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A DISTRICT HOSPITAL: ITS CONSTRUCTION AND COST. WITH A DESCRIPTION OF A NEW METHOD OF CONSTRUCTING IRON BUILDINGS.

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[*Read before the Sanitary Section of the Royal Society, N.S.W., 12 July, 1887.*]

YOU are aware that among the multifarious functions of the Health Department is reckoned that of examining plans for proposed Country or District Hospitals in aid of which a subsidy of the public money is asked. The object of such supervision is, of course, to secure a reasonably wise and reasonably economical expenditure of the monies granted and subscribed. The intention is good, and it would be useful if means of practically effecting it were provided; but, for reasons into which I need not go, the power of the Department to cause alteration to be made in

faulty schemes is but small. Now although fairly good plans are sometimes submitted, it is very seldom that any are met with so drawn as to show that the architect has practical knowledge of the requirements of hospital buildings; and occasionally egregious, and to the trained eye very singular errors, are unconsciously committed. Under these circumstances it has been considered whether a model plan could be put forward; but it appeared that the difficulty of suiting the tastes and requirements of various neighbourhoods was too great; moreover it is no part of the business of the Department mentioned to supply plans, for which indeed no means are at its command. Nevertheless it appeared that a carefully designed building, if its details were made known, might serve a useful purpose by showing what measurements, arrangement, ventilation and drainage, are unobjectionable, even if they might not be thought actually the best that could be devised; but in order to give this scheme practical force, it seemed to me necessary to be able to refer to an existing building, and not merely to a series of drawings. When therefore, about a year ago, Dr. Harman Tarrant, who at that time was a member of the Assembly for the Illawarra District, asked me to furnish a plan for a small hospital of 8 or 9 beds for the coast town of Kiama, I gladly took advantage of the opportunity. The building has been erected in accordance with my design, and has been occupied now for some months; photographs and a plan of it are before you; and it is this of which I propose to offer some description.

Construction and Material.—Communities proposing to erect hospital accommodation for their district seem unable to command large sums of money as a rule; apparently they can seldom gather much more than a couple of thousand pounds. And, generally speaking, they have a prejudice in favour of—but perhaps I should rather say, a preference for—bricks and stucco. But the cost of any building is proportionate to its cubic contents and the kind of material employed; it follows, therefore, that when the limit of cost is sharply defined one of three courses must be pursued. An attempt may be made to diminish the dimensions; but this course cannot be followed far, for dimensions which are large as compared with those of dwelling houses are necessary for hospitals. Then the number of beds may be reduced; but here again the downward limit is soon reached, for it is scarcely worth while to build a hospital of less than ten beds, and the administration sufficient for ten is (or should be) sufficient for 20. Thirdly, bricks and mortar and stucco may be discarded and some cheaper material chosen; whereby the largest number of beds and the amplest measurements may be had for the limited sum which I am led to name as the datum of the calculation. The last is the course I

have chosen; and the material I select is corrugated iron. Now, there are three objections to this material. The first is a certain prejudice against it which I have found exists; a prejudice which I believe is partly due to the unscientific and inartistic treatment generally given to buildings constructed with it. But these are the north and west elevations of the Kiama Hospital; and I hope you will consider that the taste of the Architect, Mr. Charles A. Harding, of Wentworth Court, Sydney, has produced as agreeable a design in this simple material as need be. (Figs. 1 and 2.) Another objection is based on the score of durability. But I apprehend that a faithfully built structure of this kind may be trusted to endure for a generation—for 30 or 40 years at least; and, as far as I can understand, it is not considered certain that such a building would not last considerably longer. But a generation will do, surely. At the end of that time one of two things must have happened: either the town and district will have so increased that a large hospital on a new site and built necessarily of brick or stone, must be put up; or, if it should have remained nearly stationary, then the next generation must bear its own burden by providing a new building like the old one. One of these objections then is met by showing that it is, at least in my opinion, unfounded; the other appears to have no real weight. The third remains, and this is both sounder and more difficult to overcome; it is that the conducting properties of iron render it an unsuitable material for this climate, affording but insufficient protection against the heat of summer and the cold of winter alike. This has the greater force when it is understood that, in order to secure the greatest economy consistent with efficiency, the inner as well as the outer walls are made of iron; but I have met it, and met it successfully, by adopting the following method of construction. In the first place the wall-space and the roof-space are freely connected; this is done by means of a duct which continues the former around the wall-plate (Fig. 3). In the second place, the combined spaces mentioned are very carefully shut off from communication with the rooms of the building; the ventilation of the latter is quite independent of the roof space, instead of being, as usual, into it. In the ridge are placed large louvered lanterns, (Fig. 1.) which form exits for the air passing through the roof and wall-space; these louvres should admit of being closed, or nearly closed, when desired by a suitable arrangement of connecting rods accessible from the floor level outside. All round the building at the bottom, and below the iron of the walls, runs an opening eight inches high; this being divided into suitable lengths of about eight feet, is closed by a series of longitudinal doors. They have hooks to support them open; they should shut down on a strip of roofing felt, and should be closed with pressure fastenings.

