorporated in the scheme.

Solution: Due to building control restrictions the area of the house was limited to 2,000 square feet. The owner desired that the major areea of the house be given to the living zone, which was to be built to its maximum, while the sleeping zone be reduced to two double bedrooms with provision to extend at some future date, when the main suite plus private bathroom and dressing recess would be provided.

Access to the site is from Club Street on the north boundary. The drive, off which a parking bay for three cars is allocated, ramps up the west boundary of the site and gives direct access to the garage and kitchen area.

Advantage was taken of the falling site to give added height to the living room, dining room and kitchen. Large folding sliding glass doors in kiaat Framing are arranged to merge the dining room space and terrace when so required, and two sliding panels open the lounge to the terrace and views to the north. This arrangement tends to create comfortable indoor-outdoor living conditions, particularly when, due to the nature of the site, the approach road is completely hidden from view of any person sitting in the lounge, standing on the terrace or playing in the front garden

The kitchen is well fitted out, and provides a breakfast recess and a screened scullery. A gallery fitted out with cupboards for kitchen linen gives access to the entrance hall and patio arranged on the south for summer entertainment. This patio is also usable as the children's play area. Zoned to the east and cut off from the living area is the bedroom wing. Each bedroom, though modest in size, is well fitted out with cupboards and provides ample space for the essential loose furnishings.



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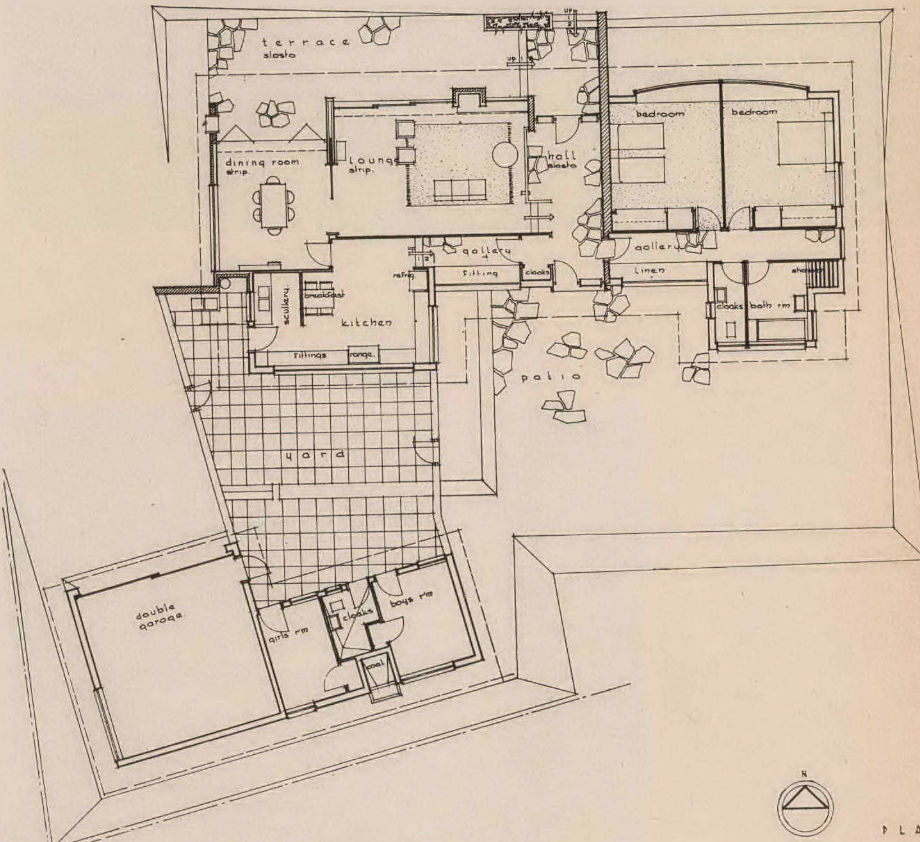
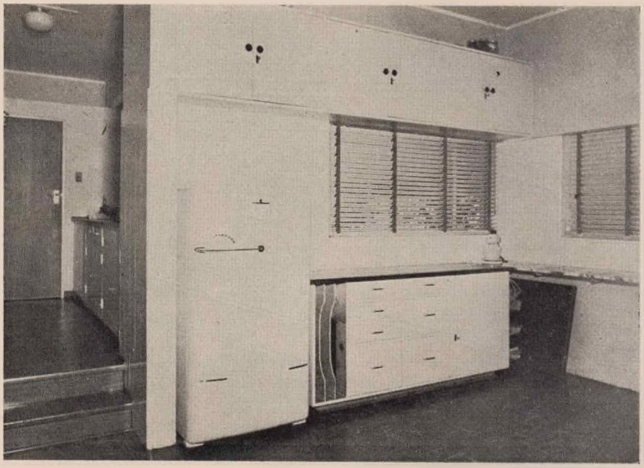


PLAN

View of house from north-east.

