William Marshall on Lime and Building Patterns, late 18thC.

William Marshall. The Rural Economy of Yorkshire Vol 1 1788

CEMENT. **Formerly, ordinary stone buildings were carried up, entirely, with 'mortar'; that is, common earth beaten up with water, without the smallest admixture of lime** [*but see below for contradiction of this - earth mortar with lime lumps present*]. The stones themselves were depended upon as the bond of union; the use of the 'mortar' being merely that of giving warmth to the building, and a degree of stiffness to the wall [*we would disagree with this assumption].*

The event, however, proves that walls built without lime have, in many instances, stood for ages. Even part of the walls of Pickering Castle, formerly esteemed a fortress of considerable strength, have been carried up with a cement which, *to appearance,* seems little superior to common mortar: nevertheless, such is the effect of time, upon walls which are exposed on every side to the atmosphere, that they now hold together with considerable tenacity…

The citadel, or central stronghold, of the fortress under notice, has been built with better cements; which, however, vary much in outward appearance. One specimen…is a smooth childlike substance; another, a coarse rough mass, composed of sand and gravel, with a smaller proportion of chalk-like matter [….lime].

In the fosse, which surrounds the outer wall, lies a fragment…whose cement has acquired a stone like hardness, especially the part which is exposed on the outer surface.

I have bestowed some attention on the decomposition of these four specimens…

EXP 1 CEMENT OF PICKERING CASTLE: - the coarser specimen, taken from the ruins of the central tower.
In *general appearance* it resembles dirty chalk, thickly interspersed with small gravel; some of the granules as large as peas. Its *tenacity* that of common writing chalk; the asperities easily broken off with the fingers. One hundred grains, pounded, dried, immersed in water, and balanced together with the menstruum lost in solution 25 1/2 grains of air, and yielded by filtration 40 grains of residuum; which afforded…35 grains of gravel and rough sand, and 5 grains of suspendible mudlike matter; the solution yielding, by precipitation, 64 grains of calcareous earth…

From this analysis it appears,

1.that the proportion in this case (supposing crude limestone in lumps fit for burning to be of equal weight with sand and gravel) was three measures of unslaked lime in lumps to two of sand and gravel. *[probably the opposite by volume, since lump lime 40% lighter than unburned limestone].*
2.That the sand and gravel, in this case, has been washed; either by the brook, which runs at the foot of the Castle mound, or more probably, by hand; the

proportion of dirt being smaller than that which is generally found among *drift sand*.
3.That the lime had not regained the whole of its fixed air.

EXP 2 - finer specimen of the central tower.

General appearance that of stale lime, run together with water, and baked to a crust; almost a pure white; surface rough; shewing the cells and the unbroken granules of the original lime. *Contexture,* more brittle than common chalk; full of pores; the materials do not seem to have been well incorporated, at the time of preparation.
One hundred grains yield, in decomposition, 21 grains of air; 42 grains of whitish grit, 5 grains of suspendible dust like particles; 56 grains of pure chalk.
OBS. The residuum…is evidently *the powder of free stone*. The particles are small, and of irregular figures, very different in appearance (when magnified) from common sand. I was at a loss to ascertain their nature, until pounding some freestone, and washing it in the manner I had done the residuum, I found it to resemble exactly the 42 grains of washed grit of the experiment. It appears to have been pounded or ground very small, and to have been put through a fine sieve…no fragment so large as a pin's head.

It is observable that the cement of this experiment is *weaker* than that of the last (different aggregate; less lime content)….It is also observable that, in the decomposition of the specimen, a urinous smell rose, during the solution…**It is at present a practice, among some plasterers to make use of urine in the preparation of plaster.**

EXP 3 - taken from the ruins of the old outer wall facing the northwest. Collected in three or four different places; a few feet above the foundation; and mostly from the inner parts of the wall, not from the outer surface.

In appearance that of sandy loam, interspersed with specks of chalk *[quicklime, surely],* some of them larger than peas *[we see this pattern locally where quicklime has been added to earth mortar].* Its fragility similar to that of dried brick earth.

100 grains…yield 13 1/2 grains of air; 30 grains of rough sand, and a few large fragments; 37 grains of silt and fine sand; 36 grains of calcareous earth.

OBS. There are two causes of the *weakness* of this cement: the small proportion of lime, and the impurity of the base…chiefly of mere mud, or of sand so fine as to be impalpable between the fingers. *all consistent with the simple use of locally sourced sub-soil and modest addition of quicklime - the sand and silts being naturally part of the subsoil. Fairly typical of modern disaggregation in this area].*

EXP 4 - taken from a fragment in the northwest corner of the fosse.

The general appearance somewhat resembling the last-noticed specimen; but in *contexture* very different. The crust of the outer surface, which has been exposed to the influence of the atmosphere, probably during many centuries, has acquired almost the hardness of limestone; nor is any part of it to be broken with the fingers; nevertheless, this specimen also, is **full of lumps of unmixed lime;** some of them

the size of small hazel nuts, and, at the time I took the specimen (the season wet), as soft almost as butter; when dry, they are of the consistency of very soft chalk.

One hundred grains of this specimen yield 15 grains of air; 8 grains of fragments; 12 of coarse sand; 36 of fine sand; 3 of size-like matter; 45 of chalk. *[linseed oil?].*

…GENERAL OBS:

1. All these cements, whether weak or strong, have laid hold of the stones with a degree of firmness proportioned to their respective strengths. **Every crevice of the wall is filled with cement; whole form one united mass.**

Hence, it is more than probable that these cements have been poured into the walls, in a liquid state, in the state of *puddle*…

2. The subjects of EXP 3 and 4 are strong evidence that, in the preparation of these puddles, the ancient builders were very deficient *[we would probably disagree].* Not more than half of the lime they contain appears to operate *[as binder, but will seed carbonation as porous aggregates].* The lumps, whether large or small, are *more* than wasted; weakening, rather than strengthening, the cement *[Marshall is going somewhere with this argument - see below].*

3. From the whole of these experiments, it is evident , that the several cements had acquired the principal part of their fixed air; chiefly, perhaps, after they were deposited in the buildings *[by carbonation].* Hence it is entirely probable that the stonelike tenacity of old cements is chiefly owing to the transmutation of lime and sand to calcareous earth and sand; a substance resembling the original limestone *[the lime cycle].*

On examining a wall, which has been built with loam alone, without any admixture of lime, and which has stood about a century, I find that the loam has laid not hold whatever of the stones, and that time has made no alteration on its contexture. It is still the same friable substance it probably was the day it first became dry in the building; without having the smallest appearance of **acquired tenacity** obtained during the century of time it has been exposed to the influence of the atmosphere.