Where the iron meets the frame of the doors at the bottom, the latter being sloped to run off water, a fillet (Fig. 3.) must be introduced; and the channel thus formed must be filled with cement in order that no space may be left by which air might travel up the corrugations of the iron, even when the doors are shut; and a similar expedient must be used around all door and window cases. At the top, the duct is let down square on to the top of the corrugations; and the sheets being tolerably true, it will there be sufficient to see that the painters in finishing the outside carefully putty up any small chink which may remain. Attention to secure the same quasi air-tightness should also be given to the bottom edge of the inner skin of iron. Four inch studding is used. By this arrangement two conditions are secured; in the summer, when doors and louvres are both open, the heat of the sun on the roof draws a current of air of considerable velocity between the two skins. This not merely abstracts heat from the interior of the building, but effectually prevents the transmission of heat from the outer to the inner skin; and the result, as practically seen at Kiama, is that the interior of such a building is, in hot weather, markedly cooler than buildings otherwise constructed and of more solid materials. Secondly, when, as in winter, the doors and louvres are closed, the inner skin of the building is surrounded by a layer of that excellent non-conductor, air, not less than four inches thick; and I have no apprehension that difficulty will be experienced in keeping such a building sufficiently warm. But on this point I cannot adduce the same degree of practical evidence as on the foregoing; for, through some incaution, the wood used was imperfectly seasoned, so that both the floors and windows present numerous and large cracks communicating with the outer air. Yet, although it is thus impossible to say to what temperature the interior might be raised, even with these serious drawbacks it is not too cold. This mode of constructing iron buildings I believe to be entirely new; its novelty consisting, not merely in the arrangement by which the whole surface is kept bathed in a rapidly moving current of air, but in the control to which the latter is made subject; so that the moving current may on occasion be converted into a nearly stagnant and non-conducting coat. I am much indebted to Mr. Harding the Architect, for working out the practical details and for successfully executing them; he having been supplied by me with a diagram of the arrangement, and some measurements only.

Having thus dealt with the material, and with the mode of construction as far as that is necessitated by the material, I proceed to give details of cost. The Kiama Hospital, just as it shows in the photographs, (Figs. 1, 2 and 4.) holding nine beds, and having, in addition, a detached ward for isolation, a dead-house, a windmill over

the water-tank, and a water-service therefrom over the building; having moreover a suitable arrangement to dispose of the slop-water by irrigation; was built for £1,478, to which however, Architect's commission must be added. Farther, had the full original design been carried out, it would then have held 17 beds, and the cost would not have reached £300 more, or, say £1,750 The building as it stands is satisfactory. It has, indeed, been so highly approved by all who have visited it, that I have already had applications for details from other colonies. On examining it however, I perceive that some of the measurements of the administrative block are rather small. I have therefore re-drawn the plan, so that while the ward measurements and general arrangement of the building remain exactly the same, the dimensions of the administrative block are suitably enlarged. Moreover, by adopting a slightly different manner of lighting the smaller wards I have contrived to put five beds in the space occupied by four at Kiama, while the full-sized ward holds ten, instead of eight as originally projected. In every other respect the amended plan is exactly the same as that of the actually existing building; and the cost of carrying it out, reckoned as at Kiama and in the same state of the market (which was not exceptional)—and subject of course to any special difficulty and cost of foundations which some sites may involve, would be, for 21 beds £2,000, or for 11 beds £1,700. I will now ask you to regard the amended plan, (Fig. 5.) while I point out some of its special features; bearing in mind that the description applies equally to the existing hospital at Kiama in so far as the latter has been carried.

