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Redstone Masonry Article - Key Points

Review of key points to keep in mind about planning and scheduling characteristics of masonry systems

1. Increasing attention is being given during the design phases to selection of masonry materials which best fit conditions under which they must be installed as well as to their end function and appearance.
2. Materials specified for masonry systems particularly in substructure and structural bearing applications must permit all weather erection to the greatest exent possible.
3. Early design identification should be made of the construction requirements of all built in elements in a masonry system.
4. Be cautious about using mixed structural framing systems where masonry supports are combined with fully framed systems.
5. Where possible avoid using thickened floor slabs on grade to support masonry walls, particularly if there is a possibility that floor slab construction could be delayed by weather, large amounts of under slab work or design revisions to the slab or wall layouts.
6. Trades interfacing with masonry construction should be put under contract in a manner that does not interfere with erection of key masonry units. Remember, a contract released for field operations usually must allow the contractor to plan and schedule work the way he wants it built.

7. Masonry wall openings must be sized carefully to avoid difficult, dirty, costly revisions after the wall is erected and the mistake discovered.

8. Masonry as a structural element must be given special design attention so integrity of appearance, structural compatibility and uninterrupted construction sequencing is maintained. Watch for unusual tension or shear stress situation.

9. Where masonry is to be used in large multiple unit projects contracted out group by group to different general trades contractors brick should all be purchased at the same time from the same manufacturer and firing so consistency of appearance is maintained.

10. Assemblies of which masonry is a component should be designed always keeping in mind the construction sequence that is most effective.

11. Prompt processing of all submittals, mockups, and samples of structural masonry elements should be a high priority activity during the architect's administration phase (construction).

12. The architect should help minimize the need for multiple handling of masonry in the field, when pre-ordering is done by early deciding with the owner what storage space can be made available to the contractors.

13. The architect should inspect early exposed brick work to insure that the color range of the brick is distributed properly from the bulk packages of material.

14. Avoid using special masonry shapes particularly in structural masonry assemblies.

15. Temporary bracing needs for masonry elements should be kept in mind as design of the element proceeds.

16. Avoid designing masonry systems where damage sensitive surfaces must, by their design, be installed early in the construction sequence where probability of field damage is highest.

17. Careful selection of embedded structural devices to avoid dangerous corrosion of load carrying elements such as anchors, shelf angles, reinforcing steel and ties is a responsibility of the designer. He must further insure that such specified material are actually installed.

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THIRD AND SECOND ROUGH DRAFT FOR LOUIS G. REDSTONE BOOK - MASONRY IN ARCHITECTURE

Planning and Scheduling Masonry Construction

Masonry materials are used in nearly every phase of construction and are available in a bewildering range of materials, colors, and textures. On any given job might be found masonry products made from concrete, clay, ceramic, glass, gypsum, or even artificially created materials all assembled in horizontal and vertical systems to serve varying purposes throughout the entire facility.

Of the major building components,(sub-structure, super-structure, exterior skin, interior rough work, interior finish work, and systems) masonry may be an integral part, from minor to major, in any one or all six components. Because of this versatility great care must be taken by the architect and engineer to insure that the planning and scheduling for installation of masonry elements is properly considered during design.

Usually five major steps are taken in the design and construction

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process once design work starts, preparation of documents, award of contracts and procurement, installation, and maintenance of materials. The last of these, maintenance, is a post-construction activity; however, since the responsibility of the designer and the contractor extends beyond turnover of the facility they certainly must consider their design and construction obligations inherent in using a masonry system of any type.

A factor of increasing importance to properly planning and scheduling the use of masonry and other building materials is the movement during the past 10 to 20 years toward project management forms other than those considered traditional. The emergence of re-arranged design and construction teams has proven that the design and erection of a building can be successfully accomplished by other organizational systems than are utilized when full architectural engineering contract documents are prepared and then followed by hard cost contract proposal, award and construction. The need for greater flexibility than in the past for awarding construction contracts, combined with the high cost of financing, creating a frequent desire to occupy facilities at early dates, along with the demonstrated success of constant construction, feedback into the design process, have made it imperative that the architect, engineer, owner, contractor, and sub-contractor recognize and seriously consider both old and new forms of managing building programs.

