

VII-6a. Trowel-ready mortar: A Contribution Towards Greater Efficiency in Masonry Work

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ABSTRACT

With the introduction of mechanization in the building trade in the beginning of the 60's a speedy end was predicted for masonry construction.

Premanufactured masonry mortar would be a desirable goal of improvement, a goal that which was strived for by the masonry sector of the building trade.

Through the development of premixed mortar the same breakthrough was achieved for masonry as the development of transportable cement achieved for the cement industry.

Through the efforts of a German inventor of construction material premixed mortar of ≥ 2 Mio. m³ was produced for masonry.

Premixed mortar is masonry mortar, which is delivered ready-to-use to the construction site and which remains ready-to-use for 36 hours, while the settling time (time in which the mortar becomes hard) in the joint is equal to that of usual mortar.

The mortar is produced and delivered in the usual transport cement trucks.

At the construction site the mortar is transferred to tight vessels, which accomplish the functions of measurement vessel, storage vessel, transportation vessel and working vessel.

Through introduction of premixed mortar cost of machines, implementation, energy and wages are decreased.

It is concluded that the economic feasibility of masonry construction is increased 10-30% with the use of premixed mortar.

Durch die Mechanisierungswelle im Bauwesen zu Beginn der 60er Jahre wurde dem Mauerwerksbau ein baldiges Ende vorausgesagt.

Die Vorfertigung des Mauermörtels wäre eine wünschenswerte Ergänzung der Verbesserungen, die auf dem Mauersteinsektor bisher erzielt wurde.

Durch die Entwicklung des "Kellenfertigen Werkmörtels" ist der entscheidende Durchbruch für den Massenbaustoff Mauermörtel in gleicher Weise gelungen, wie für den Massenbaustoff Mauermörtel in gleicher Weise gelungen, wie für den Massenbaustoff Beton durch die Entwicklung des Transportbetons.

Von einem großen deutschen Baustoffhersteller ist Kellenfertiger Werkmörtel für ≥ 2 Mio. m³ Mauerwerk hergestellt.

Kellenfertiger Werkmörtel ist Mauermörtel, der verarbeitungsfähig zur Baustelle geliefert wird und im Arbeitsgefäß 36 Stunden verarbeitungsfähig bleibt, während der Erhärtungsverlauf in der Fuge nahezu wie bei üblichem Mörtel ist.

Der Mörtel wird in Werken hergestellt und in üblichen Transportbeton-mischfahrzeugen geliefert.

An der Baustelle wird er übergeben in dichte Gefäße, die zugleich die Funktion als Abmeß-, Vorrats-, Transport- und Arbeitsgefäß erfüllen.

Durch Einsatz des Kellenfertigen Werkmörtels entfallen Maschinen-, Geräte-, Energie- und Lohnkosten.

Die Summe der Rationalisierungseffekte ergibt, daß die Herstellung von Mauerwerk zwischen 10% and 30% wirtschaftlicher wird.

INTRODUCTION

Mechanisation in the construction industry in the early Sixties brought many a forecast that manual bricklaying was facing a rapid end.

In actual fact, masonry work has adapted well to the changing conditions. Larger-size bricks, lighter and easier-to-use perforated bricks alongside other improvements in brick-making technology and better on-site transport methods, like palletisation, have all helped to keep masonry work competitive.

In the process, however, mortar has not always been given the attention merited by the important part it plays in achieving faultless brickwork.

It is small wonder then that most mortar is still mixed on-site with all the shortcomings inevitably connected with this method.

Up to now, the pre-mixing of mortar at central plants has been done only on a small scale for a few, special applications.

PLANT-MIXED MASONRY MORTAR

Up to now, plant-mixed mortar, supplied in the form of "ready-mixed mortar", "semi-ready mortar" or "retarded mortar", has been unable to achieve the crucial breakthrough into mass use on construction sites.

All previous plant-mixing methods have incurred wage and machinery costs on-site or have proved inadequate

because of other problems. Accurate assessment of quantities was a frequent difficulty, another was the need for constant ordering.

BREAKTHROUGH IN PLANT-MIXING THROUGH "TROWEL-READY MORTAR"

The development of trowel-ready masonry mortar," tailored exactly to the requirements of construction sites, indicates that the all-important breakthrough in the use of bulk mortar is nearing realisation. The situation is very similar to the developments that led to the emergence of ready-mixed concrete.

For example, a large German building materials company, whose production range includes ready-mixed concrete and ready-mixed mortar, has already produced trowel-ready masonry mortar for over 3.8 million cubic metres of brickwork. Licensees are achieving success with this product on the German and international market. They do not, of course, take on just the product but all the relevant process, sales and marketing techniques.

WHAT IS TROWEL-READY MORTAR?

Trowel-ready mortar is defined by the following features:

- in the technical sector:
 - by being mixed at a central plant with quality control and special mortar technology
- in the technical-organizational sector:
 - by the system of supply and delivery adapted to the requirements of construction sites
- on the site itself:
 - through the effect it has on rationalizing masonry work and boosting productivity
- for ready-mixed concrete companies:
 - by extending the product range and consolidating their market position

TECHNICAL SECTOR

Plant mixing and quality control

The technical possibilities for mixing mortar at a central plant are far better than they are when mortar is mixed on site:

- extensive storage facilities (for various types of mortar sand and, if necessary different sorts of binder) together with the use of chemical mortar additives facilitate preparation of technically optimum mixes.
- accurate batching equipment for adding the individual components guarantees the preparation of a mortar with uniform properties when both wet and hard.

The raw materials and the finished product are subjected to quality controls stipulated by current regulations and standards.

Quality control, however, is aimed particularly at optimising the product in order to satisfy the technical requirements of the user. The application is given greater emphasis in quality control than is required by regulations and standards.

In other words:

the quality control, practiced by the manufacturer in his own interest and on his own responsibility, normally makes greater demands than any existing standards on raw materials, production machinery, finished products and personnel.

Mortar technology

In the Federal Republic of Germany, trowel-ready mortar is manufactured to the requirements stipulated in DIN 1053. The mortar is delivered to the site ready-for-use and remains ready-for-use in the container for 36 hours.

No re-mixing of the mortar is required nor need any water be added. The required green stability enabling bricklaying to continue smoothly is guaranteed, as the hardening process in the joint is virtually normal.

It is obvious that for a mortar, which remains fresh in the container for 36 hours but which remains fresh in the container for 36 hours but which hardens virtually normally in the joint, suitable additives need to be used not only for influencing the setting and hardening of the binder. It is also essential to ensure the mortar has the required water retentivity in order to prevent dead slaking.

The mortar strength can be adjusted to the structurally required strength. In Germany, this lies between 2.5 to 10 N/mm² for the average strength that has to be obtained for different grades of mortar.

The strength is tested after 28 days on test cubes measuring 4 × 4 × 16 cm.

The composition of the mortar, including all additives, is assessed in a preliminary test. In this, not only the strength requirements are important but also the wet characteristics. For only a workable; easily placed mortar permits a bricklayer to construct solidly filled flush-jointed masonry.

Flush joints are essential for

- keeping out damp
- fire protection
- thermal insulation
- uniform distribution of loads

The properties of fresh mortar are just as important as those when it is dry. This requirement often gains too little attention because of the priority attached to strength by designers and structural engineers. In pursuance of this priority, it is frequently overlooked—for example—that the load-bearing capacity of brickwork largely depends on whether the fresh mortar has the degree of consistency that permits the bricklayer to build flush-jointed masonry.

The technical-organisational sector

Supply and delivery system

Trowel-ready mortar is mixed at central plants, most of which also produce ready-mixed concrete and ready-mixed masonry mortar. The mortar is delivered on site in the type of truck mixer used for ready-mixed concrete. On site, the trowel-ready mortar is off-loaded in contain-

ers that serve simultaneously as measuring, supply, transport and working containers.

Effects of trowel-ready mortar on on-site work

The use of trowel-ready mortar not only brings about changes in bricklaying work but also influences operation of machinery, including cranes and other lifting equipment. It will also improve productivity provided certain conditions are met.

Requirements from the point of view of site management

Masonry work with trowel-ready mortar can only be done efficiently on fulfilment of the following conditions:

- there must always be sufficient mortar available on site
- only a minimum of effort must be involved in ordering fresh supplies
- the mortar must be ready for instant use without any further preparation
- wherever possible, the mortar must also simplify other on-site work directly or indirectly influenced by bricklaying
- the price of trowel-ready mortar must not be so high, that it eliminates the rationalisation advantages it offers compared with mortar mixed on site or other mortar supply systems.

These requirements are met by a special distribution and supply system that provides construction sites with adequate mortar supplies, while eliminating the on-site effort involved in ordering replenishments.