It is therefore probable that the atmosphere imparts nothing *voluntarily* of a cohesive nature to the mortar of walls which are exposed to it.

But it is more probable that cement, **containing a portion of lime, imbibes from the atmosphere something, which gives it a degree of tenacity, superior to that which it had on its first becoming dry in the wall;** and it is a fact well established, that lime begins to imbibe, the moment it grows cool from the kiln, that which the fire has deprived it of, namely, fixed air; which fixed air being imbibed, after the cement is deposited in the walls, is *probably* a principal cause of tenacity.

[and so begins the run-up to recommend dry-slaking of powdered quicklime…]

This being admitted, it may seem to follow that the more quickly it is transferred from the kiln to the building, the greater proportion of air will be imbibed, after it is laid in the walls, and, of course, the greater effect will *time* have on the tenacity or

cohesion of the cement; and hence we might be led to infer that, if the ancients had superior skill in this matter, it consisted in their hastening the lime from the kiln to the building.

But in practice, it is observed, that fresh-made mortar does not *set* so well, does not cohere into a stone like substance so readily, as that which has been prepared some time before it is used.
This fact, perhaps, is accounted for in the lime having had, under this circumstance, time to lay hold of the particles of *sand* with which it is inter-mixed.

But, on the same principle, it seems to follow that, if the preparation be made too long before the mortar be laid into the wall, it will have regained too much of its fixed air to lay hold, sufficiently, of the *stones* or other materials, which it is intended to bind together.

Let this be as it may, **it is common, in practice, when mortar is not used, presently *[shortly]* after making, to cover it up closely from the outward air.** It is the opinion of a person, who has paid this subject considerable attention, that, if **mortar** be buried within the surface of the ground, it may be kept twelve months in perfection.

The same person…**has struck out a *new idea* relative to the *slaking* of lime for mortar:**

Lime, whether it be intended for cement or for manure, ought to be reduced entirely to a *dry powder.* And, for cement, it ought to be mixed, in this state, evenly and intimately with the sand.

It is difficult, if not utterly impossible, to reduce lime entirely to powder, **with water alone;** some part of it will always be supersaturated, and thereby be reduced to a *paste;* while the outsides…will (unless the stone be extremely fine) fall into granules, not into powder.

Every piece of paste, and every granule; though but the size of a pea or a mustard seed, is useless, if not detrimental to cement; for, with these, the grains of sand cannot be intimately mixed; much less be coated with them; as they may, and undoubtedly ought to be, with *lime in powder.*
But if, instead of water, *wet sand* be used in slaking the lime; (piling it with the lime in knobs, layer for layer, and covering up the heap with it;) those evils are avoided: no part is supersaturated, nor are any granules formed by the action of the outward air.

Besides, another great advantage is obtained by slaking the lime, in this manner, with the sand with which it is intended to be incorporated. The two ingredients, by being repeatedly turned over, **and by passing through the sieve together,** necessarily **become intimately blended;** more intimately, perhaps, than they could be mixed by any other process, equally simple.

If the sand be *washed* (and all sand mixed with lime for cement ought to be washed) the labour of preparation is, by this method of slaking the lime, considerably lessened.

But, in the preparation of cement, SLAKING THE LIME makes only one stage of the process; MIXING THE INGREDIENTS intimately and uniting them closely together, into one compact homogenous mass, is an operation which requires the strictest attention….

Much care… is requisite in the preparation of mortar for the TROWEL. Working it, with the spade alone *[what? even with the back of an Irish shovel alone???],* is insufficient. Beating it with the edge of a board, a kind of wooden axe, is more efficacious, but is very tedious. Mills for the grinding of clay are common…but a mill, for the grinding of mortar, I have not yet seen, nor have I ever heard of such a contrivance…..

….MORTAR FLOORS. A new species of cottage flooring has lately been thought of, and is now pretty commonly formed, in this neighbourhood.

The materials are lime and sand; mixed in nearly the same proportion, and prepared in the same manner, as the common mortar of bricklayers; except, that for forming floors with is generally made stronger, and is always made up softer, than it is usually done for laying bricks in.

The *method*. The bed being prepared, the materials are carried on, in pails, **in a state between paste and batter;** laying them on four or five inches thick, and about one inch higher than the intended height of the floor, to allow for the settling, in drying. The whole being well worked over with a spade, the surface is smoothed with a trowel; and as it dries, is beaten, repeatedly, with a flat beater, to prevent cracking; the workman, in this operation, standing on planks.
A fortnight or three weeks dry weather will render it stiff enough to walk upon. If, after the last beating, cross lines be deeply graven on the surface, a floor of cement has the appearance, as well as the usefulness, of a freestone floor.

LIME

This is at present a favourite manure in the Vale. It is used invariably, I believe, on every species of soil, and *in most cases,* with great success….I am not acquainted with any country in which lime is held in such high repute, **nor where the manufacturing of it is so common a practice among farmers, as it is in this. Almost every principal farmer, upon the margin, burns his own lime. There are, besides, great number of 'sale kilns' for smaller farmers, and for the centre of the Vale, where no materials for burning are to be had.** There is an instance of one man occupying eight or ten kilns; burning two or three chaldrons, yearly.

