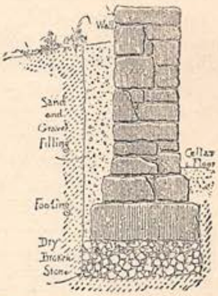
House Construction. I.

FOUNDATIONS.

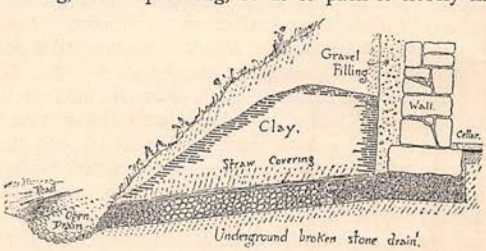
THE house-builder's first care is to secure a solid foundation. The best basis for this is either rock or gravel which has not been moved. Next come clay and sand, subject to the same conditions as gravel. Loose or soft, wet situations are more difficult of treatment, and require extreme care and scientific methods of procedure. Examination by means of wells or pits sunk at different places over the proposed site, down to or lower than the under side of the foundation, is the only sure means of determining the character of the ground. If a solid basis is found, it is only necessary to remove loose deposits and level all surfaces, so that the bases of the foundation may not be begun on inclined planes. In general, a site at the top of a hill is undesirable, because it is difficult to raise trees and shrubs there; and, as these elevations usually have a thin layer of soil above a rock substructure, rain will collect and produce springs. In the cutting of a cellar in such a position, considerable expense will be incurred in diverting springs by sinking channels. To these objections may be added the extra labor of walking, riding, or driving up and down a long hill, where gradual and easy ascent is not possible. Should it be thought advisable, however, to retain such a site, it is well to keep the cellar excavation as high as possible above the rock, grading judiciously to enhance the appearance of the building. Valley sites are as open to objections as those on hill-tops; for, when the valleys are long and deep, and there is much still water, dampness and unhealthiness of air are nearly always present. The best position for a country house is midway between these extremes, on the side of a hill and near broad sheets of moving water—such, for instance, as the slopes along the Hudson River and by the great inland lakes. In those regions, it will be found that spring is about two weeks earlier and autumn nearly two weeks later than in the same latitude east or west, where the relative conditions of land and water are less favorable.

Clay soils may be classed next to rock and gravel for stability as building sites, but they present unfavorable features on account of changes in their structure in dry and wet weather, their imperviousness to water, and the tenacity with which frozen clay adheres to masonry. Yet, by using care in draining the excavation, the foundation on clay may be made nearly as solid as that constructed on compact sand, and the site prove as conducive to health. Sand, from its porosity, forms an admirable drain, and helps to keep the cellar and substructure dry. If the soil is wet, special means must be employed to keep the cellar and walls free from dampness.

The site having been tested, the excavations are commenced. These excavations are generally, or, rather, ought to be, eight or ten inches wider than the proposed area of the building. This space outside of the wall should be filled with gravel, and if the wall is built on dry, broken stone, the surface water will not be apt to penetrate the cellar. Such preparation, however, might not be sufficient in the case of a clay-bed whose upper surface was above the cellar level. In this case, trenches must be cut outside of the building, so as to conduct the water to some main-road drain or to the foot of the slope. Sometimes the outside surfaces of cellar walls are coated with cement and sand, which is termed "rendering," and this helps to shed water in the soil. After this has been accomplished, the earth is filled in and thoroughly settled by ramming and wetting, called puddling, so as to pack it closely in



TYPICAL WELL-CONSTRUCTED CELLAR WALL.