View of kitchen looking towards gallery and door leading to entrance hall.



Photography by B.R.S.

THE HAIL RESISTANCE OF SOUTH AFRICAN ROOFING MATERIALS

CHAS. A. RIGBY, M.Sc. (Eng.), M.I.Struct.E and KEEVE STEYN D.Sc. (Eng.)

NATIONAL BUILDING RESEARCH INSTITUTE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, PRETORIA

This paper gives the results of laboratory tests carried out on 29 roofing materials in order to assess their hail resistance. Certain types of corrugated iron were found to be the most suitable material, while concrete and clay tiles were the least satisfactory, from the point of view of hail damage. Information on the frequency and occurrence of hailstorms is included, from which is may be seen that it is hard to define a hail belt, and that all the summer rainfall areas of South Africa are subject to severe hailstorms.

INTRODUCTION.

Prior to the hailstorm which struck Pretoria on the afternoon of November 17th 1949, the National Building Research Institute had been working on the problem of the hail resistance of roofing materials. The severity of this storm, which was one of the most disastrous ever recorded in South Africa, resulted in great destruction of property, and aroused such public interest that the work was given considerable priority. This report deals with tests in which the damage of the storm was reproduced on a laboratory scale. A further report will deal with laboratory work to produce a simple test for measuring the hail resistance of any material.

In view of the fact that Pretoria has been subjected to three very severe hailstorms during the past 26 years[1],* its citizens are probably more conscious of the problem than those of other centres; a knowledge of the hail-resisting qualities of the various types of roofing materials, especially of new types coming on the market, is therefore a matter of great interest. The problem of hail damage, however, is not a local one, as all the summer rainfall area of South Africa is subject to hailstorms, and while these are more numerous on the highveld, other areas have also experienced very severe storms. Some other hailstorms, in which hailstones 3" to 4" in diameter were reported to have fallen, occurred in Pietermaritzburg (1874)[2], Charlestown, Natal (1906)[3], Queenstown, C.P. (1907)[4], Durban (1929)[5], White River, near Barberton (1937)[6] and Vryheid (1940)[6]. Severe hailstorms with very large stones have also been reported at: Aliwal North (1906), Barkly East (1938), Nelspruit (1939), Newcastle (1940), Alberfeldy-Kesteil (1940), Frankfort (1941), Umtata (1942), Nongoma, Zululand (1946), Ficksburg (1946) and Port Elizabeth (1948).

While the above is by no means a complete list of the severe hailstorms that have occurred in South Africa, it does tend to show the wide area of the country over which they have occurred and are likely to occur again. Thus it may be seen that the problem of hail resistance of roofing is not a problem local to Pretoria, but one that is of interest to most of the Union.

PRELIMINARY.

After the November 1949 hailstorm, officers of the National Building Research Institute gathered some of the larger hailstones that fell near their buildings on Visagie Street. These stones, roughly egg-shaped, measured up to 3¼" in their longest axis and weighed from 0.25 lbs. to 0.36 lbs. They were quite irregular in shape, with sharp protuberances on the surface; their specific gravity was found to be 0.91, indicating that they consisted almost entirely of clear ice.

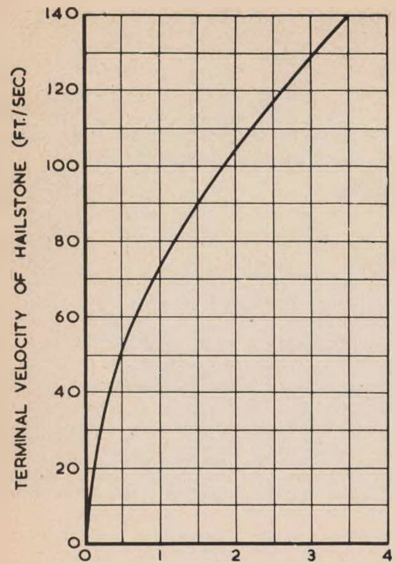
Some idea of the terminal velocities attained by hailstones of this type, can be arrived at by a theoretical consideration of the behaviour of a smooth sphere falling freely in still air[7]. If dropped from rest, such a sphere will accelerate until the drag becomes equal to its weight, when it will have attained its terminal velocity, and will fall no faster.

The terminal velocity attained varies with the size of hailstone, and Figure 1 has been constructed to illustrate this variation for smooth spherical hailstones, of specific gravity 0.91, which are allowed to fall freely in still air, having a uniform density of 0.0758 lbs/cu.ft. and kinematic viscosity 0.000159 (f.p.s. units). It will be observed from this graph that the terminal velocity increases as the spherical hailstones become larger, and that the larger hailstones have terminal velocities of the order of 80 to 140 ft/sec.