The LIME HUSBANDRY of the District, therefore, merits particular notice. The subject requires the following division:

1.the materials burnt
2.the method of burning
3.the cost, and the felling price
4.the soils, and the crops to which it is applied
5.the method of applying.

1.MATERIALS. On the NORTHERN MARGIN of the Vale, lime is burnt solely from *stones,* of different colours and contexture. The species most prevalent are

- a strong grey LIMESTONE GRANITE; and a species of blue and white MARBLE, the blocks, whether large or small, being blue at the core, and lighter-coloured toward the outer surface.

One hundred grains of the former, taken from a lower stratum of PICKERING-CASTLE-BANK, yield 43 grains of air, and 94 grains of calcareous earth, leaving a residuum of 6 grains, chiefly a brown silt, with a few gypsum-like fragments. One hundred grains of the latter, taken from the lower stratum of a quarry, near KIRKBYMOORSIDE, afford 39 grains of air, 86 1/2 grains of dissoluble matter, and 13 1/2 grains of residuum, fine impalpable silt. *[both of these may be feebly hydraulic - the Kirkby stone the more so].* The lime produced from the former is of a dusky colour, and falls in rough coarse grains; that of the latter, bursts into a white volatile flour-like powder.

The stones of different quarries are different in quality, but none of them differ widely from the specimens above described.

On the SOUTHERN HEIGHTS, the prevailing material is a singular species of SOFT CALCAREOUS GRANITE. its colour a dirty white; its contexture resembling the grains of white mustard-seed, or the roe of fish, run together with a cement of chalk or marl. The hardness of this stone (if it merits the name) increases with the depth of the quarry. The lower blocks are used in building; but the upper stratum, for three or four feet below the soil, is generally a STONE MARL of no mean quality, but varies in different quarries…

100 grains of the MALTON STONE, taken from the middle of the quarry opposite the Lodge at New Malton, yield 44 grains of air, and 97 grains of calcareous earth, leaving 3 grains of residuum, chiefly a brown silt. 100 grains, taken from a newly opened quarry, by the side of the road leading from Malton to Castle Howard, yield only 94 grains of dissoluble matter….

100 grains of WOLD CHALK, taken from a lime quarry near DRIFFIELD, yield 44 grains of air; 3 1/2 grains of a soft mucilaginous residuum; and 96 1/2 grains of calcareous matter.

2.BURNING. In giving the detail of this question, the following subdivisions will be requisite:

1.Building the kiln
2.raising and breaking the stones
3.Coals and their proportion
4.Filling the kiln
5.Drawing the kiln.

1. *The kiln.* The materials are either limestone, entirely, or limestone, lined with bricks on the inside. Neither timber, nor mortar, is here used, in building a lime kiln; the former presently decays, and the latter, by alternately swelling and shrinking, bursts the walls; besides rendering them, in the first instance, too tight to admit a proper quantity of air: no other air holes, than the ‘eyes’ at which they are kindled, being made in the kilns of this district.

The *form* of the cavity is an irregular cone inverted. At the bottom are generally two eyes, opposite each other; the cavity being here contracted to a thin point, or narrow trough, the width of the eyes. As the walls are carried up, the cavity takes, by degrees, a circular, or sometimes an oval line; at the same time receiving, as it

rises, a conical form; until, having reached somewhat more than half its intended height, the form is changed to *cylindrical,* or is sometimes *contracted* towards the top.

The size varies from 6 to 40 chaldrons

2. *The stones*. The art of *raising* stones can only be learned by experience, in the given quarry in which they are to be raised. They are sometimes raised by the day; sometimes by the load; but, most generally, the entire labour of burning is taken, together, at so much a chaldron of lime.

The *breaking,* of hard strong stones, is a laborious part of the operation of lime burning. On the north side of the Vale, it is done, by men, with large sledge hammers; but, on the Malton side, where the stone is soft, women are frequently employed in the breaking.

The medium *size* is that of the two hands; but men, burning by the chaldron, will not, unless well attended to, break them so small: stones, nearly as big as the head, are sometimes, but very improperly, thrown into the kiln; for unless the proportion of coals be unnecessarily large, the surface, only, is burnt to lime, the core remaining a lump of unburnt stone.

3. *Coals*. The Morelands, for the last fifty years, have furnished the north side of the Vale with coals, for burning lime, and for an inferior species of fuel. The seam of this coal is thin, and the quality, in general, very ordinary.

Before the discovery of these coals, lime was burnt with furze, and other brushwood; but notwithstanding the Morelands are, now, nearly exhausted of coals (unless some fresh discovery should be made), the District is relieved from the apprehension of returning, again, to its ancient mode of burning lime. The Derwent, beside an ample supply of coals for fuel, brings an inferior kind (both of them raised in West Yorkshire) for the purpose of lime burning. The eastern end of the Vale is equally fortunate, in this respect, having the port of Scarborough in its neighbourhood.

The *proportion* of coals and stones varies with the quality of the coals, and likewise, but in less degree, with the quality of the stone: the method of burning, too, varies the proportion. **Three chaldrons of lime from one of coals (the measures equal) may be considered as the mean produce.** From 2 1/2 to 3 1/2 for one, includes the whole extent of produce of well burnt lime.

4. *Filling*. **some kindling being used at the eyes, and an extraordinary proportion of coals at the bottom of the kiln, it is filled up with stones and coals, in thin alternate layers; those of the stones being 5 or 6 inches thick; with coals in proportion; the coals, if not sufficiently small, being previously reduced to a gravel-like state; in order to run down, more freely, between the interstices of the stones and thereby to mix, more evenly, with them.**

The materials are cast into the kiln, with large scuttles, or shallow baskets; which are filled with stones, by means of an iron-toothed rake, composed of four teeth, about 6 inches long, of a head about a foot long, and of a handle about four feet long.