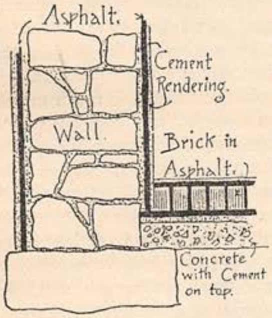


DRY STONE DRAIN UNDER CLAY BED.

place; but particular care must be taken that the walls are settled and quite dry before this is done, for if the walls imbibe moisture, especially if built with lime-mortar, they rarely part with it, and wet gradually and surely rots the timbers resting on the foundations. To prevent a soakage of water through the earth packing, a course of brick should be laid under-ground, leaning toward the building, and this should be cemented very thoroughly. Where wet soils are encountered, moisture will be conducted by means of the wall into the dwelling. The surest protection against this is to use hot asphalt, which is carried over the cellar floor, through the foundation walls, and upon the outside of the foundation walls, thus forming a complete envelope to the building, which, if properly put on and carefully regulated as to special requirements, will make the cellar floor as dry as the attic, even when the level of summer water outside is several feet above the grade of the floor. If the cellar walls of an existing building are damp, and it is impossible to keep the

BRICK WATER-SHED.

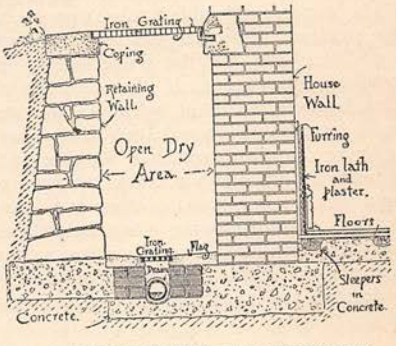
cellar floor free from moisture, the following method will make a dry cellar and add to the security of the household against disease. Nothing is more detrimental to the health of the inmates of a house or more conducive to the decay of the building than moisture. Diphtheria has developed from the fungoid growth on damp wall-paper in a house where the drainage was excellent. The first thing to be done is to take up the cellar floor, and level the soil about nine or ten inches below the finished grade of the cellar floor. In very bad locations, lay four or five inches of concrete, or, in more favorable ones, between four and six inches of coarse, clean sand. (Sand is clean when, being wet and then rubbed, it does not soil the hands.) This layer of sand should be well rolled or packed; then spread over the sand or the concrete an even layer of cement-and-sand mortar from three-quarters to one inch in thickness, and when this has well set, pour hot asphalt over the entire surface of the floor, carrying the same up on the walls above where the moisture shows. The outer surface of the cellar wall must be treated in the same way if the ground is unusually bad. Of course, a rough-stone wall will need to be brought to an even surface with cement mortar before applying the asphalt, and a second cement rendering should be placed outside of the asphalt on both sides of the walls and the floor. To make a good walking surface, which shall also be capable of resisting wear and tear, the cellar floor should be covered with bricks on edge, well grouted in cement. Or the bricks may be heated and dipped in asphalt, then laid on the asphalt bed, and afterward the cement may be spread over them.



DAMP WALL TREATED WITH HOT ASPHALT.

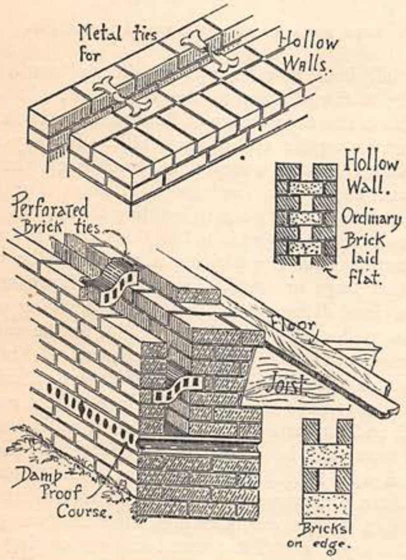
This lining is often carried up on the side walls. To prevent vapors rising from decomposed matter in the soil, a good practice is to cover the surface of the ground, before the floor is laid, with a two-inch layer of unslaked lime, which, on slaking by contact with the damp, destroys any vegetation which may be on the surface. These methods for keeping walls dry are excellent when dry areas or air-drains cannot be conveniently constructed. Dry areas are cavities between the outside of the foundation walls and the retaining walls which support the soil. Sometimes these areas are covered with half-brick arches, or a flat stone a little below the surface of the ground. This entirely nullifies the anticipated benefit, for the surface drainage descends and injures the cellar wall even if it is cemented above the covering, while the dark passage becomes a harbor for vermin. The best form is that of an area which is open to the elements, covered at intervals with a movable grating, and is sufficiently wide to admit of being cleaned out. It should have a drain-pipe laid to grade at the bottom. This area, of course, may be utilized in giving light to rooms partially below the ground surface, such as kitchens, laundries, and sculleries, although it is not well to have any working-rooms below the ground levels. The best possible arrangement would be to have the working department of a household in a semi-detached wing.