With this system—

- sites are supplied with mortar in multi-purpose containers that can be used for quantity assessment, storage, transport and as working utensils
- site management is freed from the problem of ordering fresh supplies tied to delivery schedules

The importance of this point is brought home by attempts made by building materials suppliers to make do without this type of organisation. The outcome, almost without exception has been that these suppliers have had to halt manufacture of trowel-ready mortar.

The demand for uniform consistency and strength can be met relatively easily at central mixing plants if

- controlled and uniform materials like sand, binders and additives are used
- if batching and admixture of mortar components is done carefully and accurately
- if the properties of both the wet and hardened mortar are continually checked by quality controls.

Another major point for the construction site is that the mortar must be ready for immediate use after delivery, without any further preparation.

- This demand is met by use of chemical additives that keep trowel-ready mortar ready for instant use in the container for 36 hours.

Trowel-ready mortar also simplifies on-site work.

- Construction sites with lifting equipment are supplied with mortar in containers that can be transported by crane. As the containers hold $\frac{1}{3}$ m³ of mortar, they reduce the number of lifting movements. The effect on on-site transport operations is comparable with the cuts achieved in transport activities by using brick pallets.

There remains the question of price. With the aforementioned system and efficient organisation, the price can be fixed at a level that does not eliminate the rationalisation advantages obtained over mortar mixed on site. This will make construction work more economical for the user and provide the manufacturer with an adequate return.

Effects of trowel-ready mortar on on-site costs

The use of trowel-ready mortar eliminates the need for on-site mixing plant or machines for preparing mortar. This in turn eliminates machine costs like depreciation, repairs, servicing and energy.

Trowel-ready mortar also simplifies site installations by eliminating or reducing the need for power and water supplies, space for machinery and facilities for storing building materials.

The same applies for keeping the site clean and clearing up afterwards. For example, there is no dirty water from cleaning the mixer. There is no binder packaging material to be removed and less waste.

Wage costs incurred by mixing mortar on site are also eliminated. But the worker mixing the mortar does not lose his job. He is now required to supply bricks to the bricklayer and erect scaffolding in line with the more rapid progress of construction work.

Since mortar is always available on site, no time is lost when work begins and ends. The mortar is ready for immediate use in the morning and any mortar left over at night can be used the next day.

An assessment of the major effects shows that bricklaying with trowel-ready mortar is between 10% and 30% more economical than it is with conventional mortar. There is also an improvement in productivity, since bricklaying with trowel-ready mortar is demonstrably quicker.

REQUIREMENTS FOR CORRECT MANUFACTURE AND SUCCESSFUL SELLING OF TROWEL-READY MORTAR

The potential manufacturer of trowel-ready mortar must be fully aware of the need to be conversant with mortar and masonry technology, so that he is in a position to provide the customer or building contractor with the necessary advice. This means that he has to train himself and his personnel. Training systems are available.

On-site advice consists of product information and information on the distribution system as well as technical advice, business advice and advice on site organisation. To be in a position to provide this service, the manufacturer must acquire proven techniques to enable him to talk competently to the building contractor and his site management.

Alongside this strategy and marketing knowhow, the manufacturer also requires a mastery of the technology of mixing trowel-ready mortar. This involves using several, special chemical additives with very definite properties. Acquiring or buying the right additives is, however, only one step on the road towards success on the construction site, taking the manufacturer only a quarter of the way towards his ultimate objective.

Production, distribution and on-site delivery need to be organised along the lines of the aforementioned strategy, so that the manufacturer, too, realises positive business results.

In the production of trowel-ready mortar, for example, an adequate quality control system has to be introduced.

The required knowhow is also available for production, quality control, distribution and marketing.

One of the lessons from the experience gained in the Federal Republic of Germany over the last five years is that mortar manufacturers, who have relied solely for business success on using the right additives, have had to halt production. This was necessary not simply for tech-

nical reasons, but chiefly because of business failure in their own organisation and on the site. These failures, resulting from false marketing strategy, do not further this interesting product for rationalising masonry work. Euphoria is uncalled for. Only manufacturers, who are prepared to use existing and proven knowhow, will be successful in extending their market position with trowel-ready mortar and improving the profitability of their plant by combining production of ready-mixed concrete and ready-mixed mortar.

Manufacturers can do this through their own efforts or, more easily and at a lower cost, through buying the knowhow or a licence along the lines practised in the rest of industry.

In the Federal Republic of Germany, there are already several groups of mortar manufacturers who welcome and support the development of trowel-ready mortar. For the outstanding rationalisation effect and the high technical quality of this mortar ultimately benefit all those involved in masonry work.

	1	2	3	4
	object of tests	tests	requirements	frequency
1	materials	delivery note and mark on packing material	marking (type, system class and confirmatory checking of quality control)	each delivery
2	binders	delivery note	marking/quality control	each delivery
3	aggregates for mortar	inspection by eye: type of aggregates compromising particle size and harmful components (clay, chalk, lime, coal)	observance of standards (conformity with ordered particle size fraction, particle shape, no pollution)	each delivery
4		compromising particle size by sieving test	observance of compromising particle size	at first delivery, in case of changing supplier
5		settleable solids	observance of ordered quantity	
6		organic substances	colouring: as bright as possible	

