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Precast and Prestressed Concrete for Justice Facilities

by

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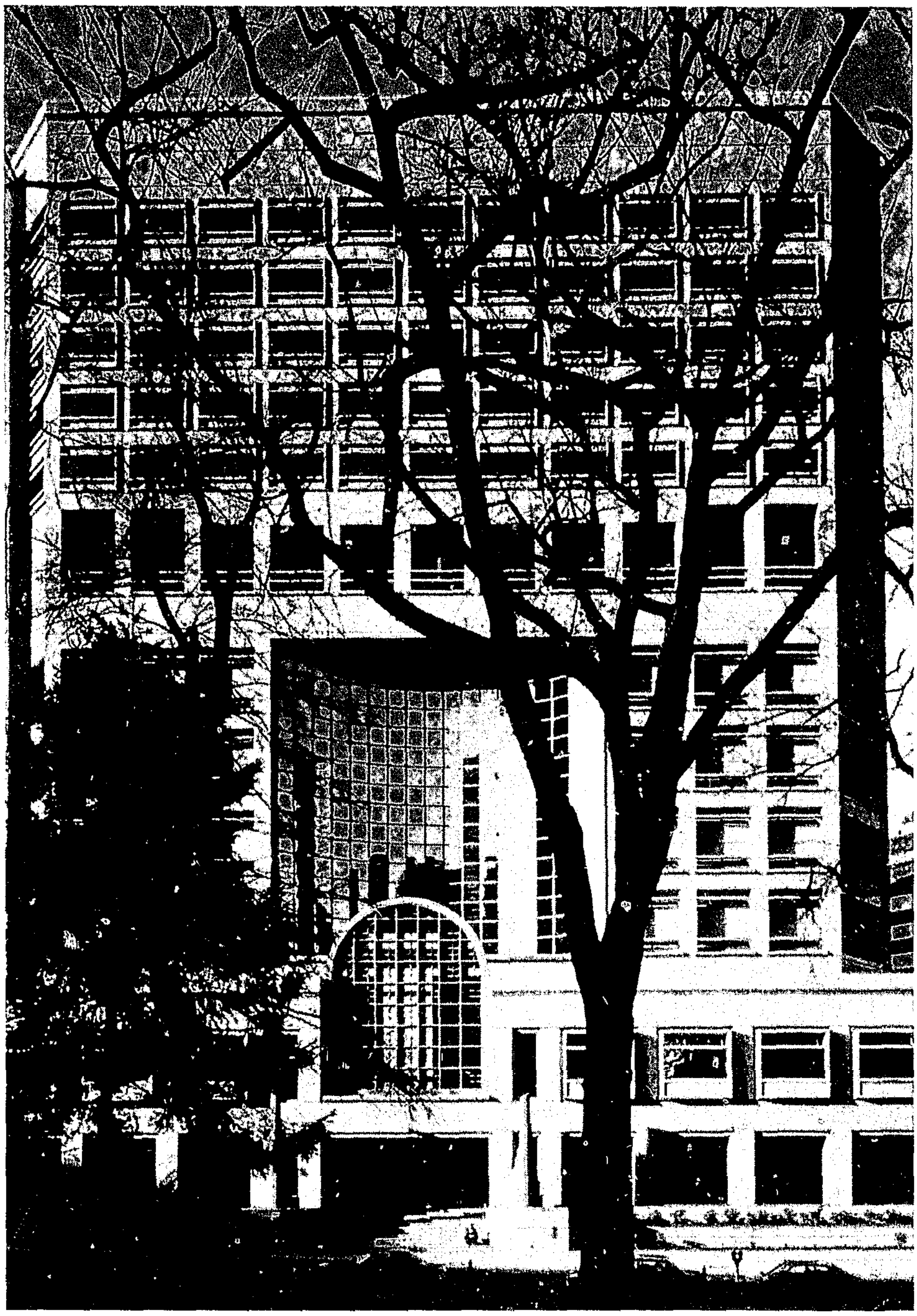

Cover Photo
Multnomah County Justice Center
Portland, Oregon
Zimmer Gunsul Frasca
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Introduction

The nation's prison and jail populations at the federal, state and county levels are burgeoning as a direct result of nationwide mandatory sentencing laws and trends toward "getting tougher". Demands for increased prison capacity coupled with court-mandated directives to replace outmoded facilities have given impetus to the boom in justice facilities construction and renovation.

To meet the urgent needs for new and additional detention/correction facilities, the design professionals and construction industry have responded, utilizing and developing alternatives to conventional construction methods. The responses have affected both design concepts and material utilization.

This booklet recognizes the need for the development of innovative solutions to building new facilities and renovating the old. It concentrates on the specific applications and advantages of precast and prestressed concrete for the design and construction of detention/correction facilities.

Precast concrete is a desirable building material because it has many inherent benefits which are important to this building type. It is more than a building material, it is a building process. To utilize the full potential of precast concrete as a prefabricated building system, it is important to conceive a project from the start with precast concrete as the total building system. For example, if precast concrete is viewed merely as a cladding or architectural component, then the material's inherent structural capability must be duplicated by another structural system. Similarly, if precast concrete partition walls can serve as bearing walls or shear walls, then the cost savings become more apparent by utilizing these strong components to serve multipurpose functions.

Precast concrete can be molded into a variety of shapes and can be fabricated with many different architectural surface textures. This design freedom is an important benefit of precast concrete and imaginative designers should take full advantage of its potential. At the same time, discipline and restraint are called for in order to maximize cost savings. Square and rectangular buildings are much more economical in precast concrete than those with odd external shapes or involved angular interior layouts. Maximum economy and construction speed are more likely to result from simplicity and repetition. Generally, the agencies operating detention/correction facilities prefer more straightforward layouts because they are easier to administer and maintain.

Precast concrete can provide impressive cost savings in construction by reducing the time to completion. The precast components can be produced in the plant of a concrete precaster while site preparation and foundation work are proceeding concurrently. When the foundations are completed, precast building units can be erected swiftly in almost any kind of weather. No on-site storage is required because the components arrive ready to erect off the truck, an advantage for urban sites where access is limited. Once closure is accomplished, the inside trades can get to their work faster.

There are many examples of all-precast concrete projects saving one and two years of construction time over the estimated schedule for other methods of construction, or by comparison with actual construction time of traditionally built facilities. Case Study 7 describes three 512-man medium security prisons in Virginia built in under 20 months each. A similar size masonry and cast-in-place concrete prison in the same state took 42 months to complete. The entire first phase of the California State Prison at Vacaville (Case Study 13) was completed nine months after the start of preliminary design.

A totally precast concrete structure and enclosing envelope will normally cost less than 20% of the project budget. Therefore, a reduction of 10% in the cost of the floors, roofs and walls will reduce the total project cost by a mere 2% if only the installed cost of the components is considered. But the real savings with this construction method is in the cost of money for the shorter construction schedule as shown in Table I.

All else being equal, a net savings of $2,291,000 is very significant considering that the cost of the structural/cladding system itself is budgeted at about $4,000,000. Of course, the major benefit to the owning agency is the earlier occupancy of the facility, particularly if there is a court order to relieve over-crowding.

In many jurisdictions the overcrowding problem is being handled by the states' housing their inmates in county facilities. In order to do this, the states are paying per diem rates to the counties. These rates are normally higher than the costs of housing inmates in permanent state institutions. Furthermore, many states are erecting temporary facilities in order to house inmates while they construct permanent prisons. Usually, these temporary facilities are much more staff intensive. Therefore, the fact that precast concrete will allow the construction of permanent facilities much quicker, produces savings in the cost of housing inmates on a temporary basis and there are significant cost savings in staff reduction as well.

By plant-casting the concrete building elements, the owner can be assured of receiving a product with a better quality finish and tighter dimensional tolerances than can be achieved by casting at the job site. The structure will have a tight-fitting, cleaner appearance and exposed surfaces will be more durable, due to the higher strength concrete mix used for plant-cast elements. The cost savings which goes along with the time savings, plus the quality assurance and uncompromised security are significant benefits for designing detention/corrections facilities in precast concrete.

It is important to begin talking with a precaster at an early stage in planning a facility. The precaster can suggest ways of reducing costs and may offer ideas for interfacing with the electrical and mechanical subsystems.

This booklet covers general planning and design considerations, including structural and subsystem (e.g., mechanical, electrical) components, and case studies of selected justice related projects utilizing precast or prestressed concrete as the primary building element in the construction process.

Table I. Sample Project Budget

Item	Masonry and Cast-in-place Concrete 40 Months	Precast Concrete 20 Months
Estimated Construction Cost (Structural/cladding system is budgeted at $4,000,000)	$ 20,000,000	$ 20,000,000
Development Costs (Land, A-E fees, management fees, legal fees, insurance, and contingency funds—assume 25% of construction cost)	4,000,000	4,000,000
Subtotal	24,000,000	24,000,000
Financing Costs		
Interest on construction loan is 75% of construction cost @ 13% interest assuming loan average balance of 50%		
Masonry and C.I.P. Building		
Construction time based on 40 months $0.75 \times 20{,}000{,}000 \times 0.13 \times 0.50 \times 40/12$	3,250,000	
Precast Building		
Construction time based on 20 months $0.75 \times 20{,}000{,}000 \times 0.13 \times 0.50 \times 20/12$		1,625,000
Interest expended on development costs @ 10% interest. Assume costs were expended at beginning of project.		
Masonry and C.I.P. Building		
$4{,}000{,}000 \times 0.10 \times 40/12$	1,333,000	
Precast Building		
$4{,}000{,}000 \times 0.10 \times 20/12$		667,000
Total Projected Cost	$ 28,583,000	$ 26,292,000
Net Savings		$ 2,291,000

(2,291,000/20,000,000) × 100% = 11.5% savings on the construction cost of project due to earlier completion.