Damp courses are used to prevent the moisture which may get into the foundation walls from rising by capillary attraction. The absence of this simple precaution,



OPEN AREA TO PROTECT AGAINST MOISTURE.

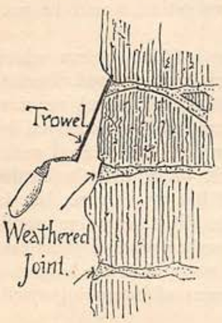
especially in the so-called "jerry-builder's" work, while saving a few dollars to the contractor, ultimately results in the expenditure of hundreds, by the householder, in repairs and doctor's bills. In very cheap buildings, several courses of brick-work, laid in cement above the footings and below the floor, sometimes take the place of building the entire wall in cement. Another way is to bed thick slates in cement in courses with lapped joints through all the walls, whether large or small. This method, however, has fallen into disuse, either from the breaking of the slates by the superincumbent weight, or the want of adhesion of slates and ordinary cement. If Portland cement is used, it will, from its well-known adhesion to slate, prove more satisfactory. A layer of hot asphalt, sand, and tar, between the foundation walls and the superstructure, has proved very efficacious. Gas-tar mixed with lime it is said will resist the advance of moisture. In some of the old and well-constructed buildings of two centuries ago, sheet-lead was placed on the top of a wall to prevent any wet coming down from the gutters; what has worked so well on the upper portion has been suggested for the lower part of the wall, but it is an expensive method. Thus far, one of the best and cheapest means discovered to keep dampness out of a wall is to insert a damp proof course, which is made of vitrified pottery or stoneware. These blocks come in various sizes; they are perforated entirely through their lengths, which go across the width of the wall; each block has a half air-space, which remains open after the mortar-beds are laid on each side of the block. These slabs can be introduced into work already executed, by cutting out a course of bricks. Hollow walls have been used to accomplish the same all-important result, and also the layer of air, being a non-conductor, helps to keep the inside of the building at an equal temperature. The two portions forming the hollow wall have been variously placed as to their position and bonding. They have been arranged with the thin portion sometimes on the inside and sometimes on the outside. When the thin portion is inside, the bulk of the wall is exposed to the wet, which may penetrate to within a few inches of the interior. The span of the roof has also to be increased, to bring the wall-plates on to the substantial part of the wall; this, however, can be avoided by building the upper portion solid, which will render that portion of the wall liable to damp. If the thin portion is on the outside, the damp is at once intercepted by the air-space; it does not attack the greater bulk of the wall, and is kept at a considerable distance from the interior of the structure. The roof will now rest on the interior, thicker wall, and the whole will be a more economical arrangement. If the outer or thinner portion, however, is built of bad bricks, the attacks of frost, for instance, will soon destroy it. In bonding or tying the two portions together, bricks like an S have been used; the end which goes into the outer portion being a course lower than the other end. This prevents any moisture running along the surface of the tie into the main wall. These bonders, as they are termed, are placed about two and a half feet apart in a horizontal, and about ten or twelve inches in a



DAMP-PROOF COURSE AND HOLLOW WALL BONDING.