Figure 4. Range of tests own quality control trowel ready mortar



Figure 1. Mixing on-site mortar

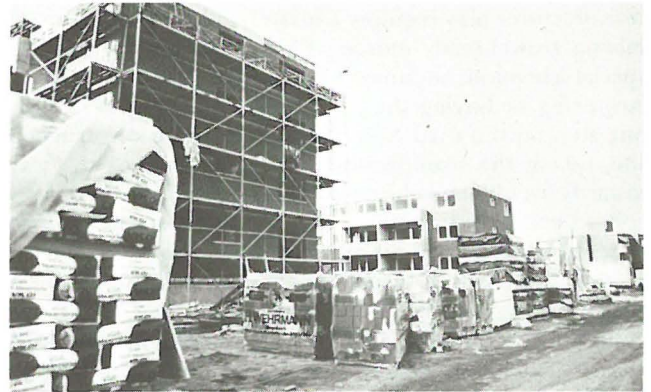


Figure 2. Use of dry mortar sac

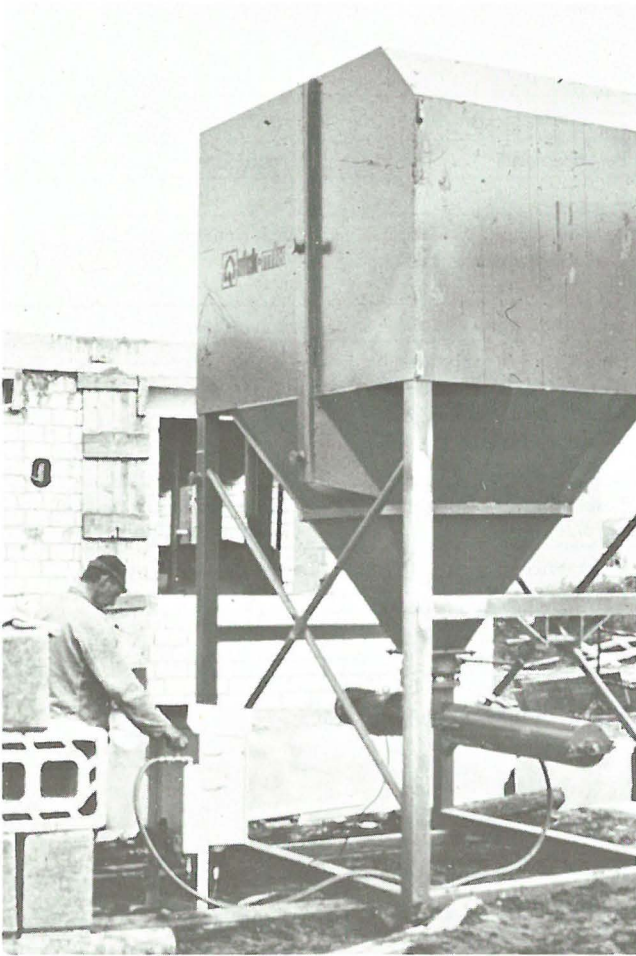


Figure 2a. Use of dry mortar silo



Figure 3. Use of semi-mixed-mortar

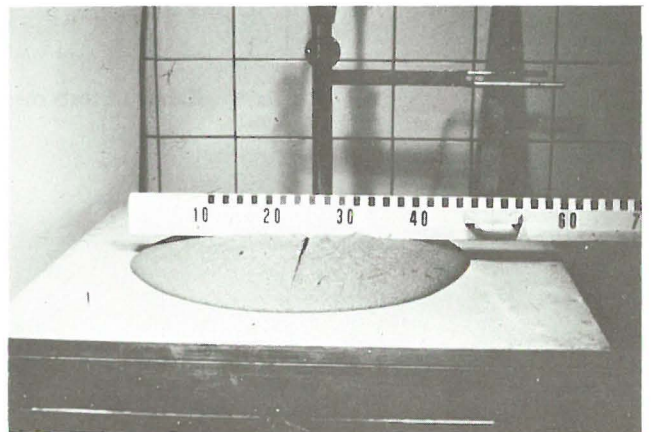


Figure 5a. Illustration: Consistency measurement on flow table

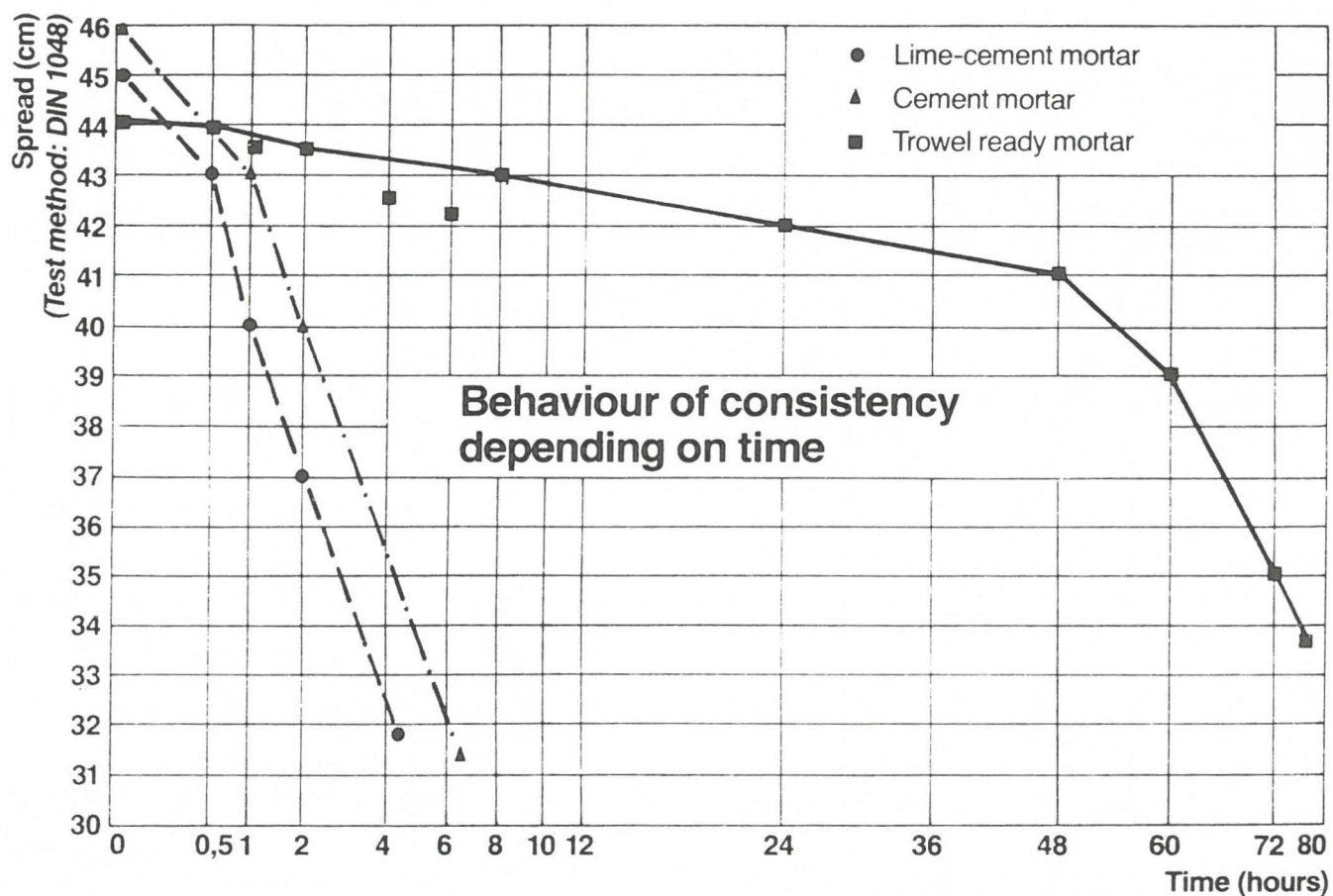


Figure 5. Diagram: Consistency in relation to time—
(cement-lime mortar, cement mortar, trowel-ready mortar, sibo system) Flow table testing method as in DIN 1048