Planning and Design Considerations

Preface

Justice facilities encompass many types of building occupancies. Most people view these buildings as being a jail or prison, but they also include police stations, courthouses, juvenile halls, and special mental health or drug abuse centers. All of these building types play an important part in our country's justice system. This booklet is not intended to be an all encompassing planning and design guide for the various types of justice facilities, but rather a general information source addressing the specific use of precast concrete. Included in this booklet are selected case studies which dwell mostly on detention and correctional type facilities. Each of the selected projects have made appropriate use of precast concrete components resulting in the design and construction of cost-effective buildings.

Security

Justice facilities have varying degrees of security requirements, all of which have some impact on the design of the precast components. Precast concrete is an excellent building component that is both durable and secure.

Thickness of precast wall components will generally be determined by loading conditions and local codes, with a practical minimum thickness for casting and handling considerations. High strength concrete (i.e., 5,000 psi minimum compressive strength) and normal reinforcement provided for shrinkage and temperature control will provide the necessary resistance for security. No special reinforcement is required for security purposes. As a guide, non-loadbearing security walls, such as walls located between inmate cells, may be 4 in. thick with normal reinforcement provided for shrinkage and temperature control. Cell walls 6 in. thick can be used as loadbearing walls. Loadbearing cell front walls are normally 6 to 8 in. thick, depending on how the dayroom floor framing interfaces with these walls.

Exterior walls should be a minimum of 6 in., but can be in the form of a sandwich panel with a layer of rigid insulation between wythes of reinforced or prestressed concrete as thin as 2 in.

Security Hardware and Communication Systems

Security hardware and communication systems are two of the most complex and important considerations in a justice facility. The selection of these specialty equipment systems, and their ultimate location and installation, have an impact on the design and fabrication of precast concrete components. It is, therefore, important to coordinate the planning of these subsystems early in the project. If such early coordination is not possible then attachment devices such as weld plates can be cast into the precast panels for field installation of this hardware.

Security hardware differs greatly from commercial and builder's hardware. The physical size of these specialty items, in addition to the complex operating functions, often requires detailed coordination with the hardware supplier, the hollow metal frame manufacturer, and the precast concrete manufacturer. By coordinating these items early, door and window frames can be pre-installed in the precast concrete elements at the precasting plant, greatly simplifying the field installation work, as well as saving valuable time along the project's critical path.

Joint Mechanics—Location and Security Treatment

As in most precast concrete structures, incorporating practical and economical joint details is a prime consideration in designing the building. This important consideration is magnified for detention and correction facility construction.

All joint treatments should recognize realistic production and erection tolerances. Interior joints should provide soundproofing, achieved, for example, by grouting, to reduce the noise level transmission which is often a concern in this building type. If the joints are exposed to the elements (exterior applications), they should provide for movement and also be weatherproofed to prevent air and water infiltration. Elastomeric joint sealants are generally used for exterior exposure.

When the joints are exposed in a high security location, such as an inmate's cell, further treatment is generally necessary to resist abuse. The preferred method is to use a high strength, non-shrink grout. This material can be used to seal narrow joints and also to fill the cavities over recessed structural connections.

Mechanical and Electrical

As with any structural system, accommodating the needs of the mechanical and electrical systems requires coordination between designers and suppliers when using precast components for justice facility construction. The ability to prefabricate portions of the building away from the site has tremendous advantages in both time and money. Many of the mechanical and electrical systems can be incorporated directly into the precast units at the plant.

Cast-in-place electrical conduits for security locking systems and controls, as well as communications conduits, supply and return air grilles, attachments for security toilet and light fixtures, can be accomplished at the same time the precast components are manufactured.

Inmate Cells/Housing

The repetitive nature of detention/correction housing lends itself to precast components. This is especially true for the basic building block in prisons and jails ... the inmate cell. Floors, walls, and ceilings can be factory precast as a unit, complete with all specialty hardware and mechanical/electrical fixtures and furniture installed (see Modular Box Components). A more common approach is to ship and erect the individual components for the cells and install all the mechanical, electrical, and other assemblies at the site in the precast chases provided between the cells. This provides more design flexibility, but the designer should nevertheless strive for repetition and simplicity of construction so that speed and economy will result.

Cell design and the need to configure the cells around major circulation and support services are strong determinants that often dictate the facility design. An important aspect of this is the strict requirement of security surveillance and management. Direct sightlines from control stations provide the best response in meeting these needs. Reliance upon electronic supervision should be minimized. The following features should be considered to further enhance the value of cell facilities.

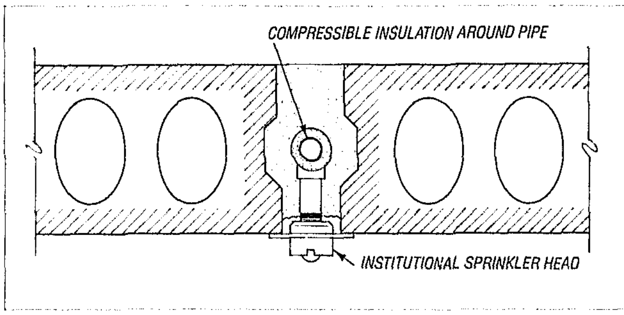


Fig. 1 A fire protection sprinkler supply pipe embedded in the grout joint between precast concrete floor planks.

– Vision from the control station and dayroom ... provide a window in the cell door.
– Maintenance access to mechanical/electrical services from outside the cell.
– Surface or recessed fixtures.
– Communications systems, i.e., intercom, closed circuit television, etc.
– Finishes that are durable and easily maintained ... smooth finishes are most appropriate in cells.

Security Furnishings

An aspect of the justice facility which may be underestimated is the requirement for security furniture. This need is usually in the high use inmate living areas such as the individual cells, dining/dayrooms, and visiting spaces. The typical inmate cell includes a bed, table/desk, and stool. Sometimes a bookshelf is also provided. The dining/dayroom areas usually have fixed tables, stools and lounge furnishings. There are also similar requirements in the visitation areas.

The term "built-in" reflects the nature of the furnishings being physically attached to the floors or walls, rather than custom designed to fit a specific area, such as bookshelves and cabinets. The need to securely anchor these furnishings in the high security inmate living areas is to reduce the incidence of vandalism.

Precast concrete furniture components can be used successfully if the designer is aware of a few specific requirements. Important considerations in designing precast furniture is to know the limitations and characteristics of the material and the importance of proper anchorage systems. Avoid thin edge details ... such weak points are often the first thing destroyed by inmates. Casting a steel forming pan into the furniture piece will help to eliminate breakage. Initial costs would be slightly higher, using this pan detail, but replacement costs would be reduced substantially. Reinforcing steel in precast furniture is usually spaced closely in a tight grid pattern, typically 3 to 4 in. on center.

Anchorage is extremely important ... it is possible to get tremendous leverage on these furnishings which will allow them to be ripped from their anchors. Welding is the preferred choice for attachment, rather than bolts. Simple, clean detailing not only looks better, but also reduces the temptation for tampering. When attaching tables and stools to the floor, consider using embedded sleeves that can be hidden in the finished floor slab. It should be noted that tables and stools are subjected to constant use and the anchorage details should be designed to accommodate substantial abuse. Eliminate all types of projections, such as flanges, plates and angles. Also avoid spaces between the furniture and wall where contraband can be stored or hidden. Eliminating bed legs allows for uncluttered floor space underneath. When a modular box system is used, the bed is often cast integrally with the rest of the cell and the other furnishings are welded in place prior to shipment to the job site.

Support Buildings

Often overlooked in the planning and design is the importance of the type of construction used in the support buildings. Too often the bulk of the project budget is dedicated to the living areas and whatever is left over is directed toward the support buildings.

It is important to realize the support buildings serve a vital role in the institutional complex. The constantly changing needs and trends in corrections demand that the design of these support buildings be flexible. Ever changing facilities, programs and industries impact the future uses of these spaces, not to mention the need for expansion in areas such as food services, warehouse and laundry.

Utilizing long-span precast, prestressed concrete building components for construction of these support buildings will result in the realization of buildings that will be secure, economical, fireproof, easy to maintain and above all flexible in use.

Building Codes

Government fire protection regulations often demand devices which may be appropriate for most public facilities but complicate corrections administration. For example, smoke detectors should be located where they cannot be falsely set off. Sprinkler systems can be a different problem. The sprinkler heads might become a support for suicidal hanging attempts or the system could be falsely set off to cause disorder. In many states, precast concrete construction can eliminate the need for sprinklers if the facility is designed to properly detect real fire smoke and control the spread of fire by compartmentation. Sprinkler hardware can be recessed in the precast walls or ceilings to reduce inmate vandalism (Fig. 1).

Most justice facilities are required to be constructed of fire resistive materials. The fire resistive characteristics of precast concrete construction make it a primary consideration for these structures, as well as an aesthetically pleasing enclosure for the building.

Design Based Upon Use of Precast Concrete

Design flexibility can be achieved without sacrificing economy if the designer respects a few basic precast concrete construction guidelines.

- Provide repetition of precast elements ... the key to quality and economy.
- Standardize connections and reinforcement details.
- Minimize joints by using large components.
- Allow practical tolerances that will enable rapid erection.
- Integrate non-structural elements with the precast components.

The PCI Design Handbook is an excellent source for detailed design information (see Bibliography).

Factory precasting allows for maximum quality control and specified quality can be inspected prior to installation.