Site.—If the adjacent ground is higher than the hospital reserve and slopes towards it, such intercepting drains must be cut as will restrain surface water from flowing on to or near the building area. In addition, it will sometimes be found necessary to under drain the latter and a space around it; and this may be done by setting drain-tiles four feet below the surface, and in lines at such distances apart as the nature of the soil may require. Neither of these precautions was necessary at Kiama. The natural surface should be carefully cleared, and excavated six inches deep. It should be covered with a layer of coal-ash and a proportion of tar. Around all outside walls a space of four feet or more should be tar-paved, and carefully graded to a fall away from the building; the tar-paving had best extend to the whole of the court-yard between the two blocks, where it would fall to gullies in the middle line.

Construction.—This has already been described. The walls consist of a double skin of corrugated iron; and at Kiama the ceilings are of sheet iron. The appearance of the wards and rooms

within will greatly depend on the taste displayed in colouring the walls. Sheet iron of the requisite guage for the ceilings cannot be got free from buckling, and cannot be made therefore to lie perfectly smooth or to make sufficiently neat joints. For this and for other reasons I think lath and plaster had better be substituted in future for the sheet iron ceilings used at Kiama. This modification also allows the ventilating openings to be somewhat reduced in size. Foundations should be of brick or stone; and a good damp-course should be built in above the ground-level and below the flooring joists.

The General Plan.—I have observed that the traditional front door in the middle of the principal elevation constitutes in such small hospitals as these a stumbling block; leading to waste of space, and the introduction of rooms for which uses have to be found. You will perceive that I have got rid of it. The entrance is at one end of the administrative block (Fig. 2), and gives, without intervening hall, upon a fairly large room which is destined to serve several purposes. It is intended to be the operating room; and therefore it has a good top light. But instead of a sky-light the windows may be made to run up to within six inches of the wall-plate; and this plan will doubtless be sometimes preferred. Then it is intended to serve as the dispensary; and a suitable press for this purpose should be regarded as a part of the building and provided for in the contract. Here also may be placed the hospital library, and the books of the institution; here, too the Board of Management may meet. And at this point I feel it necessary to break off for a moment, in order to point out that, if these arrangements do not seem all that can be desired, they are yet practically sufficient, and practically unobjectionable. A hospital of 21 beds is, after all, a very small place; and while the arrangements which, in larger institutions would be necessaries are here merely conveniences, the restriction of narrow means must not be lost sight of. When I come to speak of lavatories, much more forcible criticism of a similar kind may be offered. But again I should reply that the arrangement shown is not unhealthy, practically is sufficient for its purpose, and is as convenient as the money at command can provide. It would be very easy to furnish the two customary pavilions attached to each ward—the one for closets, the other for the lavatory, if money were no object. This entrance, then, gives on a large room intended for general business purposes. By it all patients enter; and as they must sometimes be carried, it is important that no steps should be necessary to reach it. For a similar reason the doorway should be four feet wide; and it may now be observed that all doors from, and including the entrance to the two wards on each side of the hall are of this width, while the passages measure six