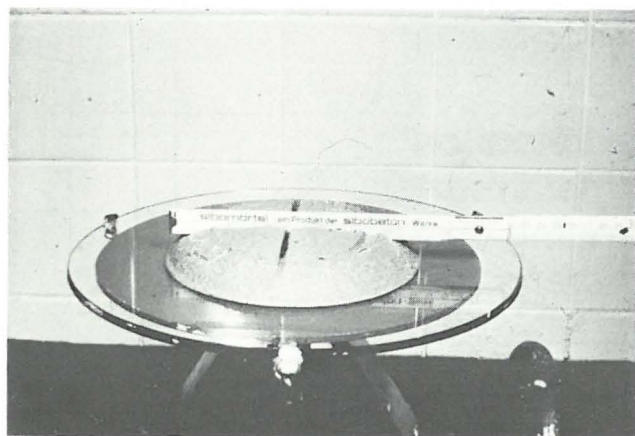


Figure 6a. Illustration: Consistency measurement on Hegemann table

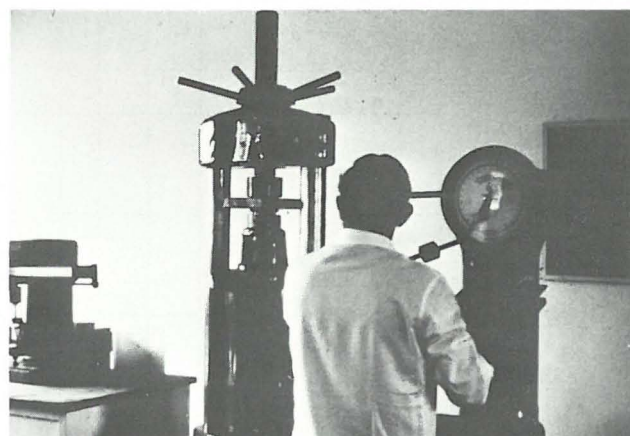
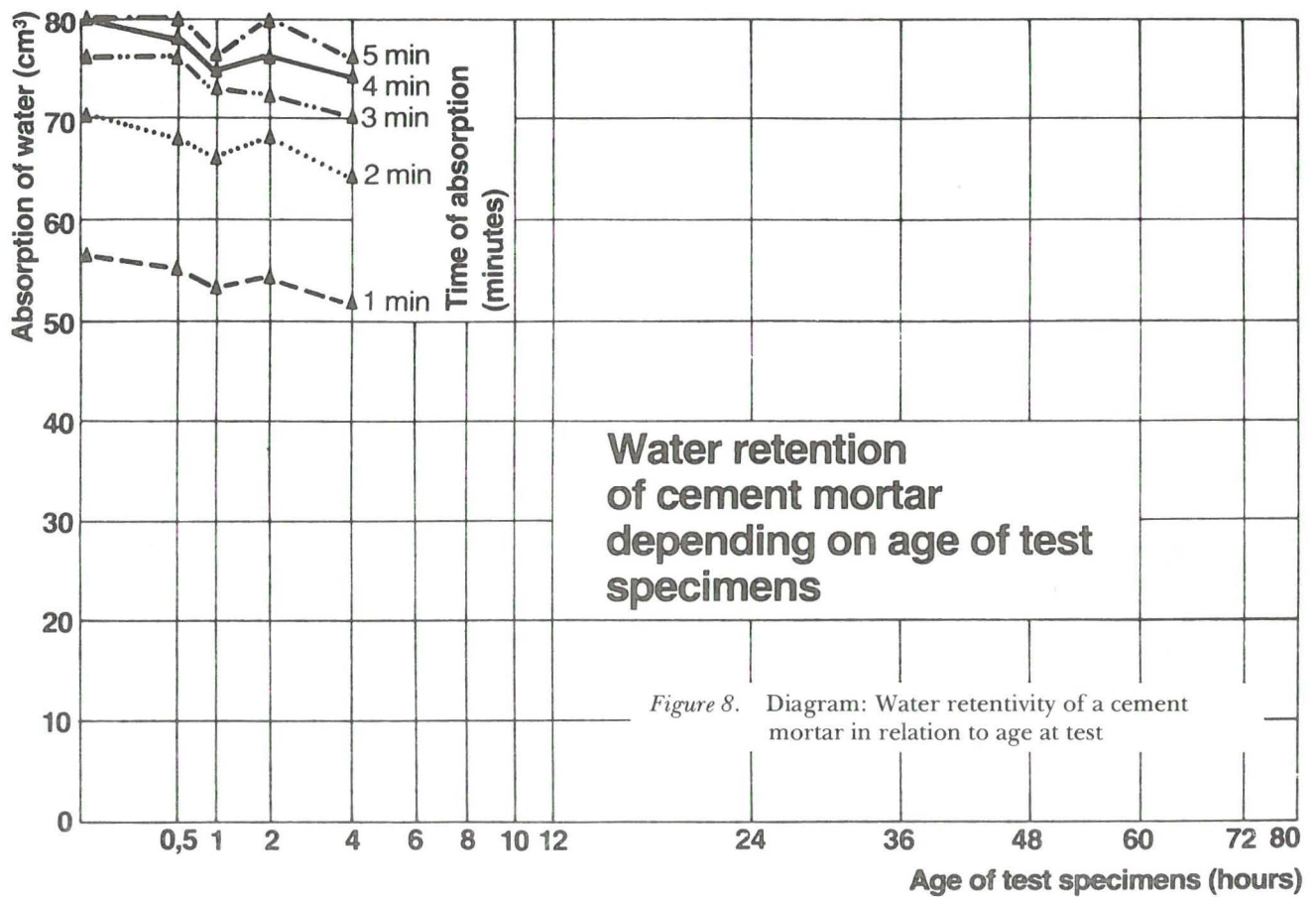
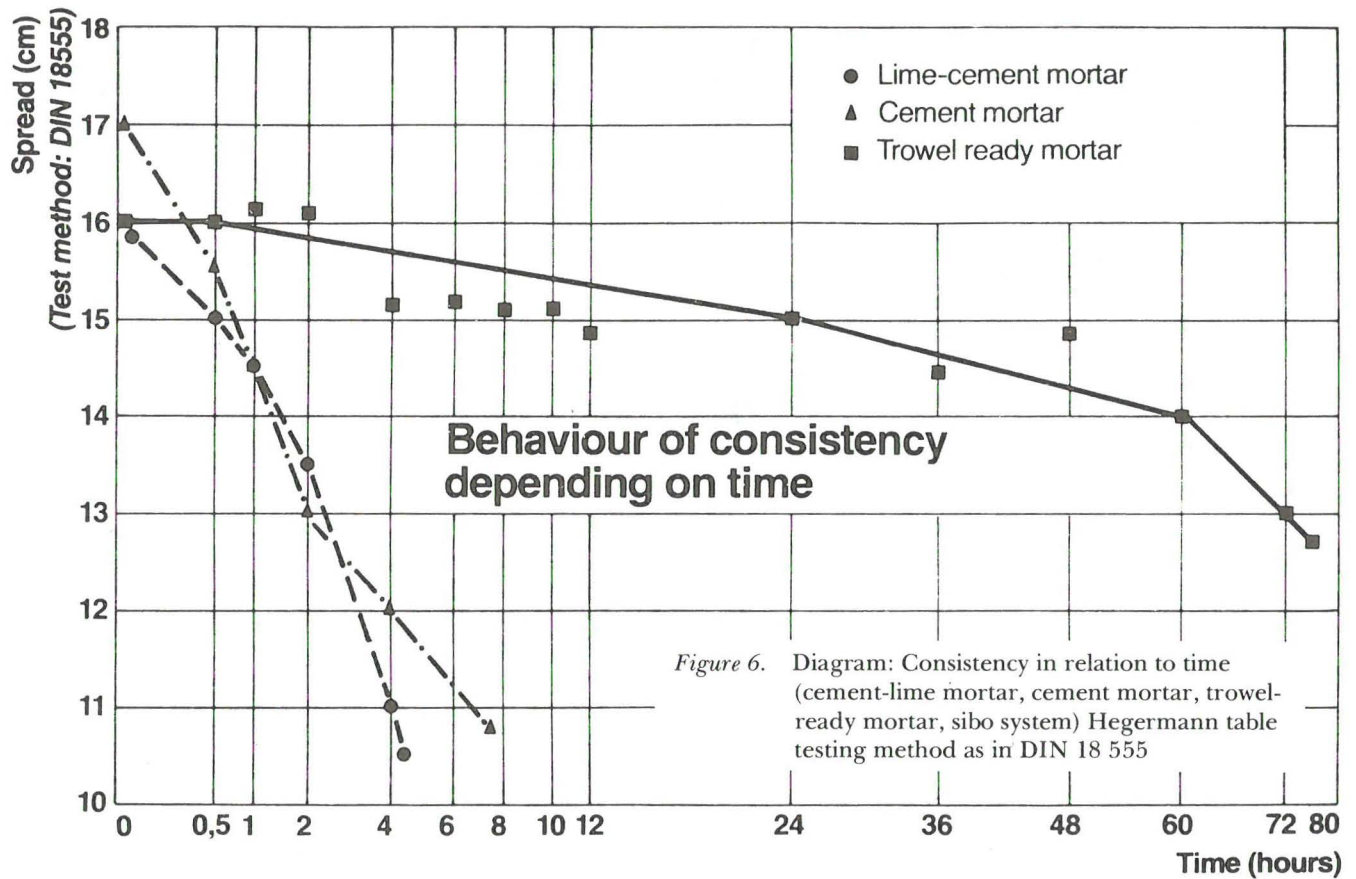


Figure 10a. Illustration: Strength test as in DIN 1053



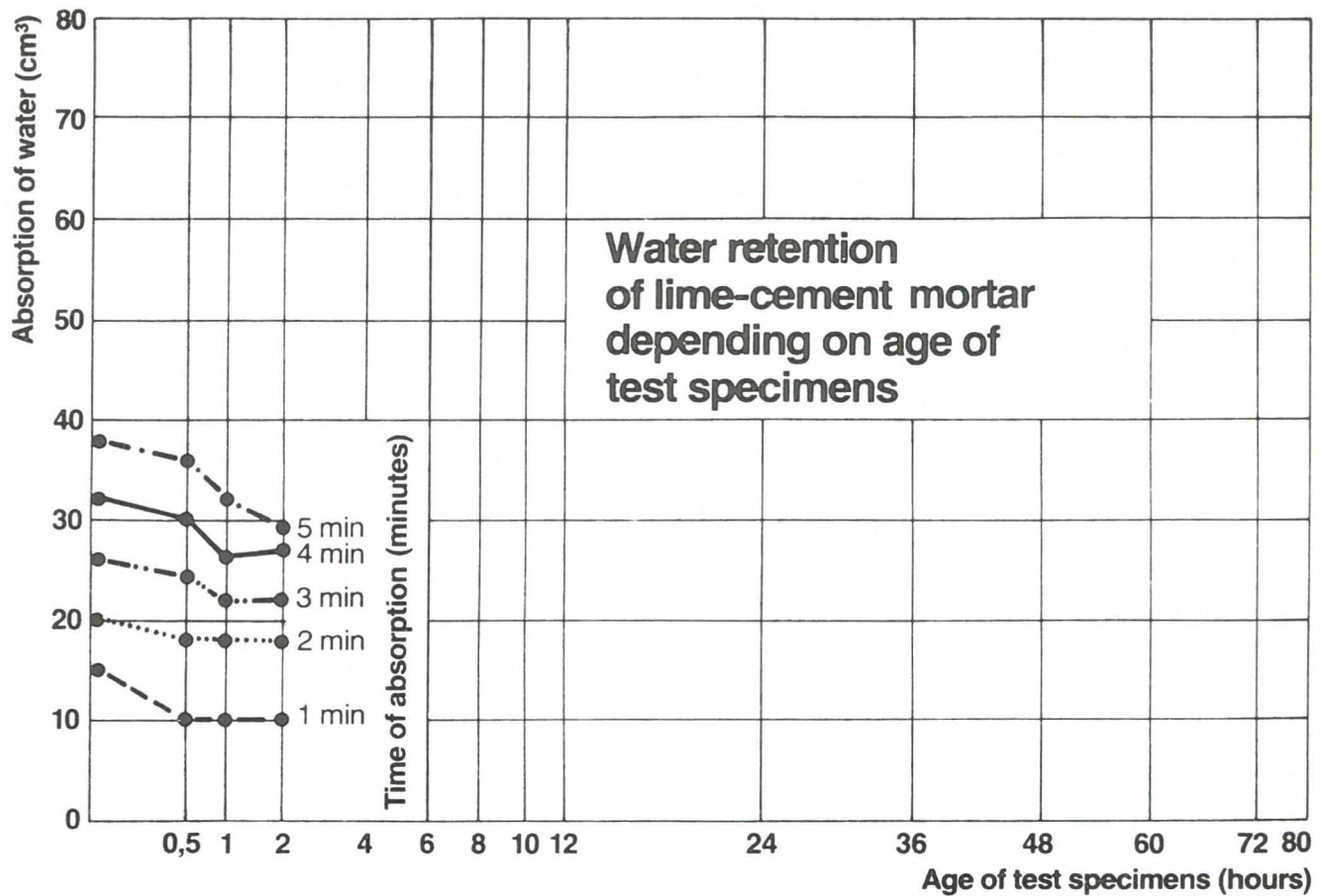


Figure 7. Diagram: Water retentivity of a cement-lime mortar in relation to age at test