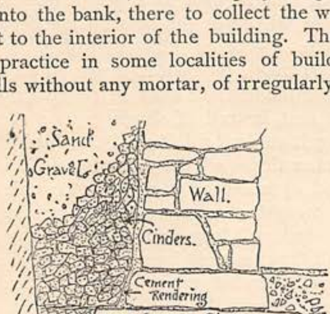
vertical, direction. Wrought and cast iron ties, properly painted or tarred, with a depression or a twist at the middle to prevent water passing and to resist compression, are also of general use. Special hollow bricks have been used for the entire building, and sometimes the walls are built of ordinary bricks on edge, previously dipped in tar and asphalt, and with ordinary bricks as bonders from front to back. Or the bricks may be laid flat, with a two-inch space between; the headers or bonders will then be too short to span the width of wall, and must be filled out with "bats," or broken bricks. These methods, which may be used in constructing hollow walls with ordinary bricks, are defective in strength and durability as compared with those having special bonding-bricks or metal ties; for the durability of the wall is affected by the porosity of ordinary bricks, which conduct moisture to the inside wall, and thereby defeat the very object to be obtained in making the wall hollow. In the absence of special bonding-bricks or metal ties, it is better to use pieces of slate-slab as thick as the courses of brick. Use may be made of this in the ornamentation of the front, by having the edge of the slab rubbed smooth where it is exposed to view, and if a Philadelphia brick is employed for the exterior, the deep contrasting color will produce a pleasing effect. Often a stone wall is lined on the inside with four inches of brick-work or three inches of fire-proof material, leaving a two-inch air-space between; this lining must be tied into the main wall, and will go from the foundations up to and between the beams.

If concrete is used in the foundations, care must be taken that it is made of proper materials, and that the mixing and laying are well executed. Concrete is an artificial compound, generally made by mixing lime or cement with clean, sharp sand, water, and some hard material, such as broken stone, gravel, burnt clay, bits of brick, iron slag, and breeze. The broken material for convenience is called the "aggregate," and the mortar which incases it the "matrix." If there is any choice about the aggregate, preference should be given to fragments of a porous nature, such as brick or limestone, in one and a half or two-inch cubes, rather than to those with smooth surfaces, because the cementing material will more readily adhere to the rough surfaces of the former. The following modes of mixing concrete are systematic, scientific, and practical: The proportions decided upon are measured out in boxes. The measured materials are then heaped together, and turned over with hoes and shovels at least three times; when thoroughly incorporated, the mass is sprinkled with water from a watering-pot. If too much water is added, the lime or cement is washed away. Another method, recommended by engineers, is to mix the matrix separately and then add the aggregate. In this method, the mortar should have about as much moisture as in ordinary brown sugar, and the aggregate should be thoroughly moistened in order not to abstract any moisture from the matrix. When the aggregate is in the form of a sandy ballast or gravel, the first method is better, as the expense of screening would have to be added if the second method were used. As a rule, mixing separately is more expensive, and for ordinary concrete need not be adopted. In laying concrete, the common practice has been to tip it from a height of ten or more feet, but this is considered objectionable, because the heavy and light portions separate in falling and the concrete is therefore not uniform. After thorough mixing, the concrete should be wheeled to the position desired and gently tipped from a height of not more than three feet, and be carefully rammed immediately, if a quick-setting cement is not used, in layers of from eight to twelve inches in thickness, and then not disturbed after setting has commenced. Before adding a layer, make sure that the one on which it rests is thoroughly set; the upper surface of the lower one should be swept clean, wetted, and made rough with a pick. When concrete is to be placed under water, it is deposited through shoots, or sometimes placed in oiled cotton-waste bags, which remain after it is laid. If footing-stones alone are used, without concrete, as a sub-foundation, it is well to see that these stones, if they have uneven beds, are fitted solidly on the gravel. An excellent way to bed an irregular stone is to heap sand without pebbles around the stone in the trench, and then turn a hose on the mass; the water in sinking through the sand carries it into all interstices, and thus gradually makes a solid bed. When the foundation wall is built of stone, care must be taken that there are no cracks in the stone, which, even if almost invisible, will allow water to soak through, and unfit the stone for resisting a strain. Any suspicious stones when struck with a hammer will, if good, ring clear, and if there are seams in them, the dull sound which follows the blow will betray their presence. The stones should have nearly flat beds and be well bonded, and the side of the wall toward the bank should be as carefully pointed as that on the inside,—that is, the joints should be well filled with mortar, and the mason should make what is called a "weathered joint," by pressing the mortar in with the trowel, the point being held up.



PROPER JOINTS FOR STONE WALL.