feet. The corners of the lavatories in the hospital block are cut off to make an easy turning for the stretcher-bearers; and the whole floor of both blocks should, for this and for another reason to be mentioned in its place, be on one level. This general room has two doors of exit; one by which the verandah is reached, and therefrom the wards, and another which leads to a special operation ward. When the latter is in use this door should be locked; access being then had to it from the central passage. Adjoining it is a room large enough to lodge two nurses; and then comes the central passage alluded to, four feet wide, leading on one side to the verandah opposite the middle of the ward-block; on the other to the ground at the back of the administrative block. On the other side of this passage, and opening from it are a room for one nurse or a servant, and a large store room; where, among other things, spare bedding may be kept. Next is the kitchen, wherein a recess is provided by cutting off a part of the store last mentioned, for the dresser; and this fitting should be regarded also as a part of the building A part of the verandah is enclosed at the end for a pantry. A close cooking range should be provided and it should have a hot water cistern attached, a tap from which should be led to the adjoining scullery. This is a somewhat larger apartment than might be expected; but it will have to serve for an ironing room, for example, and for some other purposes. It should be fitted with a wash-up sink, and a plate-rack over, and a convenient table or bench adjoining. In the floor under the sink should be a gully; and under the sink and bench should stand a bath on wheels, having a waste by which it may be emptied over the gully last mentioned. The hot-water tap spoken of above should be set at such a height and in such a position that the bath may be wheeled under it for filling. It may thence be passed to the ward in which it is required; and convenience in wheeling the bath is another reason for making all the floors on the same level. This scullery is in communication by a door with the kitchen; but it has another door at the back which issues under a covered way which runs along the laundry-shed. This should have a concrete floor with a suitably placed gully connected with the general drainage system; and it should be fitted with a copper and furnace, and with three washing troughs. These also should be considered part of the building. At the back of this shed again is the staff closet. In all of these rooms suitable battens for hanging purposes should be fixed in the course of building; especially the kitchen and scullery should have an ample supply, for hanging up utensils. Around the entrance room, and around the wards should be fixed a picture rail at a suitable distance below the ceiling; for some decoration is desirable, and it must not be forgotten that nails cannot be knocked into these walls.

I now turn to the ward-block. In the middle is a large room for the occupation of the Matron and her husband who should act as wardsman. It has French windows giving on the principal verandah; and it is guarded from being overlooked by patients on the verandah by a light barrier as shown. The room has two small casements overlooking the male and female wards respectively; and it contains a press to hold the ward linen. On each side of the entrance are the lavatories. Access to that for men is from the hall only; to that for the women, from their ward only. Both are fitted with wash-basins; and both have an appliance which I call a bath-tray. It consists merely of a tray with a sufficient combing and a waste; and it is intended to economise water in bathing, the patient having a bucket-full given him, and sponging himself from it. But at Kiama, these trays have a shower over them, and I think there is no objection to this. They should be enclosed by a curtain hung on rods. The total number of beds in this block being 20 is allotted as follows: 10 are placed in one large ward for males; a corresponding space on the opposite side is divided into two equal wards. Of these the nearer, having access from the central hall, holds five beds for women. The farther holds five beds for convalescent males—for patients, that is to say, able to some extent, to look after themselves. This ward has an entrance from the court-yard only; its inmates use the male lavatory in the middle; but it has its own closet attached. One fourth of the beds it will be seen are devoted to females, and I believe this proportion sufficient, except, of course, in large hospitals in cities. Such is the general arrangement of the building. I now mention some details under the heads Ward-space, Ventilation, Lighting, Drainage, and Water-supply.

Ward-space.—This I have taken as follows:—Floor-space, rather more than 96 feet; cubic space, rather more than 1,000 feet per bed. The wall-space in the large ward is nearly 9 feet; in the smaller wards it may be taken at about 11 feet; but the distribution of beds not being even over it, it must suffice to refer to the plan when I believe it will be found enough. The height of the wards (and of all rooms throughout the building) is 10 feet 6 inches. At first sight these measurements may be thought rather small; but it must be remembered, first that there is but a small number of patients in any ward; secondly that there will be no accumulation of serious surgical cases, nor any cases of the infectious fevers; and thirdly that the building is intended for the country.