Components and Structural Systems

Standard Shapes

Over the years, the precast concrete industry has standardized certain shapes for typical structural components (see Table II, page 12). These shapes are available in virtually all areas of the United States. By using standard shapes, the designer is assured of receiving more competitive bids from area precast concrete suppliers since the forms for these shapes are readily available.

A popular type of building system using standard precast components is shown in Fig. 2. The double tees can span 90 ft. or more, thus giving the owner an economical large bay space (Fig. 3). The exterior double tee wall panels may be cast with a layer of insulation between two concrete layers or wythes (Fig. 9). Flat or ribbed panels are often prestressed in both wythes to prevent cracking. Haunches on the wall panels may be provided to support floor or roof slabs.

This system is well suited for corrections facilities, specifically for these uses or wherever large bays are desired:

- Administration
- Medical
- Food Service/Laundry
- Mechanical and Electrical Support
- Housing and Dayrooms
- Recreation
- Correctional Industries
- Warehouses
- Maintenance Shops

Fig. 4 shows an all-precast beam-column frame with hollow-core slab floors. The elimination of bearing walls gives the designer more flexibility for floor layout and partition wall placement. It is used often for multi-story applications. Typical bay sizes are in the range of 30 to 45 ft.

This type of system can be used for court buildings and other public or office facilities ancillary to a detention center. By eliminating structural walls and reducing the number of columns, the architect can better plan interior spaces to meet program requirements. In urban or suburban areas, exterior image is important to public acceptance of the building. With this "generic" type of framing, the architect can also employ an exterior precast panel facade in whatever shape, color and texture is deemed appropriate.

Cell Components

Precast concrete components can be used to create the cell units. Fig. 5 shows a typical four-cell configuration and the precast parts used to create it.

Flat wall panels are used between cells. Panel thicknesses of 6 in. for loadbearing walls and 4 in. for non-loadbearing partitions are common. Flat panels are usually cast horizontally then stacked onto trucks and shipped to the site.

A precast concrete "U"-shaped mechanical chase between cells can be cast in a long form as shown in Fig. 6. One or two-story cell chases can be cast in this manner. A "V"-shaped chase (also common in this building type) can either be cast "V"-shaped or cast as two flat pieces and connected together at the site (Fig. 7). If installation of plumbing is planned at the plant then the "V" chase could have a flat bottom so as to be stable during storing and outfitting operations (Fig. 7a).

Cell front wall panels are usually 6 or 8 in. thick if loadbearing and 4 or 6 in. thick if non-loadbearing. Double tee stems for the dayroom can rest directly in pockets cast in the upper cell front wall (Fig. 5). An alternative

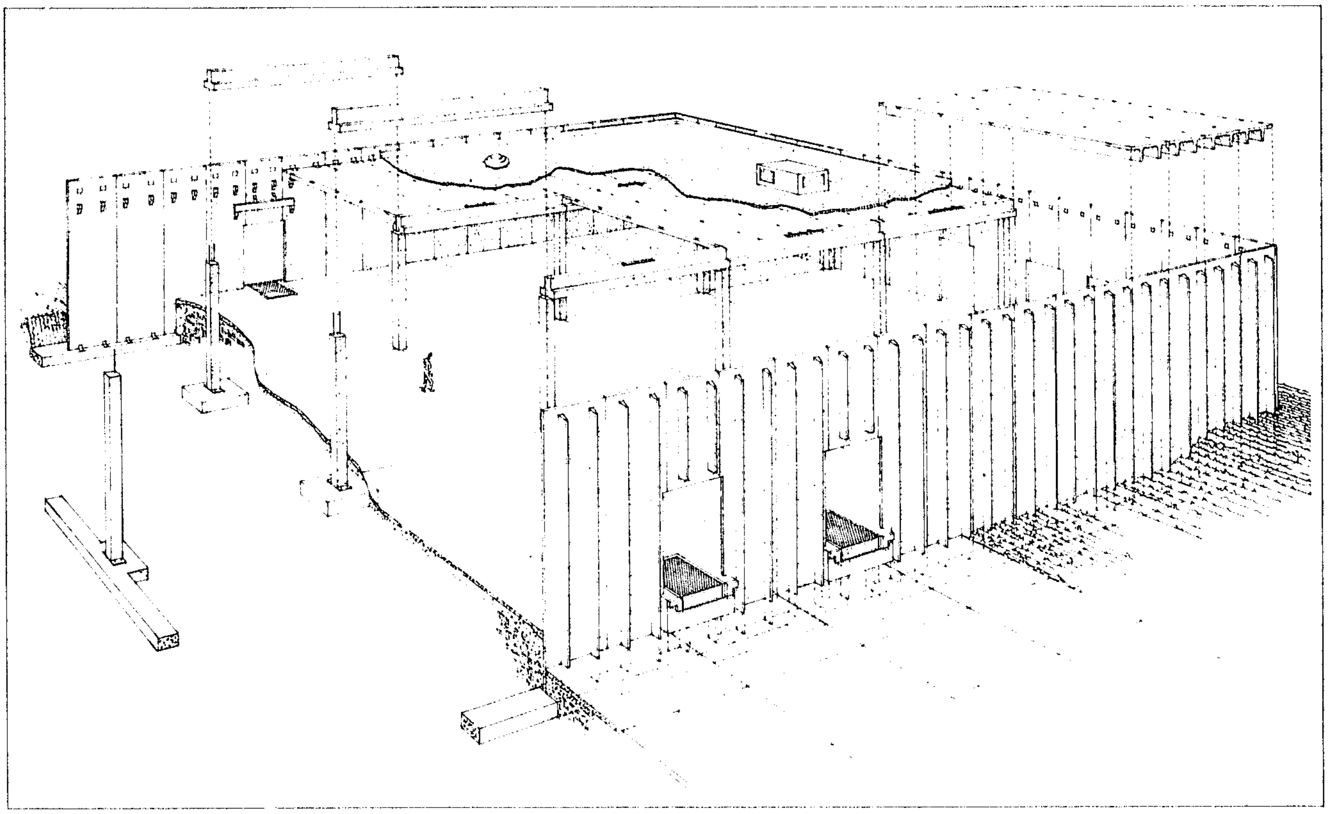


Fig. 2 Precast, prestressed double tee deck members and wall panels provide an economical large bay space.

method is to bear the dayroom framing on a beam-column frame at the cell front line or further out as shown in Fig. 8. This framing method increases the headroom above the mezzanine level in front of the cells, because the double tees stop at the beam-column frame. However, the dayroom design has to account for the extra row of columns and the resulting sightline obstructions.

Floor slab components are usually 4 to 8 in. thick. With load support at the cell front, the mezzanine level slab can cantilever over the dayroom space. The slabs can have bearing on three sides—the cell front wall or a beam, and the two side wall panels. Normally floor slabs can be conventionally reinforced concrete slabs smoothly finished on top to eliminate the need for cast-in-place topping.

Exterior insulated wall panels may be used to complete a typical cell enclosure. These sandwich panels have a structural inner concrete layer, or wythe. Over that is a layer of rigid insulation (thickness depends on "R" factor requirements). The outer concrete wythe of 2 to 2½ in. can receive a variety of architectural treatments such as an exposed aggregate or a sandblasted finish. Custom exterior fenestration patterns can be created by ribs or by using form inserts (Fig. 11). Air handling ducts can be embedded in these panels in order to reduce the size of the mechanical chase (see Mechanical-Electrical Subsystems).

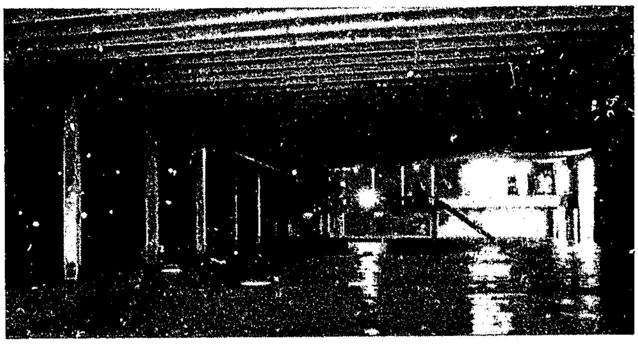


Fig. 3 Long-span double tee framing system.

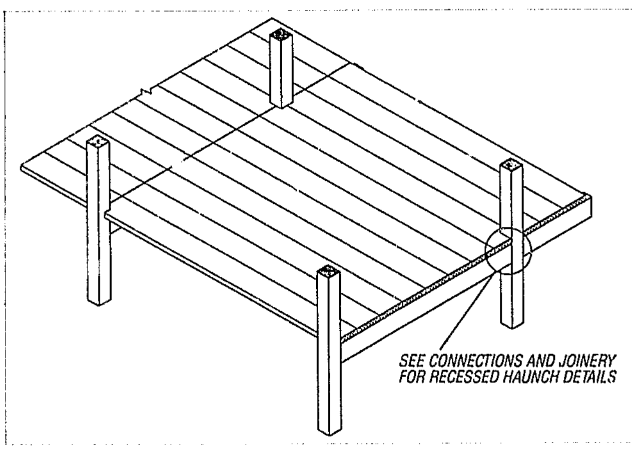
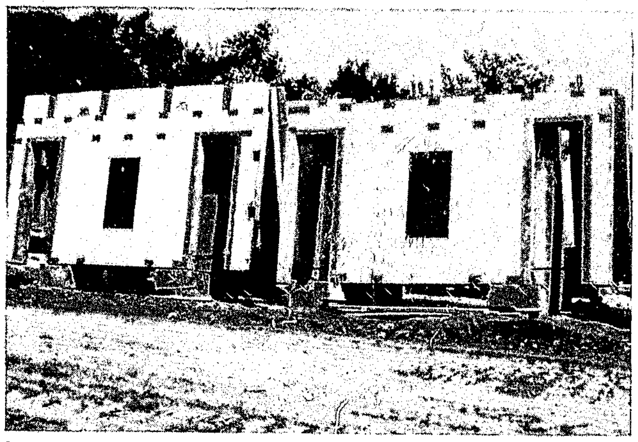
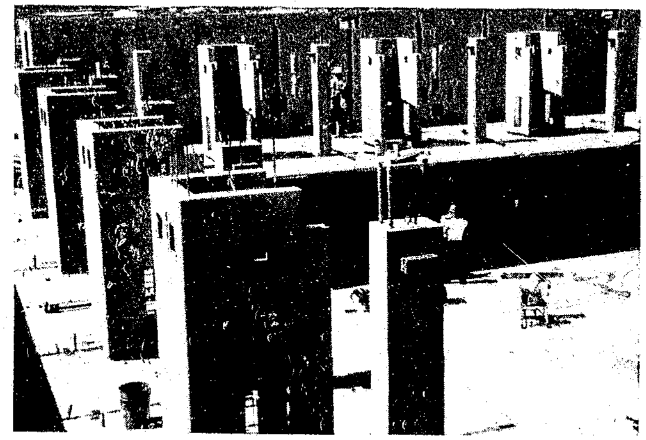


Fig. 4 A precast beam-column frame with hollow-core deck members. Spans of up to 45 ft are common.