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Strongly affected by this re-arrangement of managerial responsibilities are the masonry trade. Contemporary conditions have made it important that the ultimate installation and use of the masonry system be carefully considered as the design process proceeds. Thus, the designer must now evaluate each masonry unit selection for its design desirability, its procurement ease, the ease and economy of its erection, and, of course, its ultimate maintenance value in the completed project.

For example, in certain instances it might prove desirable to pre-select and perhaps even pre-order masonry units where there is a possibility that, at the time of construction, such units would not be available. An instance of this was seen several years ago when a severe winter gas shortage, which was somewhat predictable, forced a shutdown of many brick kilns in the midwest from early November on through to the next spring. In such a case where masonry was to have been selected from one of these manufacturer's product lines, a pre-ordering of that material certainly would have been proper to consider during design.

Successful use of masonry demands competent planning and scheduling attention by all members of the owner, design, and construction team. Let's examine the major building components and consider some of the factors affecting planning and scheduling the use of masonry during their installation in the component. The components normally

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encountered in constructing a new facility are:

1. Site work - That work installed outside the building line but within the property line or contract limits.
2. Sub-structure - Footings, foundation walls, pilings, caissons, and other related structural units which transmit loads to the sub-soil.
3. Superstructure - Structure elements which directly or indirectly transmit building loads to the sub-structure.
4. Exterior skin - Building elements used to close the structure to weather.
5. Interior rough work - Portions of the building which, when installed, can be totally or partially exposed to weather without damage.
6. Interior finishes - Items which must be partially or totally protected from weather to avoid damage.
7. Systems - Components which collectively make up a total operating unit and can generally be identified as a separate and distinct work project.

Starting from the sub-structure and working through installation of finish trades gives a clear picture of how the architect engineer and contractor can help provide optimum design and field performance when using masonry materials.

Frequently masonry foundation walls are used in lieu of cast in place concrete. On light simple buildings it may even be desirable to design a foundation that can utilize either material. Availability of concrete accessories and

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equipment varies from contractor to contractor and area to area. Even seasonal conditions and market fluctuations may affect the choice. Therefore, if possible to provide masonry alternatives to concrete foundation walls, or visa versa, cost and schedule savings of a considerable extent may sometimes be realized.

Following this course of design action involves careful correlation of the foundation design with the superstructure design, and a consideration of the desires of those who are to propose upon the actual construction of the unit. It is also important to be certain that if masonry is to be used in the sub-structure that the specifications provide for all weather maintenance of the erection operation. Schedule delays to installation of early substructure elements can be disastrous to a project just getting under way during the bad weather seasons of the year.

Another very important item in proper sub-structure design, as well as in every other masonry system, is defining all built in items that are to be part of the finished product. Masonry construction does have limitations, one of which is that putting material or equipment in a completed masonry wall is tedious, time consuming and oftem times destructive. The best time to think about what must be built into a brick or block wall is when it is being designed, rather than when it is being bid, or even worse, being erected.

A most important ingredient in using masonry as a part of the structural load carrying frame above grade is to understand thoroughly the interfacing of masonry with other

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structural materials. Interconnecting materials are usually steel, aluminum, concrete, or wood. Whenever masonry is used in conjunction with these to provide support to either vertical or horizontal structural components the erection sequence must be carefully thought out during design so as not to impose expensive and limited erection approaches upon field operations.

In general, mixtures of wall bearing and fully framed structural designs should be viewed with caution. Occasionally successful, economical, well running projects do make use of such mixed systems but only when the mix has been carefully thought through during the design period, and the combination system is recognized and understood by those proposing to build the facility. If there is any question about whether a framed unit should be supported by a similar framing material or whether it should be made masonry bearing it usually is best to frame it with the similar materials.

This is particularly true as structural components become smaller and smaller. For instance, to design a small motel canopy structure of steel columns and beams, and then to support one portion of this canopy and isolated brick piers could result in an expensive construction sequence, that could have been avoided by fully framing it in steel, or by making all vertical supports of masonry.