Ventilation.—Considering the impermeability of the walls, I think the ventilation openings should have an area of, for outlets not less than one inch to every 22 feet of cubic contents; and for inlets, not less than one inch to every 21 cubic feet. These

openings are not relatively proportionate, but the inlets as described will on the side of the building away from the wind act as outlets. These openings will be afforded for outlet purposes in the smaller wards by two tubes running from the ceiling through the roof-space each of 12 inches diameter; they should be capped above the ridge with a fixed exhaust cowl. I should prefer Boyle's, but Kershaw's or Stevens may be used, the latter being adopted at Kiama. The inlets should be disposed in two rows; one a little below the ceiling, the other a few inches above the floor. The former may consist of eight air-bricks, having each a nett opening of 24 inches; on the inside they should be guarded by a flap set at an angle like that of a Sherringham ventilator, but fixed; so as to deflect an entering current against the ceiling. The lower set should consist of air-bricks, each having a nett opening of about 12 inches, one of which should be set in the wall under the head of each bed. It is important to remember that air-bricks should be measured by the extent of nett opening they afford. Under the same head the warming apparatus must be mentioned; for this would be imperfect and even hurtful unless it were a means of ventilation as well. The apparatus I have selected as most suitable for the present building is the Calorigen; of which a few were imported at my instance by Messrs Maclean, Riggs & Co., some being subsequently used at Kiama. You are doubtless aware that this consists essentially of a slow combustion chamber for coal or coke through which winds a spiral duct communicating with the external air and with the ward; so that warmed fresh air is introduced by it. The fire draws its air for combustion from the ward. This is an excellent invention, very widely used; and although I believe that no form of stove designed for a similar purpose is equal to a Galton grate, yet this is so much simpler and is suitable for so many situations where the former cannot be fixed, that it seems to me to run it close. In the winter, if the Calorigen is proportioned to the size of the ward, all other ventilating inlets may be closed; but I do not recommend that they should be provided in this case with means of closing, since nurses and patients alike are prone to shut ventilators, if they have the means, when they should be open. The measurements just given are for the smaller wards: they should be doubled for the large one. It must not be supposed however that wards are the only rooms which require ventilation. Every room in the building should be provided with the same proportion of outlet ventilator; only the inlets, because the rooms are not continuously occupied, or because the doors must for the most part stand open, as in the kitchen for instance, may be reduced by one-half, or even more.

Lighting.—The proportion of glazed surface to cubic space which I have chosen is rather more than 1 square foot to every 60

cubic feet. It should not fall below this proportion; but it might exceed it without harm, except in elevated districts, where if it were greatly larger, some difficulty in keeping the rooms warm in winter might be felt. In the female ward it is necessary to introduce four high lights, measuring 4 feet by 3, of which the sill is 7 feet above the floor; it not being convenient to introduce more windows of ordinary construction than are shown. One of the windows in all the wards is a French light to give access to the verandah. All windows and transoms should be made in leaves or panels to open inwards from the bottom bar; they should not be centred so as to fall partly inwards and partly outwards. The latter plan prevents the adaptation of a good water-bar, which on the former may be made much more nearly continuous and more effective, not merely against rain but against drafts too.

Drainage.—All waste pipes, from the lavatory basins, slop-sinks, bath-trays, scullery, and the like should open on the outside of the building over yard gullies; while conveying the slop-water to the drain, they are thus cut off from connection with the latter. The only foul air they can introduce to the building, therefore, is that which may be drawn from the short length of piping between the sink and the gully; and in order to stop this, suitable S or P bends should be introduced. The gully over which the scullery waste discharges should be a grease-trap. The drain from the several gullies to the main outfall drain, as well as the latter should be very carefully graded, and set in cement; the joints should be gone over with the trowel internally so as to keep the interior smooth. They should be laid on such a foundation as will prevent sinking and consequent opening of the joints. After the branch drains have all come in to the main drain the apparatus known as an automatic flush tank should be introduced in the latter. Its capacity, whether for the full sized building or the part plan, may be about 25 gallons. This will secure several discharges during each day; the object of this apparatus being to reserve the slop-water until such an amount has accumulated as shall be sufficient to thoroughly flush the outfall drain, by causing it to run full bore and with a rapid stream, and yet not to reserve it long enough for putrefaction to set in. The main drain should run to a small plot of ground placed as far from the building as convenient; and should there discharge into a transverse trench leading from which several irrigation channels 6 or 8 feet apart have been cut. By a little management the stream may be conducted into one or other set of these furrows, by which it will be absorbed; and the intervening soil may be cultivated. In some situations it will doubtless be necessary to underdrain the area chosen for irrigation, and for this purpose the drain-tiles should be two feet deep. The effluent, if any one patch of the area be not over-worked will be bright