Loadbearing cell front wall panels. Note double tee stem pockets in panel at left. Panels on right will support cantilevered mezzanine balcony slabs.



Cell chases in place prior to mechanical and electrical outfitting.

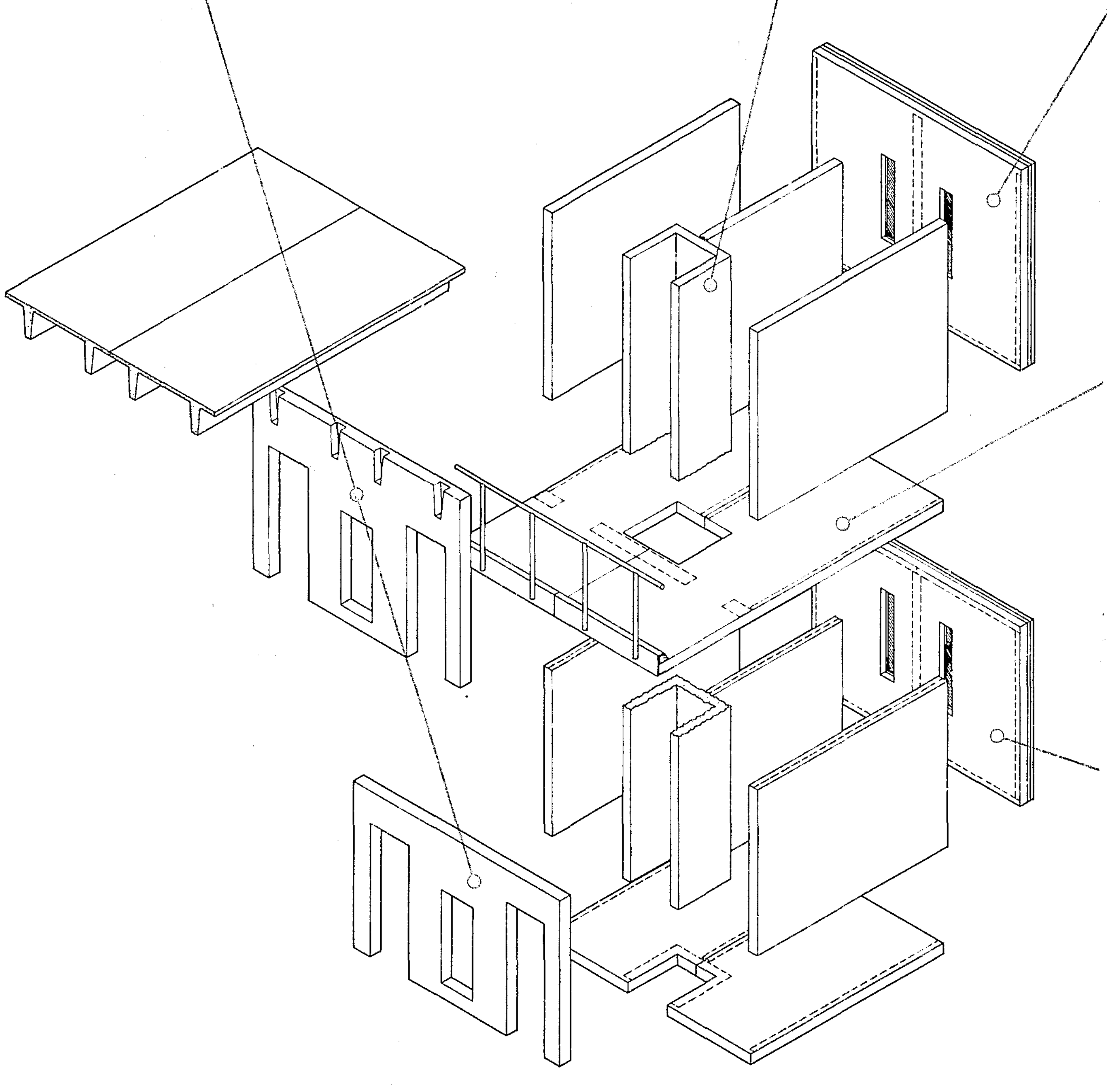
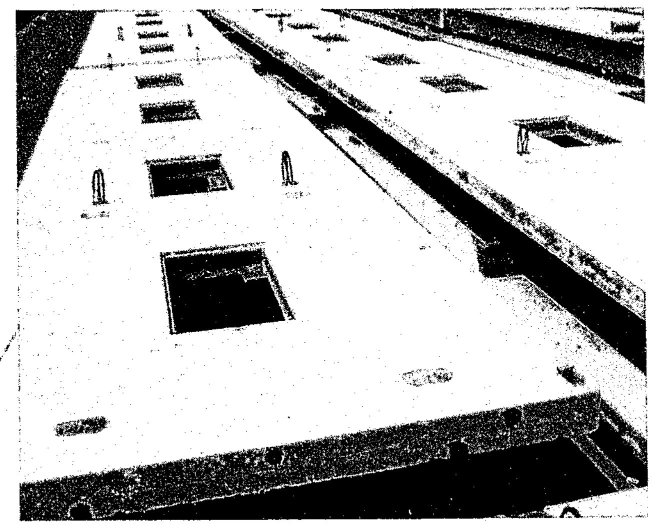
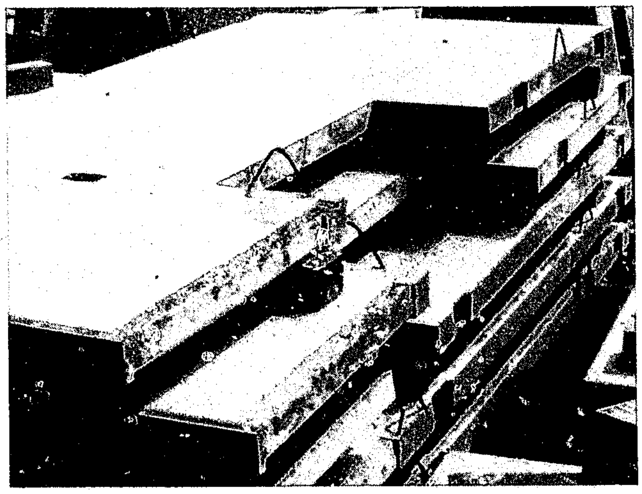


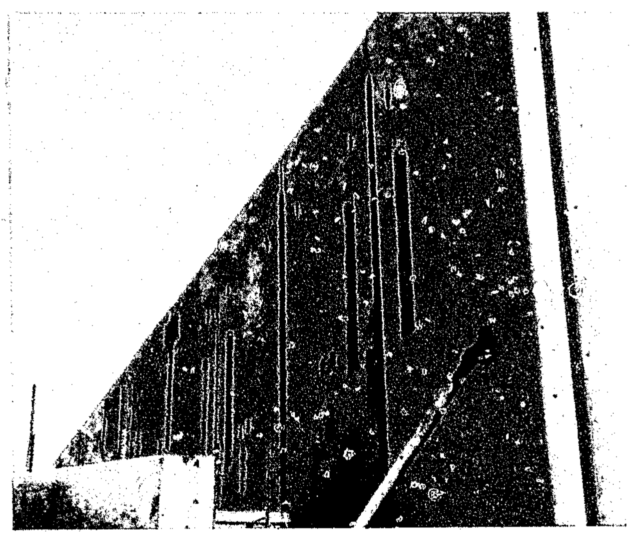
Fig. 5 Exploded view of a typical 4-cell housing configuration using precast concrete slabs and wall panels.



Insulated double tee wall panels awaiting shipment to the site. Note openings prepared for security window installation.



Precast cell floor panels. Note cut-out for mechanical chase.



Insulated flat wall panels at erection. Note "V" groove in panel edge which will be filled from the top with a high strength flowable grout (see Fig. 17).