If the filling of the trench, which must be either sand, gravel, cinders, broken brick, or stone-chips, should be in direct contact with the wall, this form of joint compels all water falling on the stones to trickle off and down until the drain is reached, when further harm cannot be done. If brick is used in the foundation walls, some one of the before-mentioned methods for excluding moisture must be employed, otherwise it will be impossible to keep the house dry and wholesome. Even when stone is used, the utmost care and attention must be practiced to prevent country masons, in particular, from constructing the walls with long stones, which they will not break but set with the neat, fair face on the inside, and the projecting portion running into the bank, there to collect the water and conduct it to the interior of the building. The reprehensible practice in some localities of building the cellar walls without any mortar, of irregularly shaped

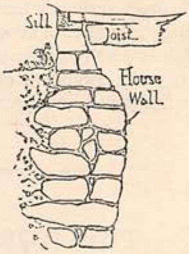


OUTSIDE FILLING FOR CELLAR WALL.

stones, and depending partly for support on the soil backing, ought never to be countenanced. Such walls have the smooth faces of the stone on the inside, the side toward the bank having many projections. To make a presentable appearance toward the cellar, the crevices are filled with chips of stone and the joints are only pointed with mortar. On completion and after whitewashing, such a wall would pass muster as a first-rate one. But after heavy rains, streams of water will percolate, and finally pour into the cellar; rats and other vermin, finding easy lodgment between the stones, will soon push out the chips and pointing mortar, thus reaching the interior, while the earth, washed in by successive floods, will soon bring such a pressure that the cellar walls will bulge inward. Dry stone walls may suffice if proper means are taken to keep the bank from the outside, but as a general rule it is better to have the entire thickness of the wall compactly filled with cement-and-sand mortar.

That portion of the wall which shows above the ground is ordinarily made with a smoother face than the rest. Slabs of granite or freestone, or even an eight-inch brick wall, are used in low-priced work. Of the three, split granite is the best, because the others absorb moisture from the ground and from snow-banks. The most solid construction is obtained, however, by carrying up the stone wall the full thickness, and depending on neatly pointed joints for the appearance of the outside.

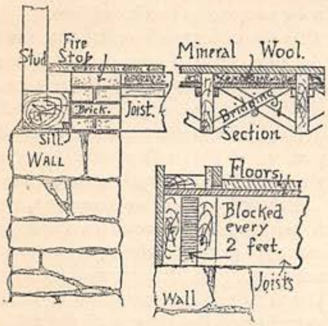
Another decidedly bad practice in country work should never be allowed; this is the reduction of the thickness of the wall to that of the sill, in order to allow of the accommodation of the atrociously bad framing in which the floor-joist is notched into the sill, so that their upper surfaces coincide, but so that the whole weight comes on the tenon, which is liable to split off. The proper way is to have the under surfaces of the beams flush with the lower part of the sill; the tenon can then be made deep enough for safety, and the wall carried up the full thickness.



BADLY CONSTRUCTED CELLAR WALL.

An excellent mode of securing the sill to the wall is by bolts two feet long, set vertically in the masonry, about eight or ten feet apart; holes are bored in the sill, which is slipped over the bolts and secured by nuts and washers, care having been taken to spread previously a layer of soft-cement mortar as a bed, which, when the sill is hammered down, closes effectually all crevices against the frost. Another most effective means for keeping out the cold, stopping the spread of fire, and preventing rats from climbing over the wall and finding their way through the floor above, is to fill up the space between the beams from the sill, and the top of the stone wall to the under side of the floor-boards, with brick-work. The same object is attained in the West by dispensing with the sill, and using two floor-beams all around the building, so placed as to leave an air-space, which is blocked every two feet. These beams are so arranged that they project inward about an inch more than the studs above. The studs rest on a plate placed on the under flooring, which is laid diagonally. The advantages claimed for this method are security and warmth, with less cost of material than with beam-filling; greater stiffness than with sills; diminution of shrinkage, and greater height of walls with the same length of studs.