It was necessary to establish some quantitative means of evaluating the hail resistance of any given roofing material, and the kinetic energy at impact was considered to be a suitable criterion, since the work required to stop any moving object is equal to its kinetic energy. Therefore, the kinetic energy at impact of a hailstone which just punctures or cracks a given roofing material, was taken as a measure of that material's hail resistance. The variation between the size of a spherical hailstone and its maximum kinetic energy, i.e. the kinetic energy when it reaches its terminal velocity, is shown in Fig. 2. The kinetic energy in this case was taken as half the weight of the hailstone in lb., multiplied by the square of the terminal velocity in feet per second. i.e. the values are expressed in foot poundals.

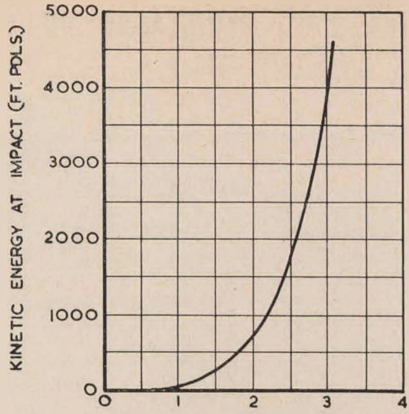
Tests carried out on roofing materials damaged in the November 1949 hailstorm, have indicated that that storm

* References at end of publication.



DIAMETER OF HAILSTONE (INS.)

(Fig 1)



DIAMETER OF HAILSTONE (INS.)

(Fig. 2)

Fig. 1. Variation between the terminal velocity and size of spherical hailstorms.

Fig. 2. Variation between the kinetic energy at impact and size of spherical hailstones falling at their terminal velocities in still air.

produced many hailstones having impact energies of up to 2500 ft. pdls. From Fig. 2 it will be observed that the equivalent spherical hailstones falling in still air would have been about $2\frac{3}{4}''$ in diameter. If this storm represents the worst type of hailstorm that may be expected, the following criterion can be laid down:—In order that a given roofing material may be considered completely safe in the areas experiencing severe hailstorms, it must be able to withstand, without damage, a hail bombardment in which the impact energies are 2500 ft. pdls. However, materials failing at energy values less than this, may be acceptable in certain cases where some water penetration can be tolerated.

TESTS UNDERTAKEN.

The object of the tests was to determine, by laboratory means, the hail resistance of the various types of roofing materials commonly employed in South Africa. An empirical approach was adopted in which artificial hailstones were made out of clear ice to resemble as closely as possible actual hailstones. These were fired at specimen roofs, their weight as well as their terminal velocities being selected to be of the same order as would be encountered in a very severe storm.

To carry out the tests, a tower 20 ft. high (see Fig. 3) was constructed. Each specimen roof was placed horizontally just above the ground between the tower legs, and artificial hailstones were shot vertically downwards from the top of the tower so that they struck perpendicularly on the roof. This resulted in the most severe exposure condition, but one which is easily attained in nature since, on the exposed side of a roof, it is quite possible for hailstones to strike perpendicularly, notwithstanding the fact that the pitch of the roof may be quite steep. Because of wind, hailstones fall at a slant, and during the storm in November, 1949, some hailstones were observed to fall at angles of less than 45° to the horizontal. (In this storm, wind velocities of up to 60 m.p.h. or 88 ft/sec. were recorded, and these were of the same order as the terminal velocities of the falling hailstones).

The artificial hailstones used in the tests were of three types, each having sharp protuberances. Type 1 was either oval or spherically-shaped, Type II conical-shaped at both ends and Type III conical-shaped at one end and cylindrical at the other. As shown in Fig. 4 these hailstones were made to resemble, as closely as possible, actual hailstones observed in the storm.

A standard 0.303" grenade thrower was used to fire the experimental hailstones. By using cartridges with different charges, it was possible to vary the terminal velocities of the hailstones and an electrical timing device was used to measure the velocity at impact. The timer consisted of two aluminium foil grids, each carrying an electric current which was interrupted when the foil was broken by the hailstone. The time taken to traverse the 2' 6" between the two grids was recorded on a R.C.A. time interval counter, and from this the terminal velocities were computed. The frame holding these grids was supported just above the specimen roof, while a portable generator set provided power for the time interval counter.

Tests were first carried out on roofing materials damaged in the November 1949 storm, in order to assess the relative strength of that storm. Twenty-nine types of new roofing materials were then tested and in a few of these tests the roofs were placed at 30° to the horizontal to observe the effect of the pitch of the roof.

Fig. 3. Firing tower used in the tests.