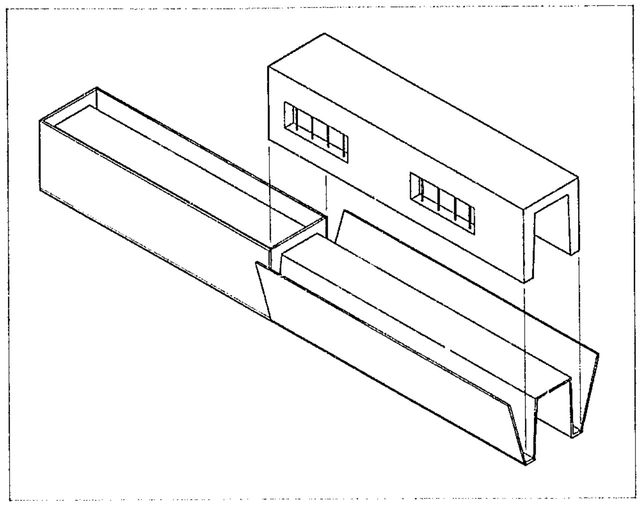


Fig 6 Two-story mechanical chases can be cast in a long form as shown.

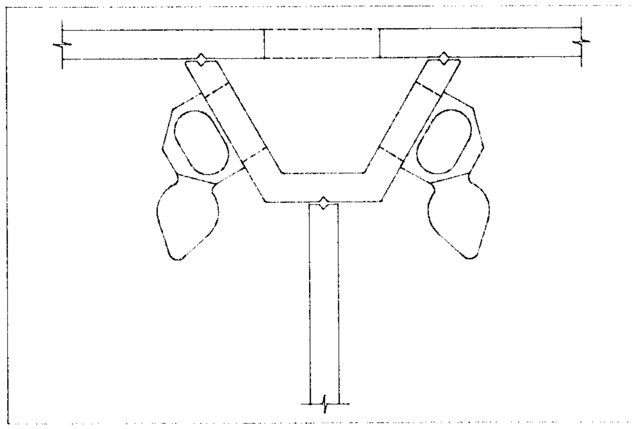


Fig. 7a Section through flat-back "V"-chase.

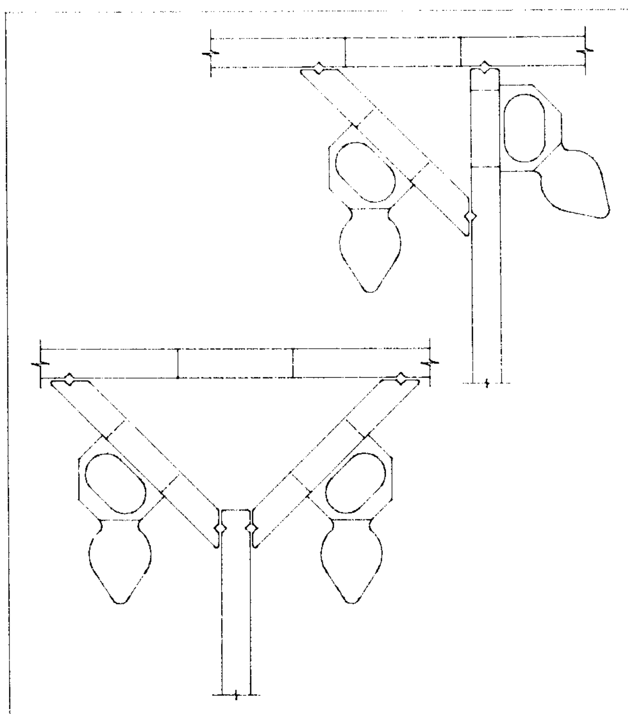


Fig. 7b Precast flat panels can be assembled in the field to create the mechanical chase.

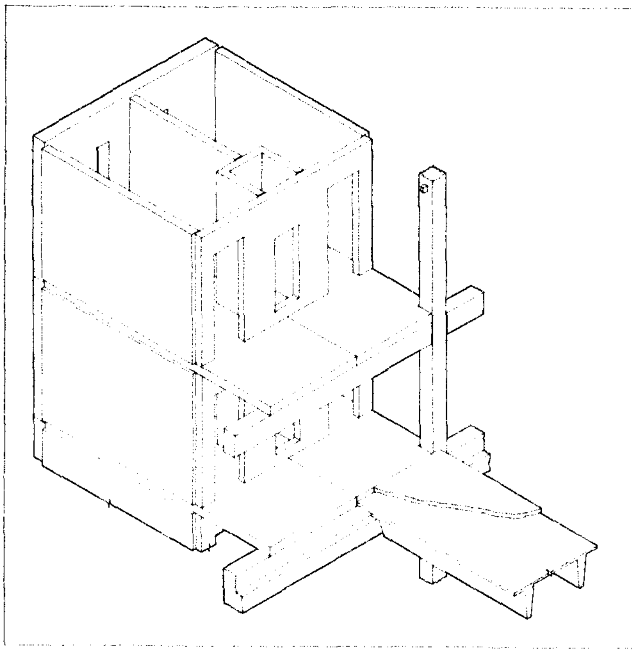


Fig. 8 A precast beam-column frame supports the mezzanine and dayroom floors.

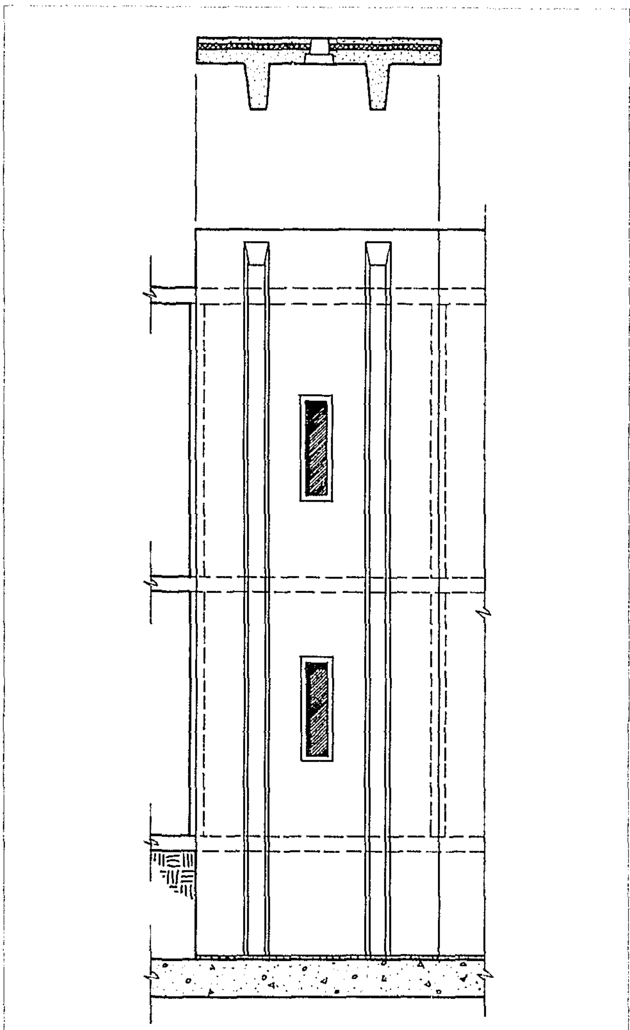


Fig. 9 Typical insulated prestressed double tee wall panel.

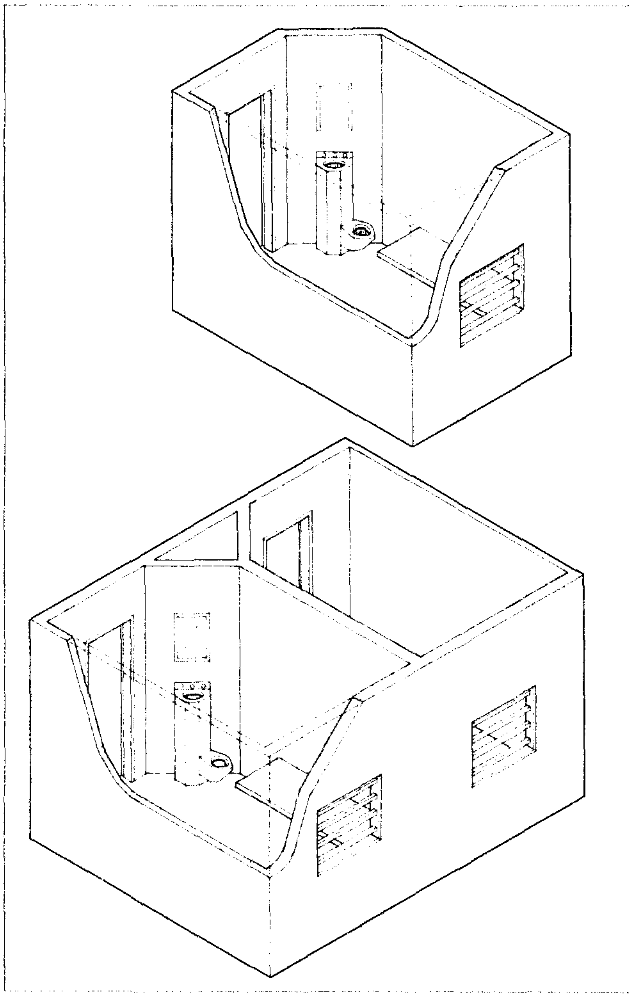


Fig. 10 Precast modular box units.