In preparing cellars or basements, it is often desirable to have board-floors. These floors may be laid on sleepers imbedded in concrete, or, if circulation is wished under the floor and through the walls by means of air-bricks, the floor may be laid on the regular beams away from the ground surface, and ought to be "deafened" with "mineral wool," which, from its antiseptic and non-inflammable qualities, is a most valuable and at the same time an inexpensive adjunct to good building. Mineral wool is prepared by passing superheated steam through ordinary iron slag, the resulting product being a white, almost weightless, woolly substance which is death to insects or vermin that enter it. Also, it is a non-conductor of heat, cold, and sound, is perfectly fire-proof, and costs only a few cents a square foot about one inch thick. The beams are prepared for the wool by nailing fillets, from one to one and a quarter inches thick, say two inches below their upper surfaces. These fillets support a thin board bottom, on which the mineral wool is laid in a moderately compact mass until it is level with the top of the beams. If packed too tight, it loses many of its valuable properties; however, it should not be merely scattered between the beams. The trifling expense incurred will be repaid a hundred-fold by the comfort and security resulting from its use. As a fire-stop, the value of this material is only beginning to be known. If placed in partitions, behind furring, between floors and under roofs, many fires unaccountable in origin and difficult to get at, would be prevented.



BRICK AND "UNDER-FLOOR" FIRE-STOPS.

Such, in brief, are some of the points which require attention in constructing a good foundation. With different conditions and novel requirements, special and novel means will be employed by a skillful architect to accomplish the desired ends. These hints are not given in order that the reader may become the architect of his own house, but in the hope that they will enable him to examine intelligently and to appreciate properly prepared plans and specifications for new structures, and in the hope that they may suggest simple means of improving dwellings already constructed.

GEORGE MARTIN HUSS.

THE WORLD'S WORK.

New Steam-boat and Engines.

IN a new steam-boat now building upon the Hudson, an attempt is being made to produce a boat that shall be self-righting, that shall be very fast, and that cannot sink unless entirely torn to pieces. The boat is comparatively small, as it is intended only for an experimental or model boat. If successful, it is intended to build ocean steam-ships upon the same principle. It appears that the inventor's aim is to make a self-righting boat by carrying the sides over the deck in the form of a dome. The side frames are made continuous and meet over the center of the hull, or, in other words, the frames begin at one side of the keel, rise directly at an angle of about forty-five degrees to the water-line, and then curve inward over the deck and back on the same lines to the keel. A section of the hull taken in the center is thus of a wedge shape, with a sharp edge below and rounded top above. This wedge form is preserved through the entire length of the hull. There are no hollow lines in the boat, and the sharp, overhanging bow is intended to part the water near the surface and to form a long, tapering wedge. The widest part of the hull is exactly at the middle, both ends being precisely alike. This is quite different from the flat bottom and straight sides, with comparatively bluff or rounded bows, of the ordinary ocean steam-ship. The boat is intended to be much deeper aft than forward, and the deck will be much higher above water at the bows than at the stern. There will be no houses or raised constructions of any kind on the deck, except the dome-shaped pilot-house, the ventilators, and the smoke-stacks. There will be an open railing around the center of the deck, so that it can be used as a promenade in pleasant weather or whenever the seas do not break over the boat. The object of this unbroken dome-shaped deck is to enable the boat to throw off all waves that break over the bows or sides in rough weather. It is thought that, instead of shipping tons of water and retaining it on deck till it can be drained off, the boat will shed or throw off the water from the long, sharp bows and open deck, and will at once relieve herself of the weight of the water. Waves striking the rounded deck will have no hold on the boat, and their force will thus be spent harmlessly. The sharp wedge-shape and rounded top of the hull, and the fact that even when fully loaded the center of gravity will be below the water-line, makes the model self-righting. From experiments with a small model, this claim of the inventor seems to be clearly proved. In laying out the boat, only the spar deck will be used for passengers, the main deck and all below being intended for cargo, coal, and engines. The state-rooms will be arranged along the outside, each room having a port in the side of the boat, while the ceiling will be formed of the curved deck above. The saloons will be the whole width of the ship, and on the spar deck. For lighting the saloons there will be sky-lights in the center, and as these in rough weather may be