If several men be employed, in filling a kiln, it is common for each man to fill and empty his own scuttle. But this is an uncertain, and therefore improper, way of proceeding. Much depends on the regularity and evenness of the layer; and the due proportion of coals; and to judge of this, with sufficient accuracy, requires some experience, and a steady eye; especially when the kiln is on fire, and the cavity to be filled up is obscured by smoke. If more than one person be employed, in this case, it is highly probable the work will be imperfectly done.

Among the sale kilns, about Malton, there is an excellent regulation, in this respect. The scuttles are all filled, and brought to the top of the kiln, by WOMEN and BOYS, who deliver them to the MASTER, or his foreman, standing there to receive them, *with his eye fixed within the kiln;* by which means he is enabled to distribute the stones and the coals, with the greatest accuracy.

5. *Drawing.* There are two species of kiln; or rather, one species used in two different ways.
A kiln which is filled, fired and suffered to burn out, before any of its contents be drawn, is called a 'STANDING KILN'.
If the contents be drawn out, at the bottom, while the upper part is yet on fire, - the vacancy at the top being repeatedly filled up with stone and coal, as the lime is extracted at the bottom, - the kiln is termed a 'DRAW KILN'.

Since coals have been used in the burning of lime, draw kilns have, until of late years, been most prevalent. But, at present, standing kilns are most in use.

The reasons given, for this change of practice, are these: first, that the lime is burnt, *evener,* in standing than in draw kilns; in the drawing of which, the stones are liable to hang round the sides of the kiln; those in the middle running down, in the form of a tunnel; thereby mixing the raw with the half-burnt stones. The consequence is, the outside stones are burnt too much, the inside ones too little; the stones, too frequently, running down to the eye, in a half-burnt state. Secondly, the unevenness of surface, left by this method, together with the obfuscation caused by the smoke, render the filling difficult; under-burnt stones, or an unnecessary waste of coals, is the inevitable consequence. A third argument in favour of standing kilns is, that a *greater proportion* of well burnt lime may be produced, from the same quantity of coals. It is allowed that more kindling fuel is requisite; and, at the bottom, a greater proportion of coals, but the fire, by this means, getting a strong head, a less proportion of coals is required, in the body of the kiln; and what, perhaps, is of still more consequence, less heat is lost at the top of this, than of the draw kiln; which is always uncovered, and too frequently hollow and full of cracks, while the top of the standing kiln, being piled up in a conical form, and closely covered with sods or rubbish, collects a greater body of fire, and keeps in the heat more effectually.

One circumstance, however, relative to the standing kilns, requires to be mentioned. The inside should be *lined with brick.* For every time a kiln, which is lined with limestone, is suffered to go out, a shell of lime peels off the inside; by which means the walls are soon impaired.

The lime is drawn out of the eyes with a shovel, and generally carried out in scuttles or in basket measures, to the cart or waggon.

Of a living kiln, the drawing is generally continued, until red ashes begin to make their appearance. But standing kilns are suffered to burn undisturbed, until the fire is rising towards the top, and a fresh supply of air is wanted, a few shovelfuls are drawn at either eye, by which means a degree of hollowness is formed and fresh vigour given to the fire.

From these circumstances, it is plain, that a regular supply of lime cannot be had from less than three standing kilns: one filling; one burning; one drawing. The smaller burners, however, have frequently only two; and for a farmer, one, proportioned to his farm, is sufficient.

Rural Economy of the West of England: Including Devonshire; and Parts of Somersetshire, Dorsetshire, and Cornwell. Together with Minutes in Practice 1791

P56
Descend towards Bideford. - Meet strings of Lime Horses, with pack-saddles and bags of Lime. Also two-horse Carts, with Lime and sea sand,

P58 Bideford and its environs

The tide out: many men employed in leading packhorses, with sand, left in the bed of the river: and, in every vacant corner about the Town, composts of earth, mud, ashes, &c. are seen. Shell sand is said to be plentiful on the coast; but little, if any of it, is brought up this river. On the shore of the estuary, opposite to the Town, are several limekilns, now in full work. Numbers of packhorses, and a few carts, loading, or waiting for loads. The stone, chiefly, and the culm with which it is burnt, wholly, brought across the channel, from the coast of Wales. The kilns similar to those of West Devonshire. This lime is carried fourteen or fifteen miles- chiefly on horseback.

P230
West Dorsetshire

IX. FOSSILS. The most useful Fossil production, that fell under my notice in this District, is LIMESTONE; which is raised, not in the neighbourhood of Bridport only, but more or less in other parts of it. Beside being burnt into Lime, it is used as a walling material, as well as for paving Slabs, Drains, Bridges, and Stiles - large Slabs of it being not infrequently set on edge for this purpose. It is also used as a road material. It appears as a mass of conglutinated shells resembling much, in general appearance, the Sussex marble: …this is found on the summits of hills. On some of the Northern Heights, detached masses of CHALK are found; fragments, probably, of the neighbouring hills; White Down, between Chard and Crewkerne, appears to be chiefly composed of Chalk; and is the most Western collection of that Fossil, which I have observed; or Which; probably, is found, in this Island.

P295

November 1. The ROUGHCAST work of this District is executed in a superior manner, being not only durable, but pleasing to the eye. Some lately done at Ivybridge is equal, in beauty, to dressed stonework. Mr. Stapleton's house, in this

neighbourhood, done in a similar way, has now stood upwards of half a century; and, excepting at the immediate foundation, and beneath some of the windows, where water has been suffered to lodge, the whole remains as firm as when first done; appearing to have acquired a stone-like texture. In both these cases Chrystaline gravel has been used; (p296) and both of them are false-jointed, to resemble dressed stonework. An intelligent workman, whom I accidentally conversed with on this subject, suggested an admirable theory of the operation of 'roughcasting'; making an accurate distinction between this and Stucco work.

Stucco being laid on, *in a state of paste*, more or less air is unavoidably shut up, let it be ever so well worked and the very expansion and contraction of this air, by heat and frost, is sufficient to break the texture of the Stucco. Beside, let the working be done ever so carefully, cracks, though not evident to the eye, will be formed in drying; and if, by means of these microscopic fissures (or of those formed by the expansion and partial escape of the confined air), water take possession of the air cells, the perishing and peeling become natural consequences.