RESULTS OF TESTS.

The detailed results of all tests are given in Table 1. Generally these figures agree very well with observations made on damaged roofs in Pretoria after the November 1949 hailstorm[x], in which many hailstones had impact energies of up to 2500 ft. pdls. If this hailstorm is taken to be representative of the severest hailstorms that can be expected in nature,

Fig. 4. Artificial hailstones used in the tests.

then it may be stated that all the materials failing at impact energies of less than 2500 ft. pdls. are vulnerable to hail damage.

The only materials tested which appeared to be completely safe from storms of this severity, were some types of corrugated iron and imported corrugated asbestos cement. Reinforced concrete slabs and thatch roofs were not tested, the former being considered completely satisfactory, while the latter showed very little damage after the Pretoria storm, and no cases where leaking occurred were reported. It is considered that thatch roofs of adequate thickness will prove to be satisfactory. The materials listed in Table I are given roughly in their order of merit, starting with the most hail resistant material.

(1) **Corrugated iron.** The types tested were found to be the best material from the point of view of hail damage, but some other types of imported iron are known to have failed badly during the Pretoria hailstorm. It is regrettable that none of these were procurable in a new condition for testing, but sheets taken from existing roofs failed at values below 2500 ft. pdls.

(2) **Slate.** Two of the types of slate tested may be considered fairly satisfactory from the point of view of hail resistance, while two others were unsatisfactory. In selecting the slate for a roof to stand up to severe hailstorms, the following points appear to be of importance:

(a) The slate should not be weathered, i.e. it should be mined from the deeper levels in the quarry.

(b) Only experienced slaters are likely to produce a satisfactory roof. Slates should be laid as evenly as possible.

(c) Thicker slates are more hail resistant, and only those which are $\frac{3}{8}$" in thickness or more should be used.

A slate roof complying with the above requirements should be satisfactory, and although some damage may result with conditions as severe as those experienced in the Pretoria storm, none of the slates will be perforated. However, cracked slates can be expected, and water damage may result when portions of these slide off the roof.