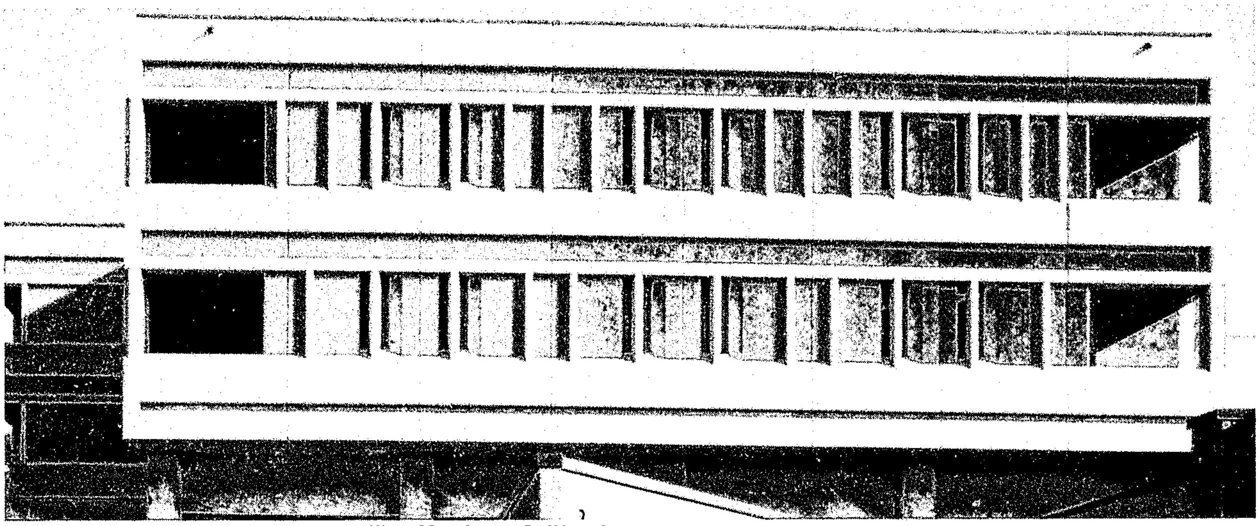
Insulated prestressed loadbearing double tee wall panels provide an economical exterior for correctional housing units up to four stories high. The panels are usually 8 ft. wide and extend from the footing slab up to the roof parapet (Figs. 2 and 9). Any of these insulated wall panels with 2 in. of polystyrene insulation will provide an "R" factor of 8 or more.

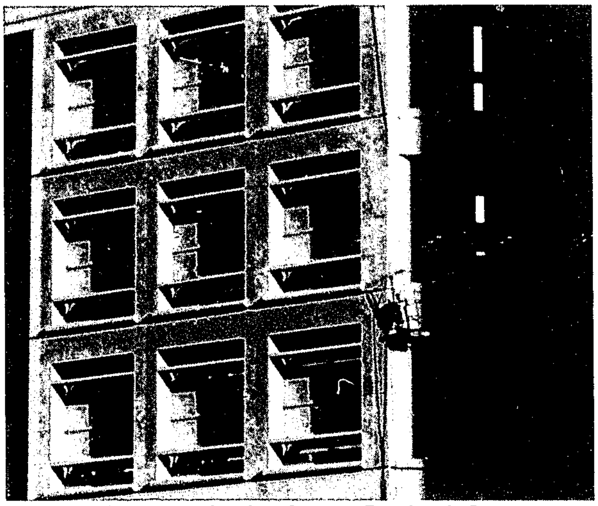
Modular Box Components

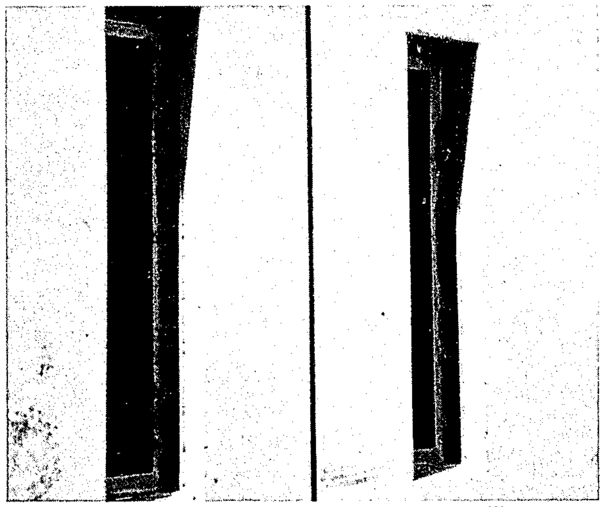
Some precast concrete suppliers have developed methods which allow them to cast an entire one-cell or two-cell unit as a modular box (Fig. 10). Furniture, hardware and mechanical and electrical fixtures are usually installed at the precast plant. In some cases the beds, desks and benches are also precast concrete. The units are then trucked to the site and lifted into position. They can be stacked for multi-story application.

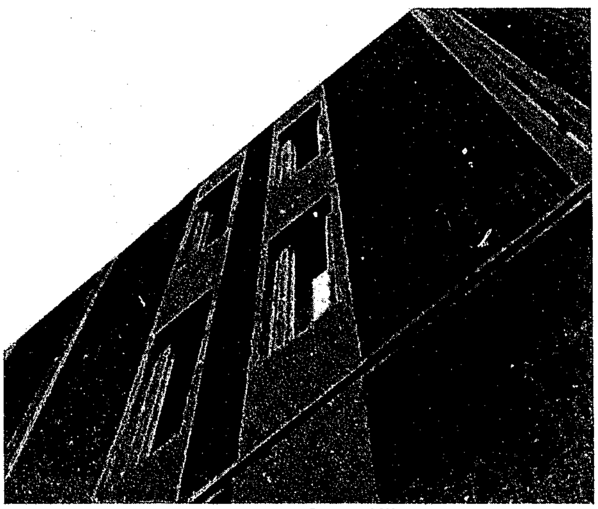
Fast erection times are possible with the modular box system. By reducing project completion time, substantial savings can result. In addition, inmate overcrowding can be alleviated sooner.

By doing as much work as possible at the plant, a higher quality level is assured. Fabrication of these box


Contra Costa County Detention Facility, Martinez, California.


Multnomah County Justice Center, Portland, Oregon.


California State Prison, Solano County at Vacaville.


Eastern Correctional Facility, Snow Hill, North Carolina.

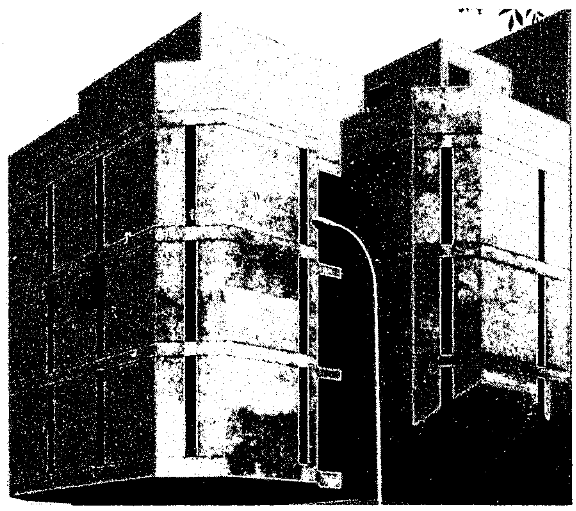

Bernalillo County Detention Center, Albuquerque, New Mexico.

Fig. 11 Exterior fenestration patterns.

units and installation of mechanical, electrical and other items is more efficient under plant control conditions. Reducing the amount of field work also reduces the overall project costs.

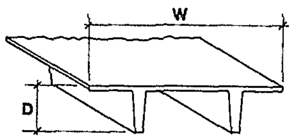
There are usually fewer joints and connections with a box system than there would be with separate panels. The wall-to-ceiling joint and/or the wall-to-floor joint is eliminated. The plumbing chase wall is usually cast integrally with the adjacent cell walls to provide a continuous cell perimeter.

Unlike separate precast components, precast box units usually require some duplication of structural components. Instead of one wall between cells, there are usually two walls. With some designs there is also duplication of floor and ceiling elements. An exterior envelope is sometimes required to insulate and cover the exterior cell walls. For tall structures, such as urban jails, additional structural elements (such as shear walls) may be required to carry the gravity load of the cells and for lateral resistance to wind or earthquake loads.

Box units may not be available in some areas since not all precast concrete suppliers have the facilities to produce them. Local availability or the size of the project are factors in determining whether to use precast modular boxes for a particular facility.

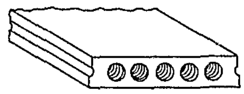
Some types of box units may place restrictions on the facility design. For example, if a box unit is 8 ft. wide, then it would be wise to consider a building dimension module that is a multiple of 8 ft. For medium or large size projects with at least a hundred cells, a custom cell could be created to meet the architectural design requirements.