ROUGHCAST, on the contrary, being applied *in a fluid state*, and by little and little, fills up every pore, and cranny in the face of the wall; as well as in the face of (p297) every succeeding coat; which being suffered to dry, before another coat is added, the cracks, if any take place, are filled up; and deep ones, of course, are effectually prevented: whereas, the cracks of Stucco necessarily reach through the coat. Stucco evidently partakes of the **nature of cement used, in a state of paste or mortar**;

LIQUID COATING, of cement poured into the wall, in a state of grout.

Stucco is analogous to the materials of a dam, or the bank of a canal, formed with earth, in a state of paste: ROUGHCOATING, to the puddle of Canal Makers:' to loam intimately mixed with Water, and permitted to subside in a liquid state: thus preventing air cells; and forming a close, homogeneous mass. i

Marshall W (1787) The Rural Economy of Norfolk: Comprising the Management of Landed Estates, and the Present Practice of Husbandry in that County.
T. Cadell

1781 p65

NOVEMBER 17. A very secure way of laying pan-tile is sometimes practised in this country. Having nailed on the pantile laths, the tiler distributes reeds, so as just to touch each other, between the pantile laths; and, to keep them in their place, inserts one end of a piece of old plastering lath or other splinter, under the tyling lath; presses it down upon the reed; and inserts the other end under the next lath; - weaving, as it were, these splinters between the pan-tile laths and the reed. Upon the reed he spreads a coat of mortar, and on this lays the tiles.

For dairy or other lean-tos, and for common garrets, the reed is covered on the inside with a coat (p66) of plastering; which, with the spars, &c. being white-washed, gives a neat appearance at a very trifling expence; and keeps the room as free from dust as if it were lathed and ceiled. This is not a common practice; but it is a very good one and is much cheaper than the ordinary practice of "interlathing" with plastering laths.

P84

JANUARY 10. It is economical to lay tile on mortar, or ceil the room they cover; they are otherwise subject to every gust of wind; not from its action upon the outside, but from finding, when pent up on the inside, an easy passage through the covering. An instance occurred the other day: a farm house had two or three yards square of tiling blown off by the late winds; not on the windward, but on the leeward side of the house; and from over the only room about it which is not ceiled.

P266

JUNE 8. It is very dangerous to run up sea-stone wall too quick. Mr. --- had one shot down the other day at Antingham, and nearly killed one of the workmen. The weather was wet, and the bricklayer run up the wall, at once, without stopping, at intervals, to let it settle. The stones, being already saturated with wet, could not absorb the moisture of the mortar - the air being also moist, the mortar, of course, remained pappy; and sea stones, being globular, have no other bond or stay than the mortar; which being unable to hold them together, the super-incumbent weight crushed down the whole. (267) Had the bricklayer proceeded by stages, letting the lower parts get sufficiently firm before the upper parts had been laid on, the mortar would have had time to stiffen, and the wall would have stood. If the stones and air be dry, one halt, when the wall is a few feet above the foundation, is generally found sufficient,

1782

Hog-cisterns in this country, are principally built with bricks and terrace *[trass]*. But this is expensive: yet a hog-cistern is among the first conveniences of a farm-house. Wooden vessels are incommodious, and leaden ones dangerous,

P349
This summer a receptacle for water in a brick-yard being wanted, I had one built of bricks, laid in clay, and surrounded with a coat of the same material: it holds water perfectly. Afterwards, I built a hog-cistern in the same manner.

This morning, on enquiry, I find that not only the tenant, but his wiſe and her maids, are fully satisfied with it. It was built in this manner:- A pit five feet and a half long, by four feet wide, and five feet deep, was sunk in the place most convenient to the dairy, kitchen, and hog-yard jointly. (350) The bottom of the pit was bedded with some extraordinarily fine Clay, fetched from the sea coast for this purpose; moistened and rammed down; and its surface smoothed over with a trowel. On this flooring were laid three courses of bricks, in clay mortar (**the best of the clay being taken for this purpose**), and in such a manner, that the joints of one course fell in the middle of the bricks of the course below; the whole being laid longways; not crossed, in the usual manner. The sides were carried up half a brick thick (that is a brick in width) with mortar of fine Clay: and, in a vacancy left between the brick-work and the sides of the pit, moist Clay was firmly (351) rammed; so as to unite as much as possible the bricks, the clay and the sides of the pit into one solid mass; carrying the brick and clay work up together; and beating

back such bricks, in to the clay, as were forced forward by ramming. The cistern when brought up level with the surface of the ground measured three feet long, two and a half feet wide, and three and a half feet deep; consequently the surrounding seam of clay is not more than four inches thick; and the stratum at the bottom is about the same thickness.

352 Above-ground, a nine-inch wall was raised on each side, two feet high, with a gable carried up at one end; and, on these, a span of pitched roof was set, and covered with tyles; the other end being left entirely open as a door way.

Marshall W (1789) The Rural Economy of Gloucestershire; Including Its Dairy: Together with the Dairy Management of North Wiltshire; and the Management of Orchards and Fruit Liquor, in Herefordshire, Volume 1. Gloucester. R. Raikes

P30

FARM BUILDINGS. IMPROVEMENTS in rural architecture are not to be expected in the district under survey. Nevertheless, the leading facts respecting its FARM BUILDINGS require to be registered; and some peculiarities, as well as some few modern improvements, are entitled to notice.

MATERIALS. Timber appears to have been, formerly, the prevailing building material of the district. Farm buildings, in general, even to this day, are of frame-work; filled up with strong laths, interwoven in a peculiar manner, and covered with plastering; or the studwork is covered with weather-boardery alone; especially outbuildings.