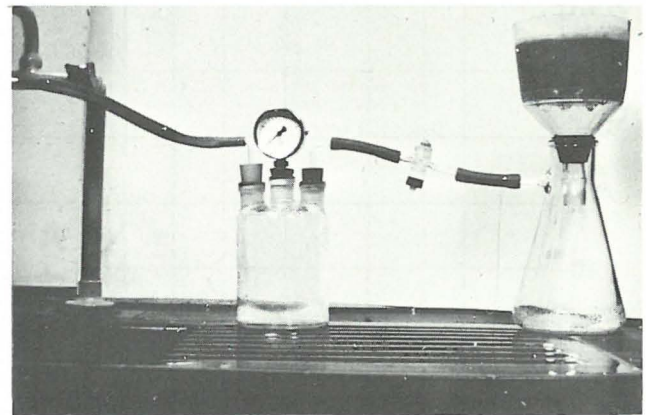
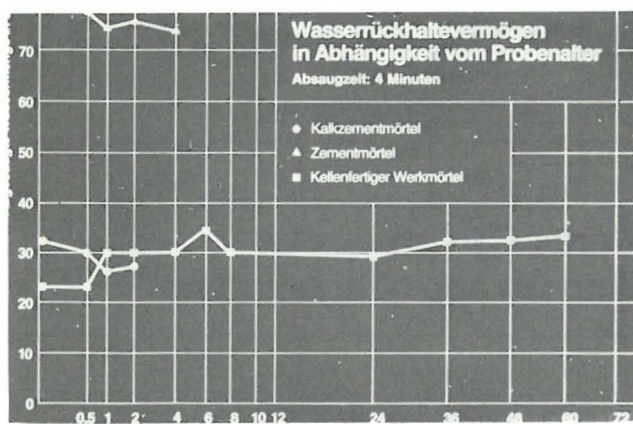
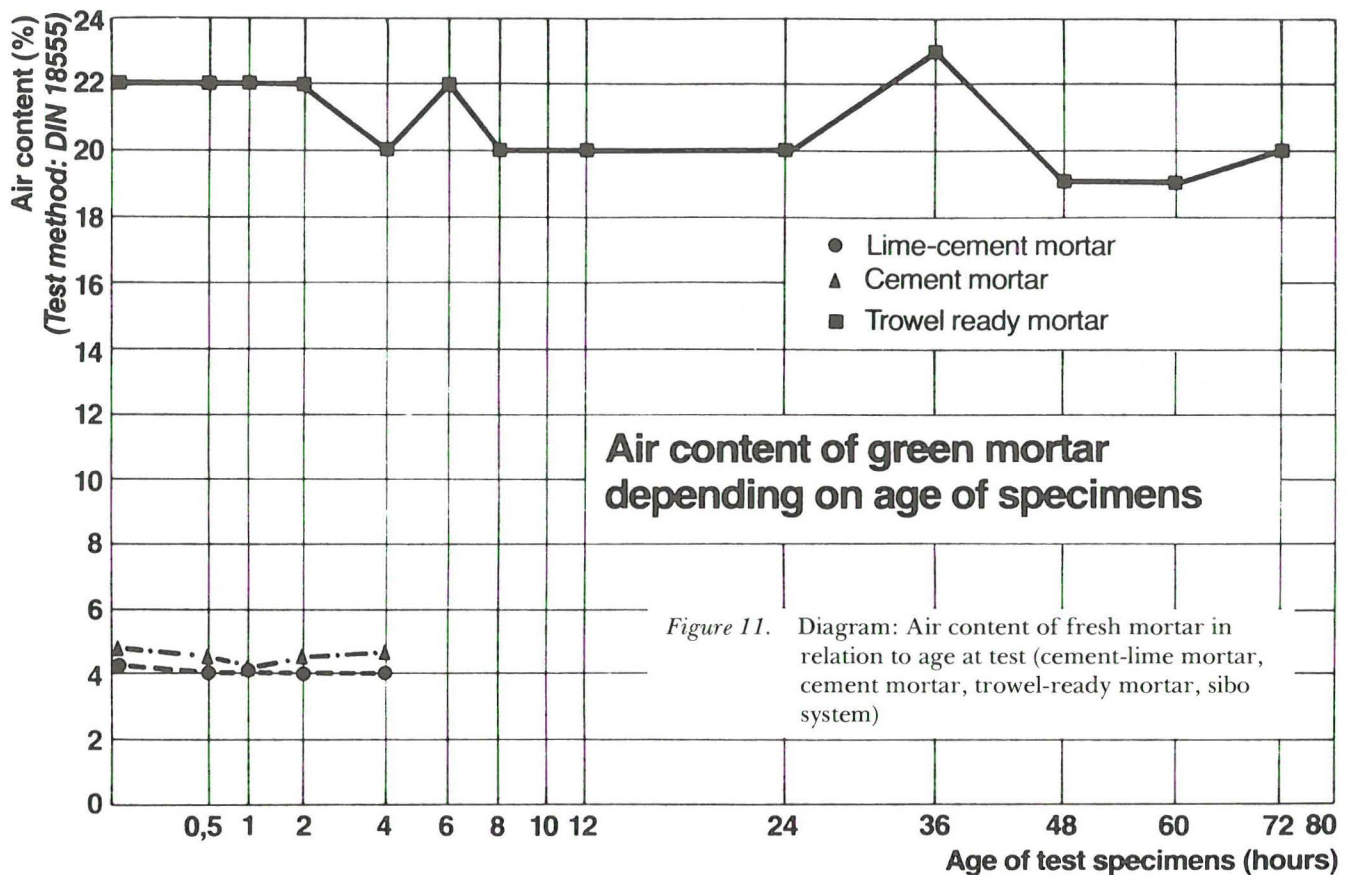
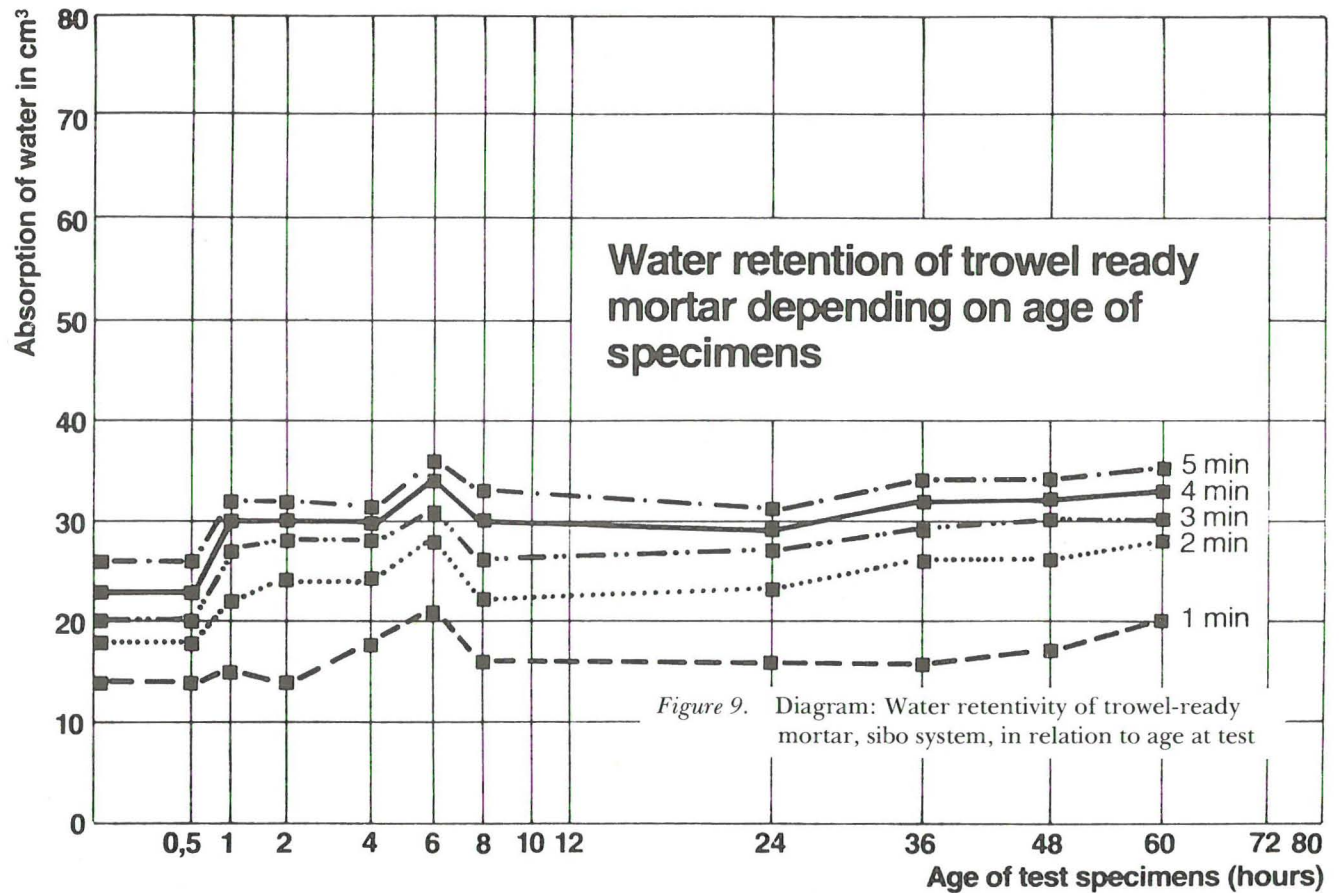


