Lime - Marshall.

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.