The present WALLING material is Brick. Some few "clay-stones," dug out of the sub soil, are used; and, under the hills, " free stone"--a soft calcarious granate, which is common to the Cotswold hills, is in use.

P31 LIME is here a heavy article of building. From 6d. to 8d. a bushel, of ten gallons level, at the kiln. The stones, from which it is burnt, are brought by water carriage to the towns upon the Severn; either from Bristol, or from Westbury &c at the foot of the Forest of Dean; where the " claystone " of the subsoil is raised for this purpose. The kilns are built on the banks of the Severn; so that no land carriage of the stone is requisite. But the lime, notwithstanding the exorbitant price at the kiln is to be conveyed by land into the area of the district. The margin is supplied with the calcarious granate (which has been mentioned), from the Cotswold cliffs; and from Bredon hill, evidently a fragment of the Cotswolds.

These stones vary much in general appearance and contexture; and the limes produced from them are not less various in their qualities. The " Bristol stone " has a somewhat flint like appearance; is of a close, hard, and uniform contexture; and of a dark reddish colour; sparkling with sparry particles; and flying under the hammer like glass: no marine silt. One hundred grains of it afford forty five grains of air, and ninety seven grains of calcarious matter; leaving three grains of residuum -- a dark-coloured impalpable matter. The lime produced from this stone bursts readily in

water; and (like that produced from spars) is, when fallen, of a light floury nature: white as snow: coveted by the plasterer; but is considered by the mason and bricklayer, as being of a weak quality. The Westbury-stone - which is a sufficient specimen of the "claystones " found in the subsoil of most parts of the district is in colour, contexture, and general appearance, very different from the rock of St. Vincent. It resembles, in every respect, the marble-like limestone of the hills of Yorkshire: generally blue at the core with a grey dirty-white crust: the base being of a smooth, even texture. When it is fresh raised out of its watery bed in the area of the vale, it is a soft substance, of a somewhat soap-like appearance but hardens (or falls to pieces) on being exposed to the atmosphere. One hundred grains of this stone throw off forty grains of air and afford ninety one grains of calcarious earth; leaving a residuum of nine grains;- an ash-coloured silt. The lime burnt from it is characterized by strength; and is high in esteem for cement; being found strong enough, in itself, to be used in water work. It falls slowly and is of a somewhat brimstone colour and is distinguished by the name of " brown lime. "

Having observed the reluctance with which the lime of this specimen (fresh from the kiln) imbibes water; while that of the Bristol stone drinks it with singular avidity, I was led to try, by a comparative experiment, whether their powers of imbibing air (that is of regaining their fixed air) were in like proportion. The result is interesting.

One hundred grains of the first (in one knob) suspended in a pair of scales, got full five grains in twenty four hours. In a drawer (which was sometimes open, sometimes shut) they got, in twenty four hours more, the same additional weight. ln seven days more (wrapped in paper and lying in a drawer) they got twenty three grains: in all **thirty three**; or about three and a half grains a day: mostly air, with, in all probability, some portion of water.

One hundred grains from the Westbury stone, placed in the drawer increased in twenty four hours not quite one grain. In twenty four hours more, in the scale, they barely made up a grain and a half. In seven days more they gained (in the drawer) exactly nine grains: in all **ten and a half grains**: not a grain and a quarter a day. Hence we may conceive how widely different may be the qualities of lime. Consequently, how dangerous to draw general conclusions from an experiment, or even experiments, made with one particular species). (p34)

The specimen of calcarious granate which I have before me was taken from the middle of a "freestone" quarrey, within the camp, on **Painswick Hill. It is common to the Cotswold and the Lansdown hills and corresponds exactly with the soft limestone granate of Malton in Yorkshire.** It varies in specific quality. The Bathstone is softer and lighter than the specimen under analysis, **one hundred grains of which discharge forty four grains of air; yielding ninety eight grains of soluble matter; and two grains of residuum**, a snuff coloured impalpable matter.

The method of burning lime in this country has nothing which entitles it to notice except (p35) the practice of riddling and hand-picking the lime as it is drawn, to take out the ashes, cinders, and rubbish which may have been thrown into the kiln with the stones or coals. The labour is not great and the work is valuable. **Lime as a building material; especially for the plasterer's use cannot be too pure**. The refuse pays the labourer, and the quantity of stone lime loses nothing by its absence. (Footnote:) The LIME KILN of this district is noticeable, as being frequently

furnished with a set upon the walls of the kiln, and contracted in a funnel-like form; the materials being carried in at a door in the side. In one instance, the kiln is built within a cone; in the manner of the brick kilns about London. The principal, if not the sole use of these tops, is to carry up the smoke and prevent its becoming a nuisance to the neighbourhood of the kilns.

TIMBER. The old buildings of this district are full of fine oak; in which the lower lands of Gloucestershire have heretofore, in all probability, been singularly abundant. But at present the vale is entirely stripped, and even the Forest of Dean (some few parts of it excepted) is almost naked of good oak timber. The vale, however, abounds at this time with elm of uncommon size and quality. This and foreign timber are the ordinary materials in (p36) use for farm buildings: oak being used only where durability is more particularly requisite.

COVERING MATERIALS. An ordinary kind of slate, got out of the sides of the hills, has formerly been the prevailing covering of the district. At present knobbed plain tile are principally in use. The knob is an obvious improvement of the hole and pin which are still used about the metropolis.

Thatch is still in use for cottages and farm buildings. A species of thatch new to the rest of the kingdom is here not infrequently made use of; especially near the towns, where wheat straw is permitted to be sold. In these situations, not only ricks; but roofs, are thatched with STUBBLE: a material which is found to last much longer than straw; unless this be "helmed"; that is, have the heads cut off before thrashing, in the Somersetshire manner: a practice which is not common in this country. That stubble should be found to endure is reasonably imagined. It has the advantage of helm (in not being bruised by the flail) and consists of the stoutest part of the stems. In many districts it would be difficult to be used on account of its shortness; but in (p37) this country, where it is cut eighteen inches or perhaps two feet high, and (in the situations where it is more frequently used) has generally a sufficient quantity of long wirey grass among it to hold it together; there is no great difficulty in thatching with it: except in the raking, which requires a tender hand. It is first driven up a little with the teeth of the rake; beaten, and then raked gently downward.