Figure 7a, 8a. Measurement of water retentivity as specified in DIN 18 555



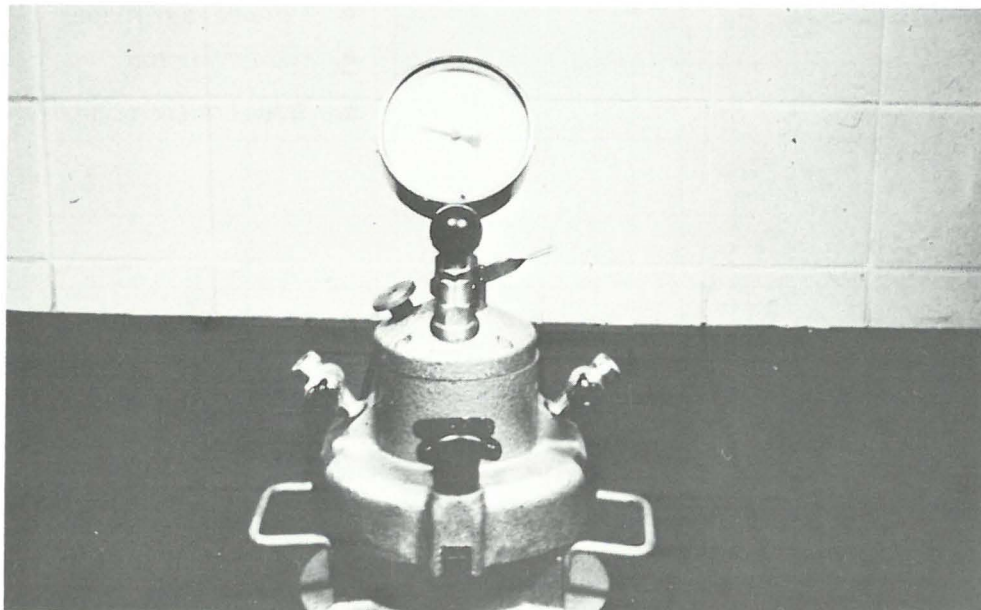


Figure 11a. Illustration: Measurement of air content as in DIN 18 555

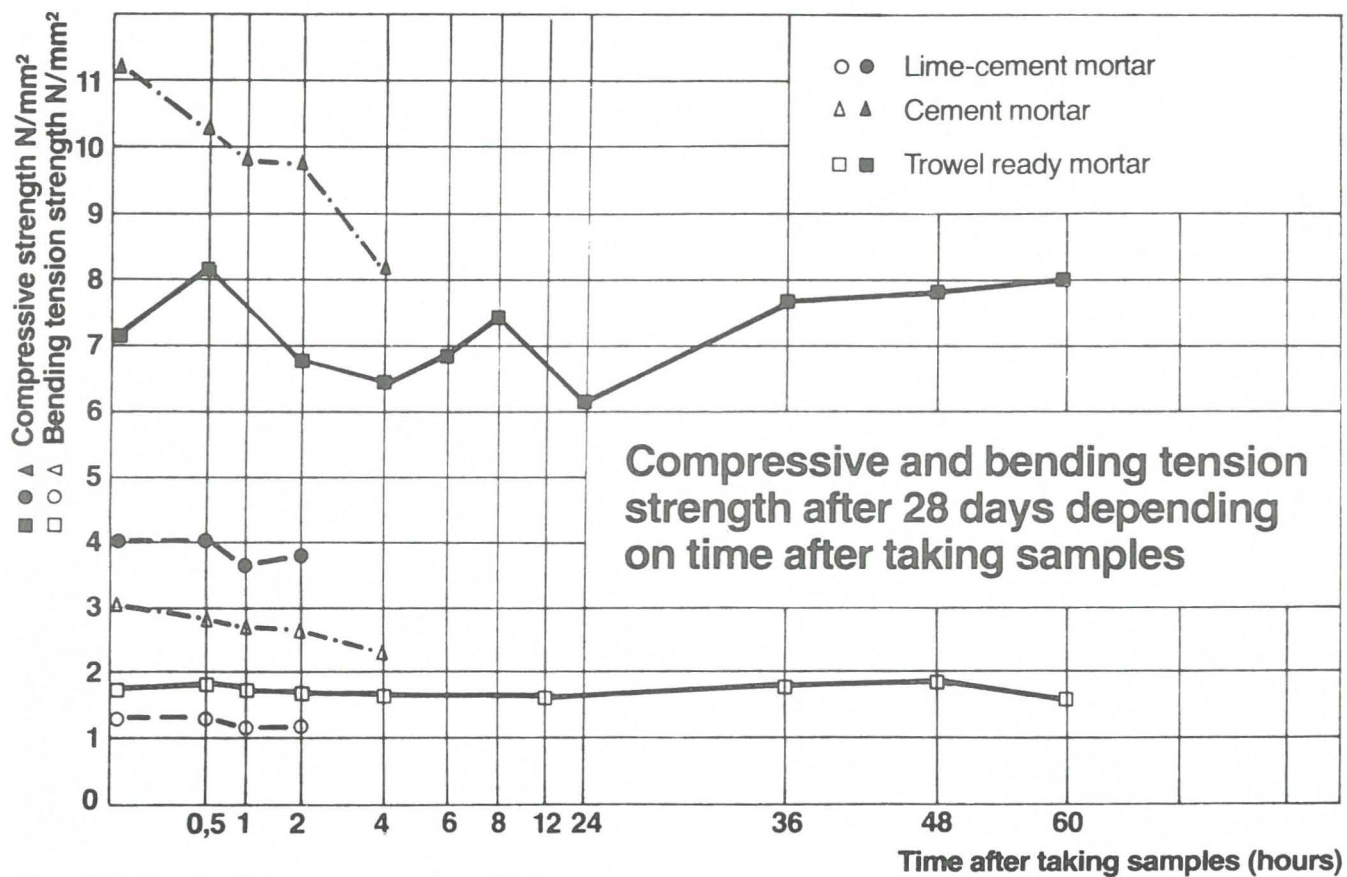
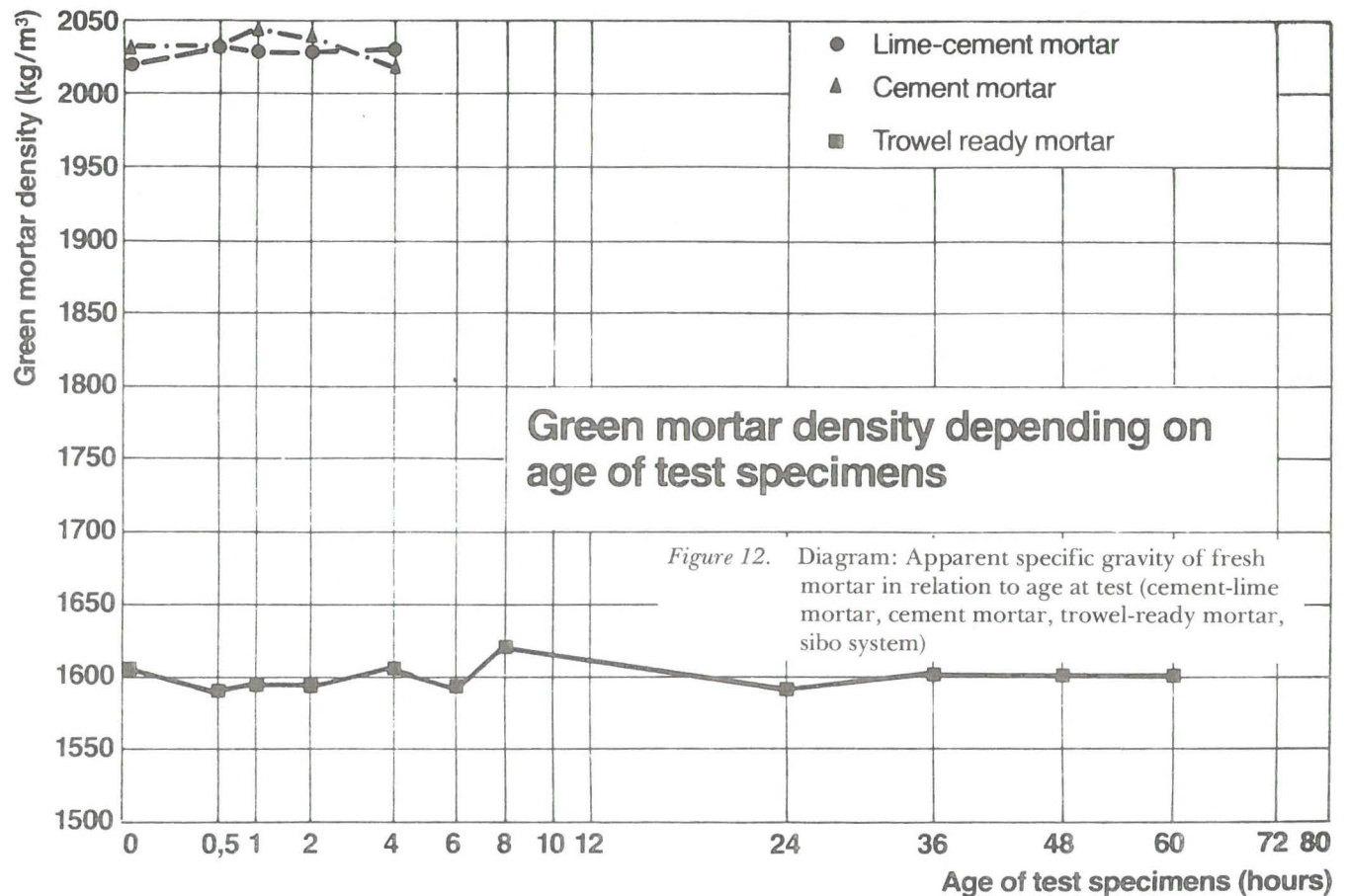