Wherever mixed structural components are used there is always the danger that varying procurement times and conditions may force contractors to make return trips

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to erect bits and pieces of one or the other of the components. Clean division lines between structural erection trades should be an important thought in the designer's mind when using masonry as a structural component.

Another situation in which the use of masonry structural elements often produces a faulty perception of cost saving is found in the use of thickened floor slabs on grade to carry structural masonry bearing walls. A problem is created when delays to floor slab construction make it difficult to provide wall supports on schedule. The problem briefly is that certain conditions such as a frozen sub-base or late release or delivery of underground materials may delay construction of floor slabs on grade but do not necessarily delay erection of important masonry vertical units. Thus, if a block bearing wall, shown on a thickened slab, is essential to continuing construction of a structural steel frame, but because of cold weather the slab supporting the masonry cannot be poured, then a serious problem results.

It is usually a good idea, especially with bearing walls, to permit an alternate to be selected of installing separate masonry wall footings with the sub-structure. Sometimes, this alternate is felt to be too expensive. However, long experience indicates that more often than not, when inclement weather or other slab delay factors are encountered that a thickened slab design with no alternative allowed, causes

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work disruption and expensive delays until the matter is resolved, often by ultimately permitting or paying for construction of separate footings.

In today's construction world it is frequently found that a phase by phase release of the contract documents is desired to maintain needed construction progress. In such cases selection of the contract package in which masonry is to be provided and erected must be properly made early by the design team. If the contractor is involved in the project during design, then he too should take part in making that decision.

The reason why timely contract releases of masonry are so important is due largely to masonry's versatility and use in so many applications. When you consider that a masonry wall might contain hollow metal frames, structural steel columns, electrical conduit, mechanical piping, panel boxes, sheet metal duct work, miscellaneous iron, pipe sleeves, plus an almost unlimited variety of other kind of construction materials and equipment the need for careful early planning becomes apparent.

If, for instance, a contract for all project masonry is let early along with the contract for concrete and structural steel the desired result of expediting early procurement and installation of masonry is satisfied on the surface. However, the instant masonry erection starts, it will become apparent that you need a plumber, an electrician, a carpenter,

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a miscellaneous iron erector, and perhaps several other trades along with the materials they are to install on the job to permit effective continuity of masonry construction to be maintained. Toothing out a wall for later installation of hollow metal or elevator door frames, or omitting a wall until a subsequent plumbing contract can be let and the contractor and material is on the job becomes expensive and disruptive. Such oversights during the design, contract award, and early construction periods are inexcusable and the competent architect must guard against such inadequate or poorly thought through scheduling considerations of masonry unit installation. Another serious problem frequently encountered in wall design is improper sizing of openings to permit setting or servicing equipment. Although this sounds like a strange occurrence, it unfortunately is a mistake commonly made, sometimes several times within any one job. It is the duty of the design team to insure that a fully coordinated and knit together design is produced. The special problems that inaccurate opening definition bring when the wall is masonry is that it is more difficult, dirtier, and often more expensive to revise masonry once erected than to rework some of the lighter forms of wall construction such as drywall or even plaster. Therefore, when using masonry, opening dimensions in walls must be carefully defined and checked thoroughly and repeatedly throughout the design period.

Such dimensional errors most frequently occur at equipment rooms, functional and service spaces and in special purpose

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areas such as sterile linen rooms in hospitals or in institutional installations where accurate sizes of food service equipment is sometimes difficult to obtain prior to an award of a contract. It is the obligation of the masonry design team to provide adequate access to all areas where entrance must be had through a wall.

Selection of masonry materials is extremely important when using masonry as a structural element and particularly if the structure is to be visible and an integral part of the total architectural design. Where there is a possibility of expanding the facility in the future careful consideration must be given to later availability of the original masonry units. As with foundations it is important to be able to erect structural masonry elements in nearly all bad weather conditions. Properly selecting where to use masonry as a structural component may prove the difference between a successful construction program and one plagued with delays and expensive revisions.

Selection of proper masonry materials is important to assuring chemical compatibility and structural expectations. There have been instances over the past several years where reactions between various types of mortar, masonry materials, and built in metallic elements has been disruptive to the system, and sometimes even dangerous, due to deterioration of hidden anchoring or reinforcing surfaces. Specifications must be closely related to architectural and structural drawings to insure that compatibility is maintained.