FLOORING MATERIALS. Upper floors have heretofore been laid with oak, which is still common in the floors and stair-cases of all old houses. Elm has, perhaps, been more recently used, and is still in use, for the same purposes. Ground floors are not infrequently of common brick (a vile material for floors) or of 'forest stone --an excellent freestone grit, raised in the forest of Dean.

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P16
III. FARM BUILDINGS.

MATERIALS. The WALLING MATERIALS are in variably stone. TIMBER, chiefly oak. Covering, slate; Flooring, stone, oak, deal. Rough stones, for ordinary building, are usually raised, by the perch of wall. The price 5d. to 8d. a perch, of 16 ½ square feet, (that is **a perch long and one foot deep**) for a-wall 24 inches thick *[8d the 2012 equivalent in economic power to 266 pounds].* This is an unusual, but an accurate mode of raising them. The variation of price is caused by the nature of the

quarry. The price of oak timber, in the stick, is 1s. to 15d. a foot. Plenty to be had at this price. A striking evidence, that a small quantity of woodland is sufficient to supply the inland demand for timber. The carriage, however, is to be added to the above price.

P17 Farm kitchens and lower rooms, in general, are laid with dressed stone. The price, upon the ground complete, 4~8d. a foot.

The slates (of a stone colour) are raised in different parts of these hills. The price upon the roof — **plastering beneath included** — about 26s. a square (of 100 square feet).

CEMENT. Lime is excessively dear; and **sand not to be had**, I believe, at any price; nevertheless, an excellent mortar is here prepared, at a moderate expense. **Invention is seldom more successful, than when necessity prompts it.**

The scrapings of the public roads; namely, levitated lime stone, impregnated more or less with the dung and urine of the animals travelling upon them, are found to be an **excellent basis for cement**. For ordinary walls, the scrapings alone are frequently used. And, from what I can learn, the proportion, for the best building, is **not more than one part lime to three of scrapings.** Nevertheless, I found mortar, which had not lain in the walls more than ten years, of a stone-like tenacity: much firmer than the ordinary stone of this country: probably much harder, than either of the stones, from which the basis of the lime was made. Similar scrapings might be collected, in any district where limestone is used as a material of roads.

The method of PREPARING this CEMENT is, simply, that of **collecting the road-scrapings, slaking the lime, mixing them intimately together, and, as the mass is worked over, carefully picking out the stones** or other foulness, which may have been collected. **This, for stonework, is found sufficient: for brickwork, however, it might be necessary, that the materials should pass through a skreen or sieve; previously to their being made up**. The price of lime, here, is 8d. a bushel of eight gallons, level. The price of coals about 30s. a ton. The kilns small, with funnel tops; to carry off the smoke, and, by breaking off the wind, to give a more regular draught.

P19 BARN floors are of a good size: 12 to 14, by 18 to 20 feet. The best of oak: some of stone: but a species of earthen floor, which is made here, is thought to be superior to floors of stone, or any other material, except (p20) sound oak plank. The superior excellency of these floors is owing, in part, to the materials of which they are made; and, in part, to the method of making.

The materials are the calcareous earth of the subsoil, a kind of ordinary gravel, which is found in different parts of these hills, and the chippings of freestone (calcareous granite) from the freestone quarries, in equal quantities. The method of making is founded on a principle which is peculiar, perhaps, to these hills. Earthen barn-floors are made, in other places, with **wet materials**;—a kind of mortar which, as it dries, is liable to crack; and requires some months, after it is made, to dry it hard enough for use.

On the contrary, the materials, in the practice under notice, **are worked dry: they of course do not crack; and are ready for use as soon as they are finished.**

The materials, mixed together, are sifted twice over. The first time, through a wide sieve, to catch the stones and larger gravel, which are thrown to the bottom of the floor. The next, through a finer sieve, to separate the more earthy parts from the finer gravel, which is spread upon the stones, (p21) and, upon this, the more earthy parts; making the whole about a foot thick; and trimming down the different layers, closely, and firmly, upon each other. The surface being levelled , it is beaten with a flat wooden beetle, made as the gardeners turf beater ; until the surface becomes hard as stone, and rings at every stroke, as metal. If properly made, they are said to last a length of years; being equally proof against the flail and the broom.

Marshall (1790) The Rural Economy of the Midland Counties: Including the Management of Livestock in Leicestershire and Its Environs: Together with Minutes on Agriculture and Planting in the District of the Midland Station

P26
THE FARM BUILDINGS of this district are many of them large, substantial, and commodious; and have several particulars belonging to them, that require attention. The MATERIALS of the district are these:

The walling material almost wholly brick. The timber mostly oak, (with) which the builders are still lavish. The covering material, formerly thatch; now, principally, in this district, knobbed plain tiles; but, in Leicestershire, mostly blue slate (Blue slates. These are raised near Swythland–provincially "Swidland"– on the southern skirts of the Charnwood hills; where an immense excavation has, within the last fifty years, been made. Superficial quarries have been worked, time immemorial; but their produce was of a coarse quality, compared with those which are now raised; some of which are nearly equal to the Westmoreland slate. They are raised in blocks, blasted from an almost seamless rock. The blocks are first cleft into slabs; and the slabs afterward into slates; or, if too strong and coarse for this purpose, are thrown aside, as coarse flags, for various uses. Out of the larger blocks, chimney pieces and tombstones are cut. The same kind of blue rock is found in different parts of the Forest hills; but none, yet, which affords slates equal in quality to the " Swidland slates.").

Ground flooring, mostly paving bricks. Chamber flooring, oak, elm, or plaster: the two last are now most common in farm houses: in this, an inland country, deal has not hitherto been much in use; but even here, it is now becoming the fashionable material.