and inoffensive, and may be conducted to the ward gutter. But, as a rule, this will be unnecessary; it being only essential to remember that the destruction of the organic matter in the slop-water is effected by the ground-air and near the surface, and that therefore the irrigation area must not be kept continually wet, but be so divided and of such an extent that one part may be rested while the other is at work. Unless this point is attended to, after a short time the soil will cease to destroy the organic matter; it will become sodden, and then offensive.

Water Supply.—The water must usually be caught on the roofs. It may be conducted to an underground tank; there is no objection to this method of storage, which even has advantages, provided the reservoir is made water-tight. But for this it is useless to trust to brick and cement work. Doubtless this can be made water-tight; but, as a matter of fact, it very seldom is so. No doubt also a sufficient thickness of puddle outside would serve; but it appears to me that asphalt affords the most suitable and the most effective means. We have here a company actively engaged in carrying out all kinds of work in this valuable material; and it would be well if it were more generally employed for the particular purpose I am now speaking of. There is no reason why the rain water should not pass through a filter before entering the tank. This should consist of a chamber divided by a septum extending from the top to within 3 or 4 inches of the bottom; empty on the supply side, but filled on the delivery side with layers of gravel, breeze, and sand, so that the water ascends through the filter bed. The size of such a tank is an important point. It will depend first on the daily amount per head allowed multiplied by the number of residents, and the rain fall of the district. I think 15 gallons per head per diem should be the minimum allowance; and the size of the reservoir will then depend upon the length of rainless intervals usually met with in the course of a year. The area of the roof measured along the eaves and expressed in square feet multiplied by one fourth the rainfall in inches will give the amount of rain-water likely to be actually collected from this source in gallons. At Kiama, as I have said, the water thus collected is raised by a windmill to an overhead tank, whence it is led to several parts of the building. But whenever this is done, the underground tank should be provided with a floating guage, and it should be the duty of the wardsman, supervised by some working member of the committeee to keep a record of the weekly amount used, so that in dry weather economy may be observed.

Closets.—It is necessary to add a word about the closets. These are pans, which should, of course be emptied every day, and which should be served after empting with some deodorant. They should be removable from the outside by a suitably placed door which is

not shown in either of the plans, and the place for the pan should be so enclosed by a fillet that when pushed in with the most ordinary care it must occupy the right spot. On the male side, and in the staff closet, the seats must be hinged so that the pan may be used as a urinal; where a constant stream of water cannot be allowed to run, a urinal connected with the drains is inadvisable. The little lobby between the closets and the wards is ventilated by immoveable louvres on two sides; and it must not be forgotten notwithstanding its partial protection, that the ward-door to the closet is practically an external door; and must be carefully fitted accordingly. In this lobby, projecting from one of the walls is a recess, marked in the plan "louvred cupboard." This, which is 18 inches square, and which should be about 2 feet 6 inches high with two shelves in it, is intended to hold evacuations and the like which it may sometimes be necessary to reserve for inspection. On the other side of this lobby should be placed a slop-sink, not shown in the plan, with a water-tap over, at which bed-pans and other utensils may be washed.

It will, I hope, be understood that I do not presume to put forward this as a model design. To the best of my knowledge it is free from any highly objectionable faults, and I point to it as a proof that a district hospital building, well-adapted to its purpose, and with all the necessary structural adjuncts, can be built either for £1,700 or for £2,000 according as it accommodates 11 or 21 beds.