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Another factor that must be carefully evaluated if masonry is intended to take structural loads, is to insure that the designer investigates forces from all directions vertically and laterally. Masonry well used is a good structural material in compression, but unless specially reinforced is of very little value in resisting tension or shear. Lateral loads that impose bending moments and high shear stresses must be identified early so the masonry component can be designed and specified properly. For instance, if an elevator masonry dividing pier restrained at one end by the floor structure is to be used in a feature elevator of a hotel, the lateral loads imposed by possible horizontal movements of the elevator in the guide rails should be investigated as part of the material selection. Lack of such investigation during design frequently forces expensive reinforcement, revision or in some cases replacement of the system during construction.

Award of contracts and procurement of masonry materials should be carefully done when masonry is used in the superstructure or other exposed areas of the building. A most important item is to insure that consistency of

appearance throughout the facility is maintained by proper ordering of the units. Masonry appearance varies from manufacturer to manufacturer, kiln to kiln, and firing to firing. Recently, for instance, a very large project which had sizable amounts of exposed masonry used in its design was to be brought on line in successive stages through the award of three separate architectural contracts. These contracts were also to be awarded at different times during the project. This meant that masonry for all three major contract units probably would have to be purchased early, and from one supplier so as to maintain uniformity of appearance.

Although this problem appears obvious, its resolution and the implementation of the solution was difficult. Masonry procurement contracts had to be awarded along with award of the first of the three major contracts. Thus, special consideration had to be given to soliciting separate proposals for masonry, and to devise a suitable technique by which the delivered masonry could be stored and then ultimately allocated to each unit architectural contractor. This matter was one that had to be resolved prior to the issue of the first of the contracts and demanded architectural design decisions for all units very early in the project. Although such special considerations are not limited to masonry it is, because of the nature of the material, important to consider future expansion needs early in the design phase.

We have touched on the need to carefully analyze contract package content when a dovetailed document issue is to be made for expediting construction sequencing. Not only must items

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that are built into masonry be carefully planned, but also those that directly adjoin masonry elements and that could cause erection interruptions and delays. For instance, at the roof of a building where masonry is used as an exterior material the nailer, blocking, insulation, and roofing sheet metal system might be designed to allow the mason to complete his work even though a roofer or a metal deck erector is not yet on the job by completion of exterior masonry units. A careful review of sections and details should always be made wherever masonry interfaces or touches another material whose installation depends upon the masonry sequencing. The versatility of masonry materials will generally allow for accommodating erection interfaces of this type. It is only when a design and sequencing dysfunction is allowed to occur in the awarding of contracts and the procurement of materials that such interfaces may prove difficult, disruptive and embarassing.

The need for careful attention of procurement of masonry is evident from the examples we have already discussed. Perhaps a brief review of the sequences usually followed in procurement would be of help in better understanding how important is proper scheduling and planning for masonry use.

Procurement usually begins for the designer with a submittal. The submittal may be a cut, a shop drawing, a sample, a color chip, or almost any kind of kind of document or sample that allows an architect and the owner to authorize proceeding further with the procurement process. Since usually the next step after submittals and ultimate approval is involved with

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committing sizable amounts of money, requirements for the content and form of submittals for masonry materials must be clearly described in the construction contract documents. The designer should also make absolutely certain that the materials specified are available. It is unfortunate, but true, that often the contractor encounters a specified masonry material, particularly in hard tiles, that is no longer manufactured. This oversight created delays at the worst possible time and a time consuming and unsatisfactory re-selection may have to be made.

Once masonry materials are selected, sample walls or mockups of the units to be used are built by the contractor. Proper location is important. The architect should select locations of these sample walls and mockups so as to provide the expected final light conditions needed to adequately evaluate the sample wall. There have been occasions where such locations, poorly selected, have had to be changed several times, resulting in expensive moves of the wall panel, or even reconstruction of the panel to permit an additional evaluation to be made.