Figure 10. Diagram: Compressive and flexural tensile strength in relation to age at test) cement-lime mortar, cement mortar, trowel-ready mortar, sibo system)



Mortar-supply-service

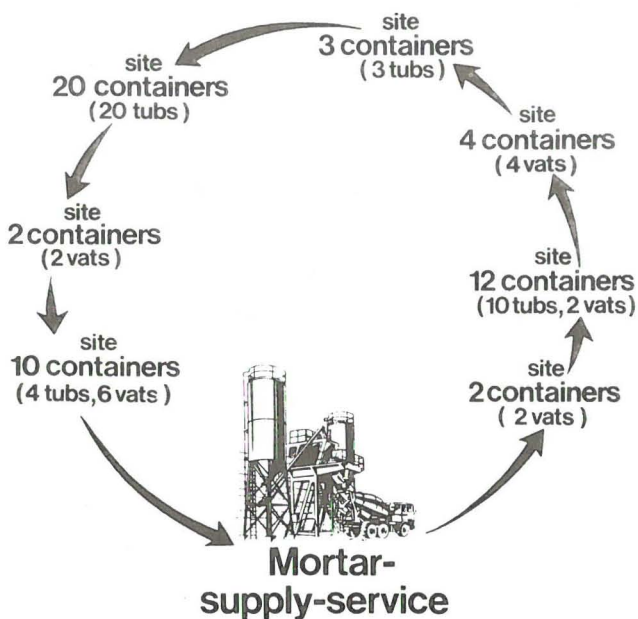


Figure 14 Diagram of mortar supply service



Figure 14a Mortar truckdriver planning deliveries

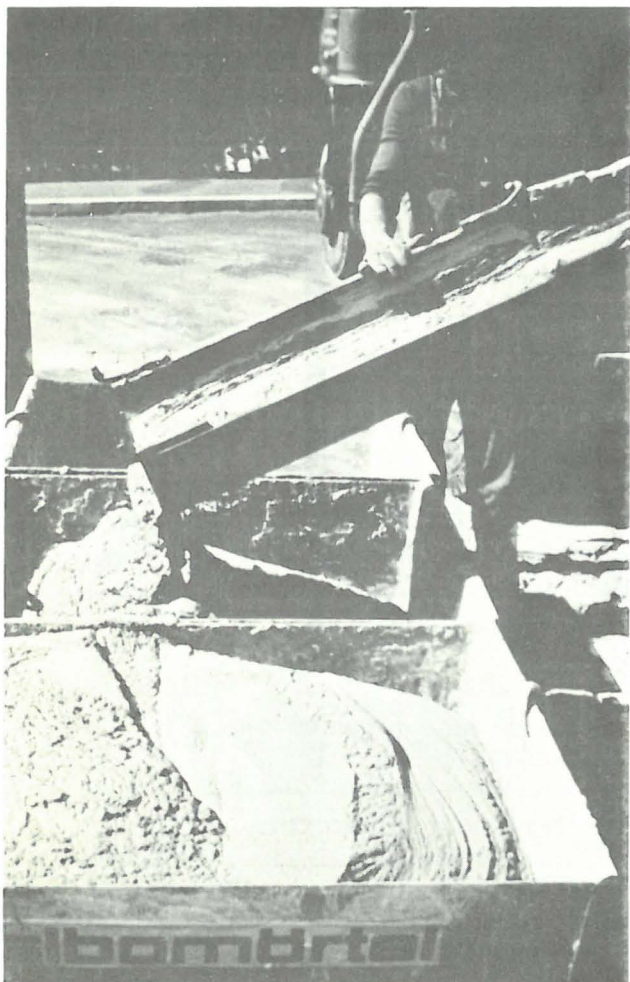


Figure 13 On-site handover of trowel-ready mortar



Figure 15a. Trowel-ready mortar after 36 hours in the container

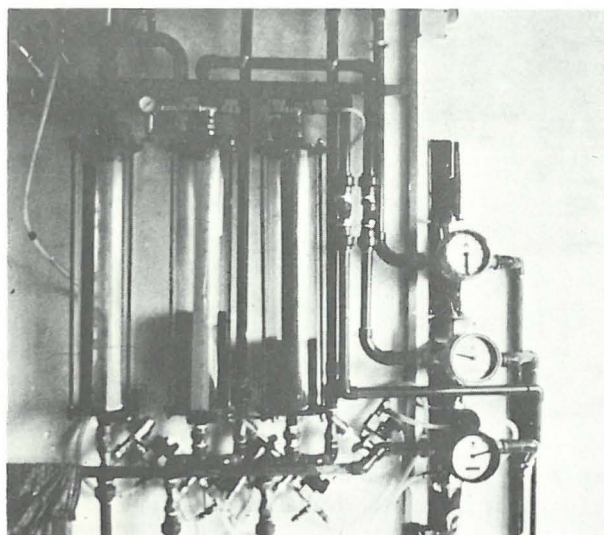


Figure 15. Batching mortar additives

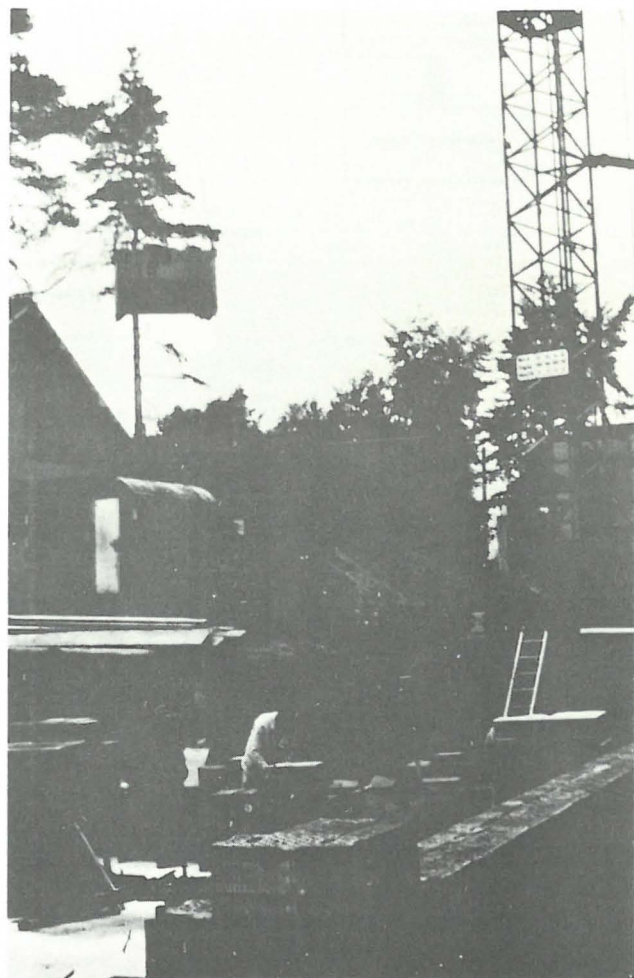
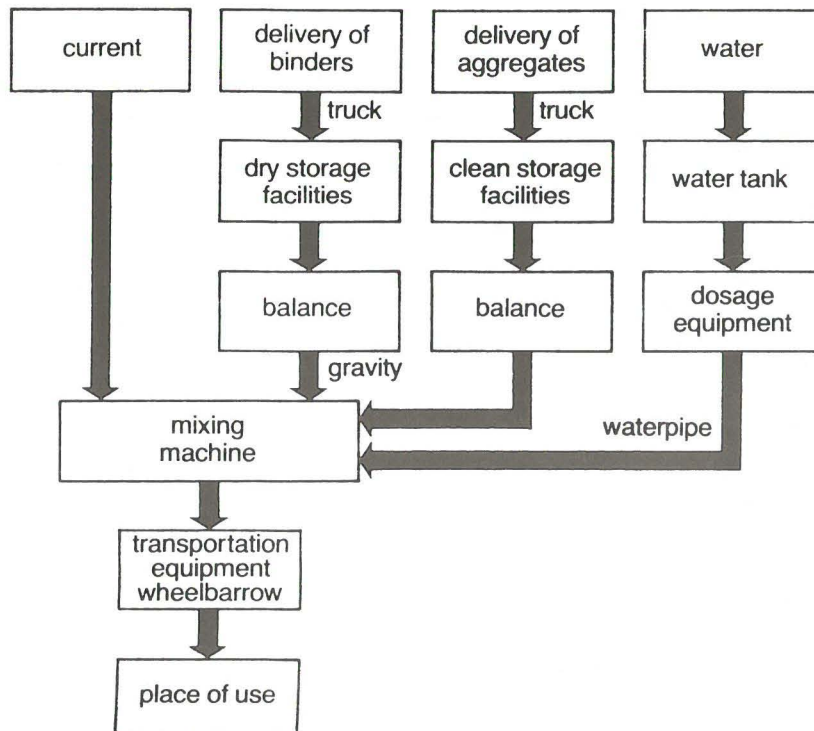