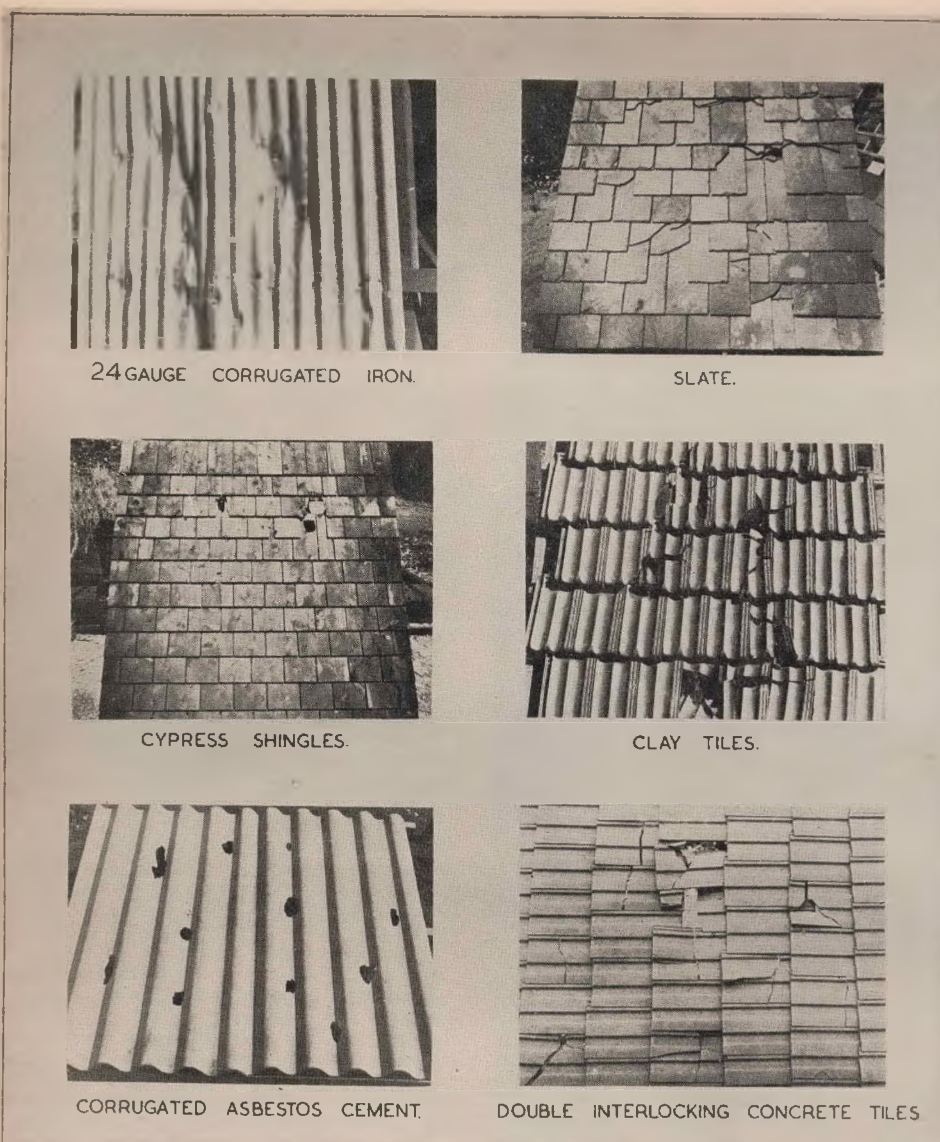


Fig. 5. Some specimen roofs after testing. (Note: The degree of damage illustrated above must not be taken as an indication of the relative hail resistance, because shots of different intensities were fired at each roof to determine the limiting value.)

(3) **Wood shingles.** South African Pine and Cypress shingles, of the grades tested, appear to be fairly satisfactory, and the possibility of water damage is not very great once the shingles are cracked. (Shingles generally crack in a vertical plane along the grain). It appears that a storm much more severe than the Pretoria one will be required before the hailstones will punch holes through the shingles. However, this is not the case for Canadian Cedar shingles which are very much thinner, and in consequence hailstones can be expected to perforate these shingles in the case of a very severe storm.

(4) **Aluminium.** 22 gauge or thicker corrugated sheeting should be satisfactory, but thinner material may prove unsatisfactory in areas subjected to severe hailstorms. It was observed that once the material was punctured, it was weakened appreciably and subsequent damage occurred more easily. In the thicker sheets the risk of water damage at the laps resulting from bending of the sheets was relatively small, but not so for the thinner ones.

(5) **Masonite Shingles.** Damage was greatest on the underside of the shingles. The $^{3}/_{16}$" thick shingles may prove satisfactory but in the event of conditions as experienced in the Pretoria storm, water damage may be appreciable. The $^{1}/_{4}$ and $^{5}/_{16}$" thick shingles were not tested but from the results obtained it is considered that these would be completely satisfactory.

(6) **Corrugated Asbestos Cement.** The sheets imported from U.S.A. appear to be completely satisfactory from the point of view of hail resistance, but the three South African brands of corrugated asbestos cement which were tested, were damaged very easily by shots hitting in the valleys. The former exhibited better hail resistance features, because the sheets were thicker and it is possible that the different manufacturing process also exerted some beneficial effect.

(7) **Clay Tiles.** These were damaged quite easily, and an important factor observed was that ageing of the tiles reduced their strength, presumably by the fact that the material became more brittle on exposure.

(8) **Concrete Tiles.** Concrete tiles were among the least hail resistant of all the materials tested. Pantiles were damaged in the valleys only, but the double interlocking tiles were cracked by shots striking anywhere on the tile. The Brosley Tiles tested were extremely weak, having almost no impact resistance. Improved methods of manufacture may increase the hail resistance of concrete tiles, but the uniformity in the results on the products of five different manufacturers indicates that this is a problem to be faced by the whole industry.

Fig. 5 shows six roofs after testing — these being corrugated iron, slate, cypress shingles, clay tiles, asbestos cement and concrete tiles.

Five further roofs which were placed at 30° to the horizontal were tested to observe the effect of the pitch. Each one of these roofs was then subjected to a hail bombardment of intensity equivalent to and slightly higher than that which failed the roof during perpendicular impact. In no case was failure observed and it was confirmed that the damage sustained was less than for the case of perpendicular impact. Limiting values of the kinetic energy at impact for various slopes were not investigated as this would have involved a great deal of work not considered justified.

STATISTICS ON HAILSTORMS.

In order to apply the results obtained, it is necessary to examine the possibility of the occurrence of severe hailstorms in any particular locality. Unfortunately, the statistics of hailstorms for the Union are not very satisfactory, the very nature of the phenomenon making it difficult to obtain accurate data. Furthermore, hailstorms are generally of an extremely local character, and usually any particular storm occurs only over a very small area, so that many storms, some of them producing very large stones, fall in open country and are never reported, even though the numbei of observers engaged in reporting the occurrence of such storms is fairly large. Also the observers are for the most part laymen whose estimates of the size of hailstones (few actually measure them) and the severity of storms diffei greatly.

However, a considerable amount of data has been collected, and Mr. Schulze of the Weather Bureau has prepared the map reproduced with his permission as Fig. 6. On this map are plotted lines enclosing areas in which 1, 2, 3, etc. hailstorms occur per year. It is based on the reports of the most reliable observers and the figures are the average for 14 years. (1932-1945 inclusive). For example, from the map it can be seen that any small area in Pretoria experienced an annual average of three hailstorms per year during this period, although the total number of hailstorms which struck the city was no doubt higher than this.