The CEMENT of this district is entitled to particular notice. In common stucco, plaster floors and water-tight walls the Midland counties excel; but in the last most especially. Water cisterns are frequently formed by a nine inch brick wall, standing naked above ground; yet as tight as a stone trough!

Something depends on management, in forming these walls: but much more on the nature of the LIME with which they are built. There is only one sort with which they can be rendered tight with certainty. **This is the BARROW LIME, which not only**

sets with extraordinary hardness, but remains invulnerable to the elements; setting water, drought, and frost at defiance *

(* BARROW L1ME. Barrow, situated on the banks of the Soar, nearly opposite to Mountsoarhill, in Leicestershire, has long been celebrated for its lime, It is an interesting fact, that the stone, from which the Barrow lime is burnt, is, in colour, texture, and quality of component parts, the same as the Claystone of Gloucestershire, from which the strong lime of that district is burnt; and what is still more remarkable, it is found in similar situations and deposited in thin strata divided by thicker seams of calcarious clay, in the very same manner, in which the claystone of Gloucestershire is found. See Glo. Econ. vol. 1 p.13, 15 and 32.

One hundred grains of the stone contain eighty-six grains of calcarious matter; affording fourteen grains of an impalpable tenacious silt, which seems to be possessed of some singular properties; forming a subject well entitled to future enquiry.

One hundred grains of the clay contain forty-six grains of calcarious matter, leaving fifty-four grains of residuum, **a fine clay**. Hence this earth, which at present lies an encumbrance in the quarries, is richer in calcariosity than the CLAY MARL of the Fleg hundreds of Norfolk, with which very valuable improvements are made. See Norf. Econ. vol. I p. 22. Since writing this article, I have observed, in the Vale of Belvoir, at the northernmost point of Leicestershire, a similar stone, situated in a similar manner, and producing a similar kind of lime).

The only preparation, of this extraordinary cement, is that of washing the sand, and assimilating it intimately with the lime, by beating; and the only judgement requisite in using it, is **to hurry it into the wall as quickly as possible from the kiln.**

P31 BARN FLOORS. In this district, a peculiar method of laying wooden barn floors is in practice. Instead of the planks being nailed down to sleepers, in the ordinary way, the floor is first laid with bricks, and the planks spread over these, with no other confinement than that of being “dowled” together (that is plowed and tongued) and their ends let into sills or walls, placed in the usual way, on each side the floor. By this method of putting down the planks; provided the brickwork be left truly level, vermin cannot have a hiding place beneath them; and a communication of damp air being effectually prevented, floors thus laid are found to wear better, than those laid upon sleepers. It is observable that the planks, for this method of laying, ought to be thoroughly seasoned.

Marshall W (1794) General View of the Agriculture of the Central Highlands of Scotland: With Observations on the Means of Their Improvement. T. Wright

In burning lime, in the Highlands, the chief fuel in use is peat; a weak ineffectual firing. **It is usual to slake the lime as it is drawn out of the kiln, shake it in a sieve, and return the numerous unreduced cores, to pass through the fire a second time**. (**This practice, when the lime is intended for the use of building, appears to be very wrong; especially when it is suffered to lie in that powdered state several months before it be used).**

Blocks of wood, and especially the large roots of trees, are frequently thrown in with the peats, to strengthen the fire, placing the fuel and the stones layer over layer, as in the use of coals; making the strata of fuel thick, proportionably to its strength. The Highland kiln, too, tends to the inefficacy of the fuel: it is too shallow and spreads too wide at the top; suffering the fire to escape before it has fulfilled its intention. It is sometimes built of sods, set upon the surface of the ground from whence, perhaps, the sods were taken, and. this perhaps the best soiled part of the farm: having, however, performed their office as walls of the kiln, they are themselves carried to the field as manure. From these temporary sod kilns, perhaps, were copied the shallowness and width of the present stone kilns of the district.

Marshall W (1804) On the Landed Property of England: An Elementary and Practical Treatise : Containing the Purchase, the Improvement, and the Management of Landed Estates. London.

P270) **Walls. With respect to their firmness, strength, and duration, much depends on the cement with which they are carried up. In erecting rough stone walls, liquid mortar is most eligible to be used, in the middles, and inner parts, of the walls. If the stones are small, or want length to bind the work firmly together, it should be the common practice of workmen to cover their work, every evening, with an entire sheet of flowing cement; to assist in preventing the wall from bursting, or parting in the middle, the ordinary failure of walls which are built of such materials.**

P271 Every large estate requires… An experienced master workman, as a mason or a carpenter, who is employed upon the estate, is a proper man for this office. His duty is to examine, annually, or from time to time under the direction of, or jointly with, the manager, the state and condition of every building upon the estate: to see that the roofs and timbers are sound, the walls firm and upright, and the foundations able to support them. The only operation of repairs that requires particular notice here, is that of setting up walls, which, for want of the requisite ties, above noticed, have lost their balance, or upright position.

The usual palliatives, in this case, are buttresses, built on the outside of the leaning wall: or this is shored up, and underpinned; or the two side-walls are tied together, with cross beams and anchors. But still the wall remains in a leaning posture. The only remedy of the evil (without rebuilding the wall) is to force up the entire wall, in a body, into its original position. This is to be done, by erecting planks, or strong slabs, a few feet apart, against the wall (the number required being in proportion to its strength and extent); placing the heads of shores, or leaning poles, in notches, against these, and their feet upon inclined planes; upon which the feet of the shores are forced forward, with a lever, working in a notch or open mortice, in the middle of each foot; continuing thus to act upon the shores, one by one, and by little and little, until every part of the wall be found, by the plummet, to have regained its upright posture; and, while it is held in that position, effectually to secure the foundation, so as to keep it in that state: letting the shores remain, until the cement be sufficiently set. This valuable operation, the little known among country workmen, is familiar to the higher order of builders; and may readily be learnt by any ingenious artisan.