Table II. Standard Precast Prestressed Concrete Components



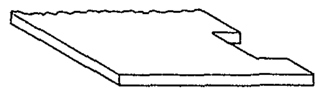
DOUBLE TEE

Width	72″ - 120″
Depth	12″ - 36″
Usual Maximum Spans	
Roof	100′
Floor	75′



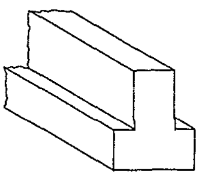
HOLLOW-CORE

Width	24″ - 96″
Depth	6″ - 12″
Usual Maximum Spans	
Roof	50′
Floor	45′



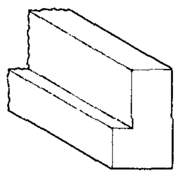
SOLID SLAB

Width	48″ - 120″
Depth	4″ - 8″
Usual Maximum Spans	
Roof	32′
Floor	30′



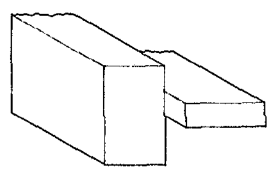
INVERTED TEE BEAM

Width	24″
Depth	20″ - 60″
Usual Maximum Spans	
Roof	45′
Floor	42′



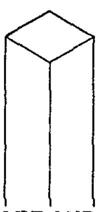
L BEAM

Width	18″
Depth	20″ - 60″
Usual Maximum Spans	
Roof	50′
Floor	45′



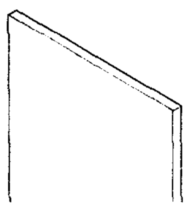
RECTANGULAR BEAM

Width	12″ - 60″
Depth	8″ - 60″
Usual Maximum Spans	
Roof	32′
Floor	28′



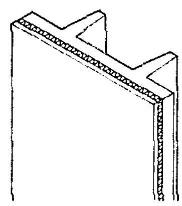
SQUARE AND RECTANGULAR COLUMNS

Width	12″ - 36″
Depth	12″ - 36″



FLAT WALL PANEL

Width	8′ - 40′
Height	8′ - 30′
Thickness	4″ - 10″



INSULATED DOUBLE TEE WALL PANEL

Width	8′ - 10′
Height	8′ - 50′
Thickness	12″ - 24″

Connections and Joinery

The purpose of this chapter is to show how standard precast concrete components, manufactured in established plants, can be assembled to provide economical and secure correctional facilities. The connections between the components may be designed as for other types of precast concrete buildings with the following additional considerations:

1. Where volume change restraint is not a significant problem, welded connections are generally preferred to bolted types in areas not continuously supervised, such as cells.
2. In seismic regions, most structural designers prefer grouted dowels or lapped reinforcement in cast-in-place concrete, instead of welded connections (see Figs. 19b; 20b,e; and 25c).
3. Connections of all types should normally be concealed in exposed areas by recessing the hardware then grouting the cavity full with well bonded, high strength, non-shrink concrete.

Although connections between precast concrete components are essential to the integrity of the overall structure, the designer should be careful not to add more connections than necessary. It is also prudent not to specify unnecessary expansion joints. Expansion joints are not needed except for unusually large or irregular buildings. Expansion joints are costly to install and maintain, and their introduction frequently requires additional costs to overcome the structural deficiencies of a discontinuous building.

Regular consultations with a local precaster are recommended when planning connection designs and specifications. The precaster can advise as to what types of connections would be most economical for a given application.

Structural Connections

Structural connections for precast concrete components are usually classified as follows:

- Column to foundation
- Column to column
- Beam to column
- Slab to beam
- Wall to foundation
- Slab to wall
- Slab to slab
- Wall to wall

The connection details shown in Figs. 12, 13, 14, 19 through 25 are only some of the many concepts that have been used for precast concrete structures. The connections illustrated are appropriate for detention/correction facilities.

Welded connections are often preferred for penal buildings. Welded connections do not require high precision in fabrication and erection tolerances. They are also quick and easy to make, as well as economical. Recessed welded connections covered with high strength grout are essentially tamper proof.

Welded connections should not be used in situations where they will restrain large volume change strains. Welded connections are to be avoided at the bottom of prestressed concrete members attached to rigid supports. Welds at the top of these members do not cause restraint cracking (see Figs. 12; 20a,c,d; 21b,c,d; 22b,c; 23; 24; and 25b,d).

Bolted connections are also appropriate in many cases, although they require more precision in fabrication. Oversized holes or slots should be provided in attachment hardware for erection tolerance and in some

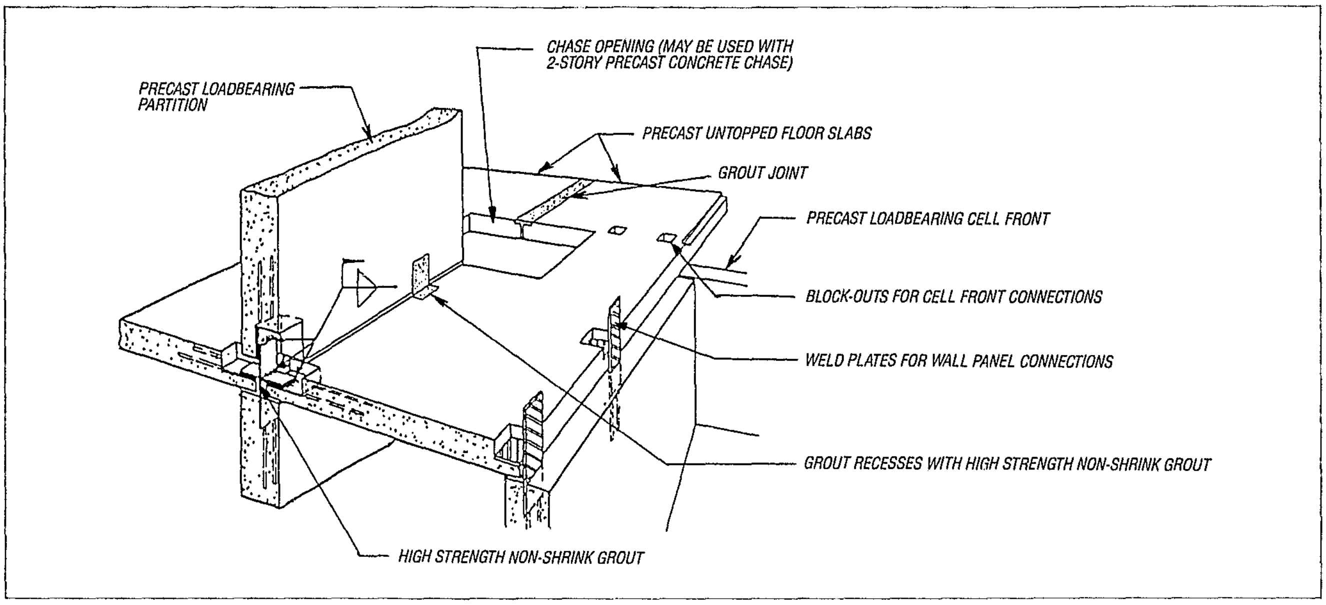


Fig. 12 Cutaway view of the connections required for a typical cell.

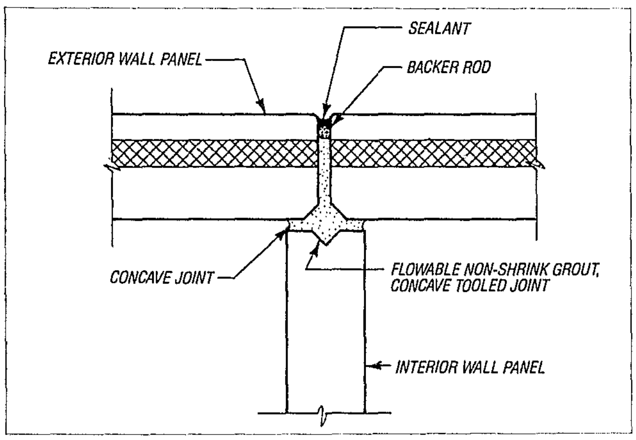


Fig. 13 Plan view of intersection of interior cell walls and exterior non-loadbearing insulated panels.

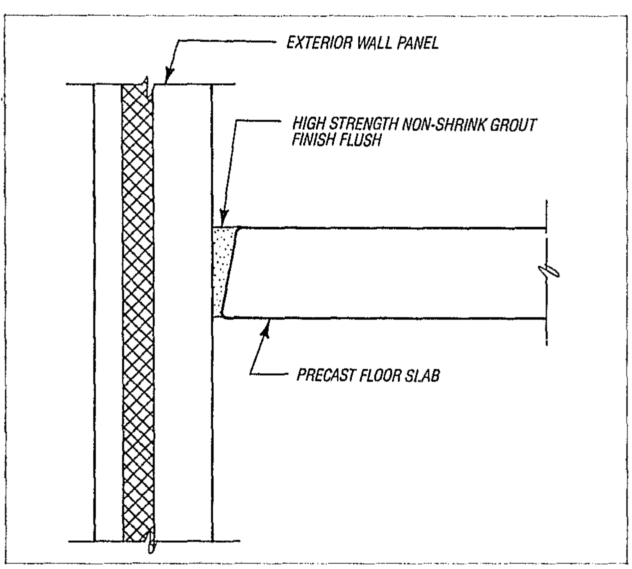


Fig. 14 Vertical section showing joint between floor slab and exterior panel.

cases for volume change movement. If recessed bolted connections are used in exposed areas the block-outs or recesses must be deep enough to provide adequate cover for the encasing mortar (see Figs. 19a,c; 20b,f,g; and 25a).

Cast-in-place concrete connections are ideal for corrections facility construction. Cast-in-place connections have proven to be resilient enough to accommodate volume change restraint and concrete encasement is often desirable to eliminate ledges, holes, and joints which could be caches for contraband. Cast-in-place concrete is also useful for embedding continuity reinforcement in those cases where it is required for lateral resistance and ductility, as in seismic design (see Fig. 20e).

Reinforcing bars can be spliced horizontally or vertically with the use of metal sleeves filled with high strength, non-shrink grout. These connections have been thoroughly tested to demonstrate that the required strength and ductility of the reinforcement can be developed in relatively short splice lengths. Figs. 19b and 25c show how the technique can be used to connect columns and wall panels.

Grouted Joints and Closures

To realize the full potential of precast concrete construction in terms of quality, construction speed and economy it is desirable to have as much of the construction "dry" as possible. Concrete topping is not needed on short span solid floor slabs and is unnecessary for roof systems even in high seismic regions. Topping is recommended for longer span hollow-core or double tee floors.

Grouting is necessary in many locations in corrections buildings, for structural, architectural, and security purposes. Grouting is a relatively expensive operation so designers and contractors should devote careful planning to this item.