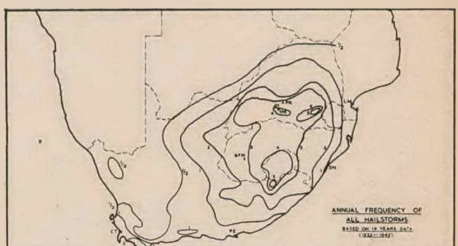


Fig. 6. The lines enclose areas in which 1, 2, 3 etc. hailstorms occur per year at any given place.

In deciding what material to use on the roof of a building, an owner has to consider many other factors besides the possibility of hail damage, e.g., appearance, durability, comfort, cost, availability of materials, etc., and it may be of assistance to give a guide as to how one may assess the chances of any particular type of roof suffering hail damage in any locality.

TABLE 1

RESULTS OF HAIL TESTS ON VARIOUS SPECIMEN ROOFS*

Type	No.	Specimen	Thickness	Roofing details	Impact energy to just cause failure, ft. pdls.	Dia. of Equivalent hailstone** In still air	Dia. of Equivalent hailstone** With wind vel 60 m.p.h	Remarks
Corrugated iron	1	Local galvanised 24 gauge	.025″	2″ x 3″ purlins on edge at 3′ 0″ o.c. Rafters at 4′ 6″ o.c.	exceeds 10,000	—	—	These materials were dented only and at impact energies of 2,500 ft. pdls., the dents were shallow. Danger of water damage at the laps due to bending of the sheets was small.
	2	One type of imported galvanised 24 gauge	.025″	As above.	exceeds 10,000	—	—	
	3	24 Gauge metal protected by bitumen and felt on both sides	.11″ overall	As above.	exceeds 10,000	—	—	
Slate	4	Slate A, roofed by supplier; slates 9″ x 12″	3/8″	1½″ x 1½″ battens at 4½″ o.c. Rafters at 2′ 0″ o.c.	2,200	2.6	2.3	The values given are those which cracked the slates sufficiently to allow the entry of appreciable rain water. Impact energies 50 to 100% greater were required to punch a hole clean through the slates.
	5	Slate A, roofed by Research Officers; slate 9″ x 12″	3/8″	1½″ x 1½″ battens at 4½″ o.c. Rafters at 2′ 0″ o.c.	1,900	2.5	2.2	
	6	Slate B, roofed by supplier; slate 10″ x 18″	3/8″	1½″ x 1½″ battens at 7½″ o.c. Rafters at 2′ 0″ o.c.	2,100	2.6	2.3	
	7	Slate C, roofed by Research Officers; slates 9″ x 12″	3/8″	1½″ x 1½″ battens at 4½″ o.c. Rafters at 2′ 0″	1,100	2.2	1.9	
	8	Slate D, roofed by Research Officers; slates 8″ x 12″	3/8″—1/2″	1½″ x 1½″ battens at 5½″ o.c. Rafters at 2′ 8″ o.c.	900	2.1	1.8	
Wood shingles	9	S.A. Pine 1st grade. Size 18″ x 7½″	1/16″—9/16″	1½″ x 2½″ battens at 6″ o.c. Rafters at 3′ 0″	2,000	2.5	2.2	The values given are those which cracked the shingles. Water damage will probably not be severe at these values. Impact energies about two or three times the limiting values were required to punch right through.
	10	S.A. Cypress 2nd grade. Size 18″ x 7½″	1/16″—9/16″	1½″ x 2½″ battens at 6″ o.c. Rafters at 3′ 0″	1,700	2.4	2.1	
	11	Canadian Red Cedar 16″ x 4″ to 7″ wide	1/16″—3/8″	1½″ x 2″ battens at 5½″ o.c. Rafters at 3′ 0″ o.c.	800	2.0	1.7	
Aluminium	12	Plain corrugated 22 gauge	.028″	2″ x 3″ purlins at 2′ 6″ o.c. Rafters at 4′ 6″ o.c.	2,200	2.6	2.3	These materials were more severely damaged near the purlins. Once the material was punctured it was weakened appreciably and subsequent shots easily extended the damage.
	13	Plain, corrugated 24 gauge	.025″	As above.	1,800	2.5	2.2	
	14	Crimped corrugated, 26 gauge	.018″	As above.	1,600	2.4	2.1	
	15	Plain, corrugated, 26 gauge	.018″	As above.	600	1.9	1.6	
Masonite shingles	16	Tempered board 12″ x 18″ shingles	3/16″	1½″ x 1½″ battens at 8″ o.c. Rafters 2′ 6″ o.c.	1,800	2.5	2.2	Greatest damage occurred on the under site of the shingles.
	17	Tempered board 12″ x 18″ shingles	1/8″	As above.	1,200	2.2	1.9	
Corrugated asbestos cement	18	Imported from U.S.A. 4½″ pitch	3/8″	2″ x 3″ purlins on edge at 3′ 0″ o.c. Rafters at 4′ 6″	4,000	3.0	2.7	Damage was confined to the valleys only.
	19	Local manufacturer A. Pitch of corrugations 5¾″ and 7″	1/4″—5/16″	As above.	900	2.1	1.8	
	20	Local manufacturer B. 5¾″ and 7″ pitch	1/4″ 5/16″	As above.	800	2.0	1.7	
	21	Local manufacturer C. 7″ pitch	1/4″ 5/16″	As above.	700	1.9	1.7	
Clay tiles	22	Marseille type 16″ x 8″ new	5/8″ thinnest	1½″ x 1½″ battens at 14″ o.c. Rafters at 2′ 0″ o.c.	1,100	2.2	1.9	Both roofs from the same batch of tiles.
	23	Marseille type 16″ x 8″ after 3 months' exposure	5/8″	As above.	550	1.8	1.6	
Concrete tiles	24	Tile A. Single-lap pantiles 15″ x 9″	9/16″—3/4″	1½″ x 1½″ battens at 11″ o.c. Rafters at 2′ 0″ o.c.	600	1.9	1.6	Pantiles damaged in valleys only.
	25	Tile B. Double interlocking 15″ x 9″	9/16″	As above.	550	1.8	1.6	
	26	Tile C. (Imported) double interlocking 16½″ x 10″	5/8″	1½″ x 2″ battens at 14″ o.c. Rafters at 2′ 0″ o.c.	660	1.9	1.7	
	27	Tile D. Double interlocking 15″ x 9″	1/2″	1½″ x 1½″ battens at 11″ o.c. Rafters at 2′ 0″ o.c.	450	1.7	1.4	
	28	Tile E. Double interlocking 15″ x 9″	9/16″+	As above.	500	1.8	1.5	
	29	Tile E. Brosley 10½″ x 6½″	1/2″	1½″ x 1½″ battens at 4½″ o.c. Rafters at 2′ 0″ o.c.	less than 300	1.5	1.2	