After submittals and mockups are completed and reviewed it is the obligation of the design team and the owner to promptly approve or to revise and fully explain what is wanted. Delays to approvals, particularly where masonry is part of the structural frame, can cause serious domino affects on construction progress. Once the full process of procurement, starting with submittals, is initiated delays must be kept to an absolute minimum if good relations are to be maintained and economical practices are to be followed in the field.

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Once approvals are obtained, the manufacture of the units is released and from that point, revisions of any type become very expensive. Of importance after release, and with responsibility resting primarily upon the contractor's shoulders, is the need to assure adequate storage space on the site once masonry materials begin arriving. Although most materials used in construction are bulky and difficult to store, the nature and weight of masonry generally make it imperative that minimum amounts of extra handling are made necessary. The architect has an obligation, in conjunction with the owner and the contractor, to locate and set aside a suitable storage space for the masonry if it is not to be used as it arrives at the job site.

Although newly received brick at the job site it difficult if not impossible to inspect for appropriate range and color, the designer should understand that differing methods of packaging brick may require the mason to have direction from the designer as to how to draw the masonry units from the stockpile. Several years ago a shopping center in Chicago was being entirely faced with a moderate range brick. Erection of the brick began with only minimal attention from the architect. It was apparent after four or five days of work that the brick had been palletized keeping masonry of the same color on a single pallet. Thus, the walls as erected consisted first of all masonry units of one tone followed by masonry units with the next range of color. Fortunately the error was discovered early and a proper pallet mix initiated that insured the material was properly allocated.

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The mason may not know exactly what the architect had in mind during design. Thus, responsibility for monitoring early masonry construction to insure adherence to desired appearance is one that rests heavily upon the architect.

During procurement it is also important to understand the potential difficulty in acquiring special masonry shapes, Unique sizes, angles, or configurations will sometimes make it necessary to obtain early approval and acceptance of a submittal so the special unit can be fired along with the typical units. Here it is an obligation of the architect and the contractor to insure that well defined submittal processes are followed carefully and prompt approvals are given. If possible, special masonry shapes should be avoided because of the potential for manufacturing difficulties or delays.

Once the procurement process has been completed and masonry materials are on the job and available for installation, installation should proceed with minimal delays caused by oversights during the design process. A most important part of masonry erection in structural uses is that it can be braced properly and economically without having the full permanent structural framing in place. As design of structural masonry proceeds, bracing needs should be considered by the design team. Bracing for masonry walls is usually space consuming and if delays to installation of permanent structural members are encountered, such bracing may interfere with succeeding activities. On a school job sometime ago, the necessary bracing for a high bearing brick wall had to be

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left in place so long that it prevented timely correction required on a floor slab prior to installation of the topping. The delay to corrective action took the project into winter time and prevented such work from being done during good weather. Although in this case the delay was the fault of the contractor, not the design team the incident illustrates the need for properly planning and scheduling masonry erection. To emphasize a point made earlier, it should be remembered that as a structural unit, masonry may have very little capacity to carry unusual construction loads prior to having all structural components in place. Therefore, its interim structural capabilities are often a source of field concern to the contractor and he may need help from the architect and engineer in determining what construction support and bracing measures can be taken.

During construction it is crucial to avoid undue or over long exposure of finished surfaces to construction traffic and weather. So, using structural exposed finish masonry which must be erected early in the job sequence must be done selectively and carefully. If the surface of the masonry is susceptible to damage there is a good chance that it will be damaged during construction if not adequately protected. Replacement of damaged masonry surfaces is very difficult.

The need to avoid premature finish material installation is not limited to vertical masonry systems; those areas that receive ceramic or quarry tile or window details that call for slate sills should be designed in such fashion that

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early installation is not required if there is a possibility of in place damage. Although it is the fundamental responsibility of the contractor to protect work, in any properly operated construction program the responsibility must be shared by those responsible for selecting the material and specifying the method by which it is to be installed.

One key secret of good design has always been identified as the ability of the designer to understand the total process of design and construction without separating one from the other by artificial responsibility lines. With masonry materials we find that the expert designer is invariably one who fully understands and is sympathetic to the construction advantages, features, and limitations of the materials from which he must produce his designs. This is perhaps true more of masonry than nearly any other construction material in common use today.