Figure 16. Working and transport container

Manufacturing process site mortar



Manufacturing process trowel ready mortar (site without crane)

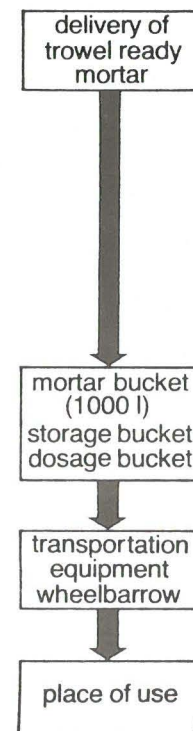


Figure 17. Diagram—Production flow comparison between on-site mortar and trowel-ready mortar



Figure 18. Problems in mixing mortar on site

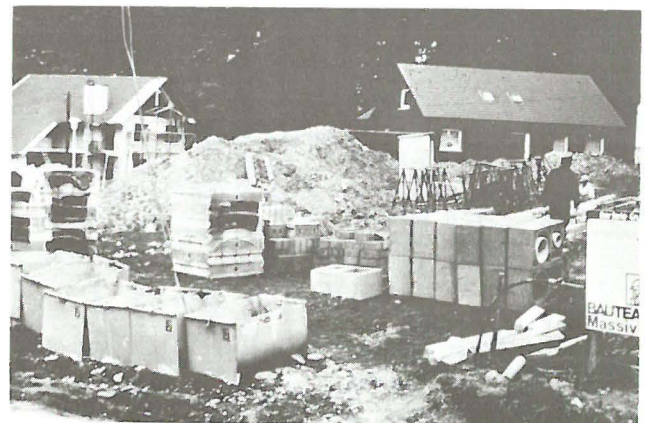


Figure 18a. Problem-free site installation with trowel-ready mortar (container stacking)

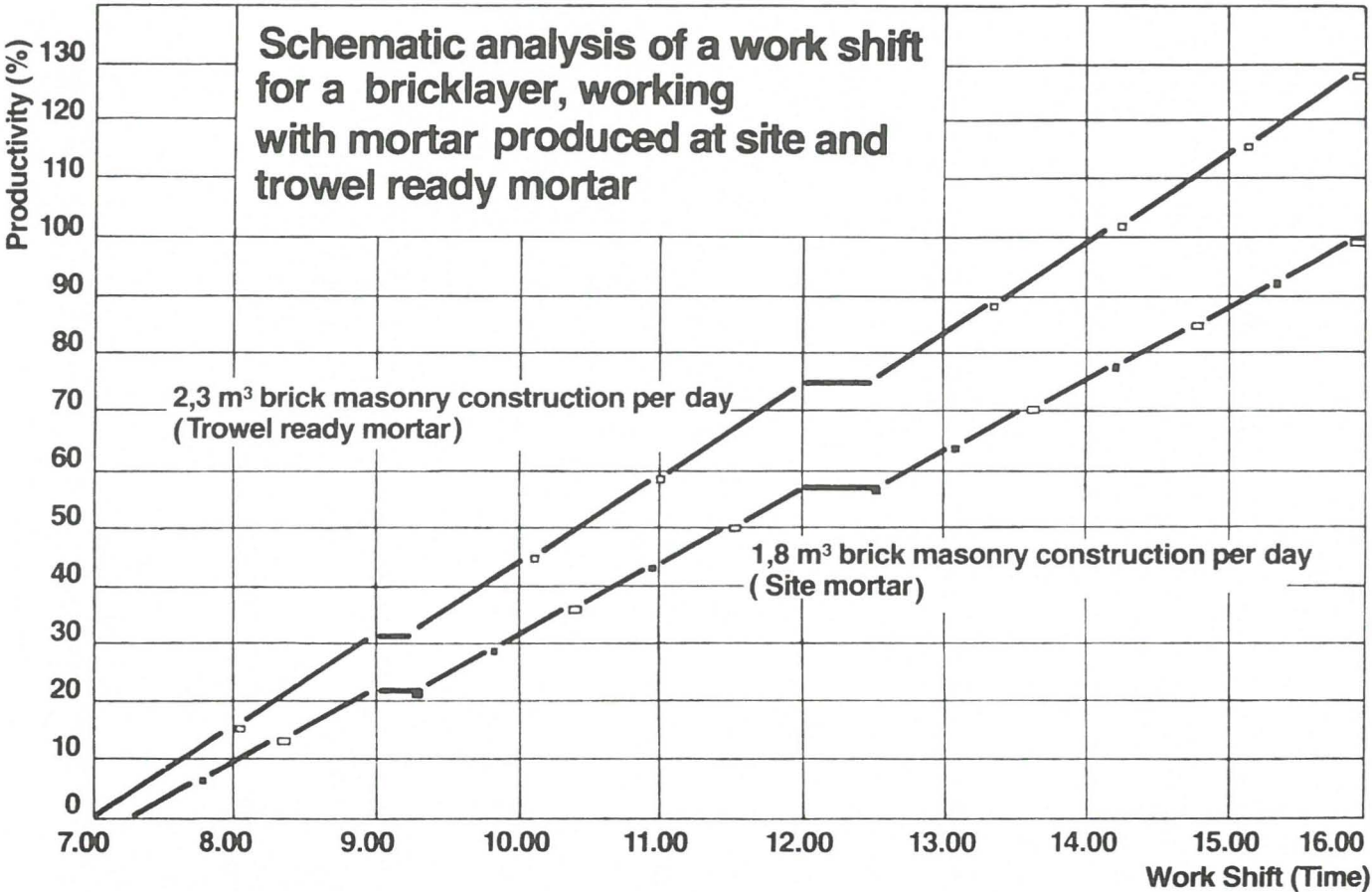


Figure 19. Comparative time study of a bricklayer working with on-site mortar and trowel-ready mortar