[illegible]

Local topographical features may play an important part, i.e., due to the presence of a hill or forest, etc., the occurrence of severe hailstorms may be more or less frequent over a smaller area, than the general average for the district. If there are no local factors influencing the frequency, then an estimate of the annual number of hailstorms that may be expected for the region can be determined from the map. Statistics collected by the Weather Bureau indicate that, on an average, one storm in every 30-40 is very severe, i.e., of the same order as the Pretoria hailstorm of 17th November, 1949. However, for any phenomenon occurring relatively infrequently, such as hailstorms, good statistics over a very long period (over hundred years) are needed before any really valid statistical deductions can be drawn, and therefore the figures given should be treated with reserve. From these, however, it can be seen that a district like Durban, having one hailstorm a year, may expect severe hail damage once every 30-40 years, while Pretoria, with three hailstorms a year, may expect severe damage about every 10-12 years. These figures, while based on the best available information, may be very far out and should, therefore, be used as a general guide only: e.g., for Germiston, which has an average of five hailstorms per year, there are no reports of very severe storms.

The type of occupancy of the building is also of importance in considering the risk of hail damage. For example, it is not imperative to have a roof with high hail resistance on a factory where the product being manufactured would suffer little or no water damage if the roof were punctured once or twice in the life of the factory. On the other hand, a building whose contents would suffer great damage with even moderate water penetration, should have a weatherproof roof.

* * *

CONCLUSIONS.

1. **Validity of Tests.** While the tests described in this paper were of an empirical nature, they reproduced the conditions occurring in nature as closely as possible and the results may therefore be considered valid. Other tests, in which the projectiles used were spherical steel balls, gave results not in direct agreement with the damage observed in Pretoria after the November, 1949, hailstorm.

2. **Pitch.** It has been suggested that the use of steep pitches for roofs may minimize the damage from hail. The tests demonstrated that less damage was caused to roofs when the stones impinged at angles of less than 90°. However, hail is usually accompanied by high winds, so that the stones nearly always fall at an angle and, therefore, may be expected to strike some roofs nearly perpendicularly, no matter what the pitch. This was borne out by observations made after the storm, when no noticeable effect of pitch was observed and badly damaged roofs at steep pitches were noted.

3. **Hail Belts.** The statistics show that it is hard to define a hail belt, and that any district in the summer rainfall area may experience severe hailstorms. However, the map indicates that some localities suffer more storms than others and are therefore more prone to hail damage.