Overall, the use of masonry must always be tempered by realizing it is a construction system made up of several diverse, multi-sourced elements. The masonry unit is the basic ingredient, but used with it are all of the devices, materials, and equipment that depend upon the masonry for sheathing, housing, concealment, structural support, anchorage, or enhancement. Therefore, masonry unit design always must take into account every other element that interfaces with it.

We have briefly identified the various features of masonry systems that make their planning and scheduling so critical in a

construction program. We also must consider the need occasionally for deviations from what might be standard design techniques to accomplish a special construction purpose. One of these, frequently encountered is a request to erect backup masonry early so the contractor can close in a masonry skin structure, with the intent to come back at a later date and install the veneer. Depending upon the time of year when construction is liable to start it may make good sense to design an exterior wall system that permits discretionary erection of the backup independent of the exterior veneer.

Another special detail feature need may be found when the masonry is to form a portion of the fire resistant enclosure around a structural member, particularly an exterior column or spondrel. In such cases, where masonry is to be built up around the outer or exterior flanges of a structural steel shape, it is found often that spray on fireproofing is called for on the web of the steel member. If the masonry is erected, prior to fireproofing, as may be necessary in cold weather, spray on material may be difficult to apply in the limited amount of room between the flange and the inside face of the masonry wall. In this case alternative methods of fireproofing the member should be carefully examined.

When we use masonry as a horizontal covering material such as for tile floors, the selection of the material and the

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conditions under which it is to be installed should be considered along with the selection of the material on the basis of appearance and wearing characteristics. As most floor masonry materials go down, they are usually sensitive to construction traffic damage and as such can cause harmful disruption of field operation sequences. Normally there is little that can be done about such sequencing during the design process, but a great help can be given once contracts are let. Prompt submissions, timely approvals, and careful scheduling of deliveries of such material will give field forces a broad time range into which the material installation can best be fitted. Frequently installation of these materials must be sandwiched into a very narrow time window and missing that time window through late delivery of material can intensify the potential disruption or damage that might be caused by its later installation.

To be remembered is that field assembly of masonry elements is still done manually, and as the opportunity arises for timely and effective placement in the field operation. Having the material on hand at the right time may spell the difference between success and failure in the use of a masonry system.

We have focused in this brief discussion on the relation of masonry design and installation to the construction planning and scheduling process. Once the project is built, turned over, and the maintenance period begins, the

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responsibility of the designer in his proper selection of the components enters a most critical phase. Every good masonry design must take into account the nature of what happens to the hidden elements within the wall systems as the facility ages. Of particular concern are critical structural supports, anchors, and inserts. The impact of a major masonry repair due to deterioration of structural anchorages can often be avoided by the architect being fully aware of the deteriorating factors present in the masonry environment. Most designers today know of the availability of various metals commonly used now in masonry anchorages. Therefore, this problem is not as widespread today as it was in the past. Nevertheless, a design and construction obligation still remains to insure that the masonry component will function during use as it was intended to function.

In summary, the good masonry designer always remembers:

1. That masonry is a material almost always used in conjunction with a multitude of other materials. Knowledge of good masonry construction demands knowledge of how each of these other materials are built in or attached to the masonry and how they behave.
2. That a masonry wall is not built only by masons but by plumbers, electricians, iron workers, carpenters and roofers, to name only a few. Each installation must be considered during design.
3. Understanding that masonry like all building materials has its scheduling limitations. Designing within those

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limitations permits concentration on excellence of use while still allowing great diversity of design.

4. That today's construction business is more closely connected to design than at any time during the past 100 years. This drawing together of the designer, constructor, owner, and user has made possible a molding of talents that, properly managed, will result in a superior end product, particularly with a complex material such as masonry.

5. That elements of plan, schedule, cost, and quality dominate after the design is turned loose. In specifying masonry it is imperative that the designer participate fully in the processes of submittal, approval, manufacture, delivery and ultimate installation of the material.

Following these guidelines it should be possible for the architect, engineer, and contractor to improve their field planning and scheduling of masonry systems installation and, in turn, to greatly enhance their ability to work with this wonderfully versatile material.

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