4. **Materials.** The best roof from the point of view of hail resistance is a solid reinforced concrete slab. Of all the common roofing materials, galvanised iron provides the best protection, although it was noted that some imported brands were pierced during the November, 1949, storm. As Table I shows, the brittle materials such as clay and cement tiles are the least hail resistant, but all materials with an impact resistance of less than 2,500 ft. pdls are vulnerable to hail damage.

5. **Other considerations.** Frequently, considerations other than those of hail resistance may dictate the use of a roof covering, whose hail resistance may be considered inadequate. In this case, steps may be taken to minimize possible water damage by providing a waterproof membrane under the roof covering. One method is to completely cover the trusses with $\frac{7}{8}$in boarding, over which malthoid or waterproof paper is laid. Battens are placed on top of this and the roof covering laid as usual. Expanded metal and wire mesh have also been used to support such paper underlining. These methods are expensive, but may be justified where water damage is likely to be costly.

* * *

ACKNOWLEDGMENT.

Grateful acknowledgment is made to those roofing manufacturers who contributed materials for testing. This paper is published with the permission of the President, South African Council for Scientific and Industrial Research.

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NOTES AND NEWS

IMPROVED PROSPECTS FOR ENGINEERS

RAILWAY SERVICE CONDITIONS REVISED

Prospects in the Railway service for young Engineers are being substantially improved. The post of pupil engineer in the technical departments (Civil Engineering, Mechanical, Electro-Technical and Signals) is being abolished and is being replaced by the grade of Junior Engineer. The starting salary in this grade is being lifted from £411 a year to £480 a year and the young engineer who now joins the Railway Service will rise in three years to £580 a year, as against £511 under the old scales.

Improved salaries are to be paid to Assistant Engineers (Civil, Mechanical, Electro-Technical and Signals) and the increases will be applied also to Architects (Grade III), Surveyors (Grade II), Quantity Surveyor (Grade II) and Chemists (Grade II). The old scale was £636 x £30 — £876 and the new scale is £750 x £50 — £900. A few new posts have been created in the Senior Assistant Engineers' group with a salary scale of £950 — £990 — £1,030.

Pupil draughtsmen are being raised from a starting salary of £216 to £261. The present grades of Draughtsman (Grade III) and Draughtsman (Grade II) on the salary scale respectively of £386 to £586 and £611 to £661 are being replaced by one grade, that of Draughtsman (Grade II) on the scale of £460 — £700 a year. The salary scale of Draughtsman (Grade I) is being advanced from £686 — £736 a year to £740 — £860 a year.

The present grading applied to Senior Draughtsman (Grade II) with a salary scale of £766 — £816, and of Senior Draughtsman (Grade I) on the £846 — £876 scale is being replaced by one grade, that of Senior Draughtsman with salaries rising from £900 to £1,030 per annum.

ASSISTANCE TO JUNIOR ENGINEERS.

It has also been decided to give assistance to junior engineers who joined the Railway service in the purchase of instruments which they themselves have to supply. The junior engineer will be able to make his own selection of instruments, but the maximum amount which will be advanced by the Railway Administration for the purpose will be £275, free of interest, repayable in 48 equal instalments.

TRADE NOTES

PILKINGTON BROTHERS LTD.

The new factory at Springs, Transvaal, manufacturing Flat Drawn Sheet Glass, is the first flat glass industry to be established in South Africa.

The Company is a subsidiary of Pilkington Brothers Ltd., St. Helens, England, who were established in the year 1826 for the manufacture of Crown Glass — the name by which Sheet Glass was formerly known.

Now run by the fourth generation of descendants from the original founders of the firm, Pilkington Brothers Limited manufacture Sheet Glass at three factories in England and one in Canada. Their Plate Glass Plants in England are the only ones in the Commonwealth.

A link between the Union and the firm has existed since 1882, when a South African agency — staffed by specially trained representatives from St. Helens, England — was established. A further link was forged in 1935 when a processing plant for the production of "ARMOURPLATE" Safety Glass was established at Port Elizabeth.

For the new factory at Springs, 2,000 tons of steel and 1,000 tons of cast iron, all fabricated in South Africa, were used in the erection of the factory which covers 28 acres and cost approximately £800,000.

The method of manufacture is the same as the process used by Pilkington Brothers Ltd. in England, and consists of drawing a continuous flat sheet of glass directly upwards from the furnace.

ACROW ENGINEERS OF SOUTH AFRICA

"I STILL HAVE FAITH IN THE UNION'S FUTURE"

British Financier Confident that the Country will Continue to Expand

At present on a visit to the Union is the man who has made the name "Acrow" familiar in building circles throughout the world. Young-looking and with a vital energy, Swiss-born

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