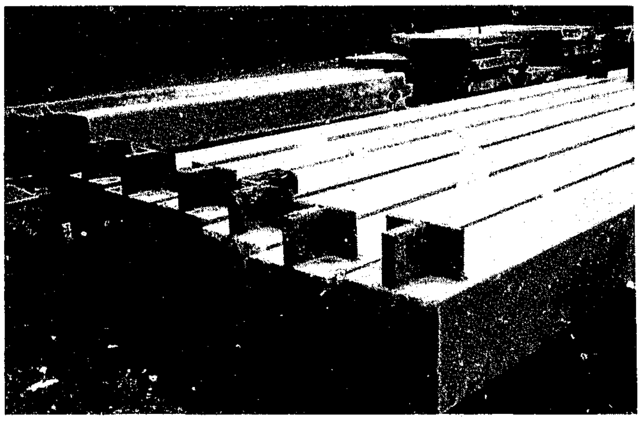


Fig. 15 Column haunches consisting of embedded steel angles allow concealed connections as shown in Figs. 16 and 20d.

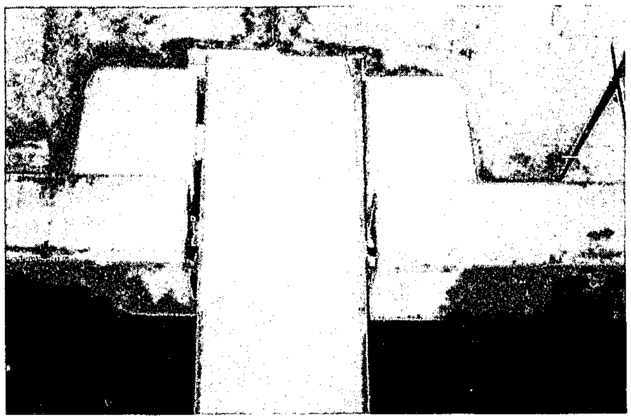


Fig. 16 "L"-girders bearing on concealed column haunches. A recessed block-out in the girder soffit is filled with a well bonded, non-shrink mortar.

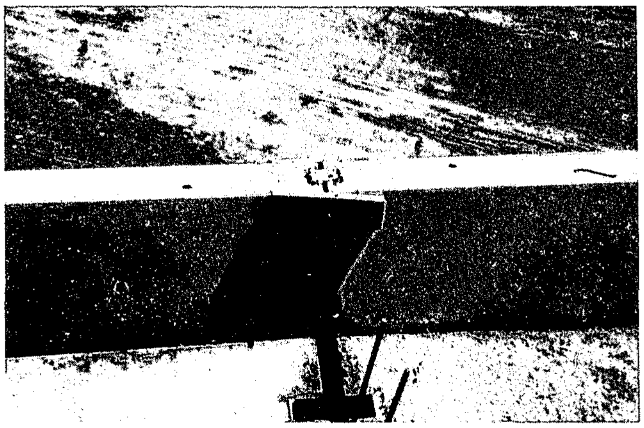


Fig. 17 Vertical panel-to-panel joint is filled with a flowable non-shrink grout.

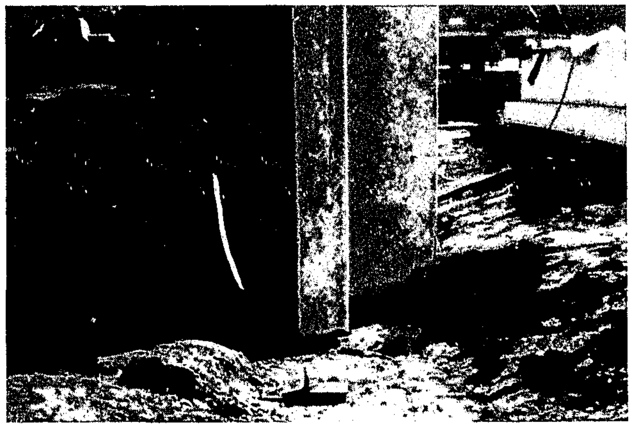


Fig. 18 Insulated double tee loadbearing wall panels usually bear directly on the footing.

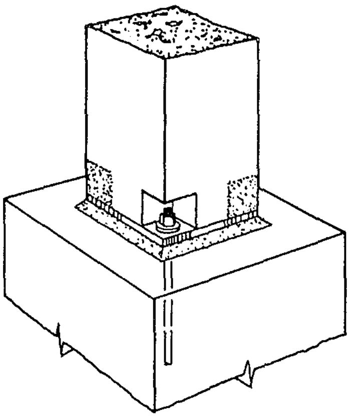
There are several types of grout which are used in precast construction. The consistency of grouts and mortars may be termed "flowable", "plastic" and "stiff". Some specifications provide techniques for quantitatively defining these general terms. There are many good proprietary grouts which have high strength and low shrinkage even at flowable consistency.

Non-proprietary portland cement grouts and mortars are satisfactory for grouting under wall panels (Fig. 23), pockets in columns (Figs. 19a,c), keys between hollow core slabs (Fig. 22a) and the vertical gaps between floor slabs and wall panels (Figs. 25a,b,c). Very stiff mortar, called "dry pack", is preferred under column base plates (Figs. 19a,c) and the horizontal joints under wall panels (Figs. 25a,b,c) when there are several levels of attached panels. High strength, non-shrink flowable grouts are also satisfactory for these applications if tests can demonstrate that the grout possesses the necessary strength to resist the bearing stresses.

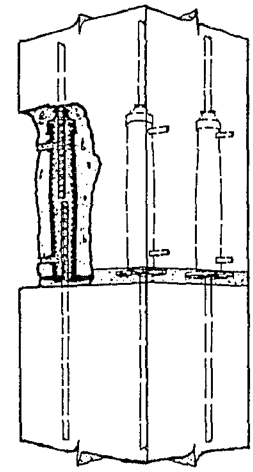
High quality, non-shrink flowable grout may be used to fill the joints between wall panels (Figs. 13 and 17), between floor slabs and walls (Fig. 14) and between floor slabs (Figs. 22b,c). Plastic consistency mortar is sometimes preferred for the latter two applications but steps should be taken to assure good bond of the mortar to the precast members when this option is used. Flowable grouts require forming or some method of sealing the joint prior to grouting. The joint shown in Fig. 13 may be achieved by retaining the grout with compressed foam plastic (elastomeric) rods. For exterior joints, the rod doubles as backing for the sealant and stays in place, but for interior joints the elastomeric rod can be attached to a wood forming strip which is removed shortly after the grout takes initial set. After grouting, the joint can be cleaned of grout leakage and hand tooled. Flowable grout used in joints such as Figs. 14 and 22b can be retained by tape on the undersurface or by forming strips.

Plugging connection recesses such as in Figs. 12, 16, 20g, and 25a,b,c should be done with high quality, non-shrink mortar. Overhead encasements such as in Fig. 16 and large vertical encasements should be reinforced by welding studs, bars or mesh to the connection hardware prior to mortar application.

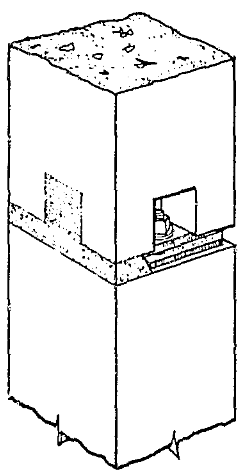
When proper attention is given to grouting by the designers in the contract documents, and by the contractors in planning their operations, the finished joint will provide superior strength, appearance, and durability.



A. COMMON METHOD FOR ATTACHING PRECAST COLUMNS TO A FOUNDATION.

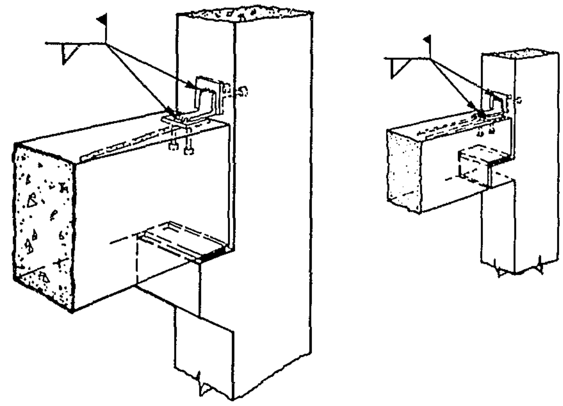


B. METAL SLEEVES FILLED WITH NON-SHRINK GROUT WILL DEVELOP STRENGTH OF REIN-FORCING BARS IN THE SPLICE SLEEVE PROVIDING MOMENT CAPABILITY.

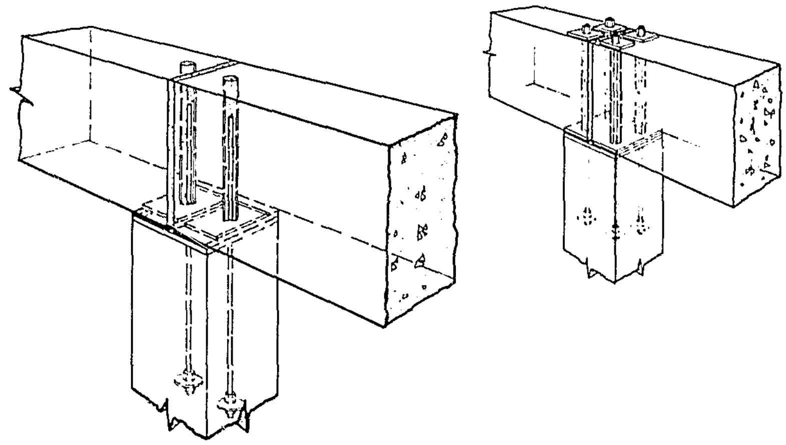


C. COLUMN SPLICES CAN BE MADE BY BOLTING AS SHOWN OR SIMILAR TO 'A'.

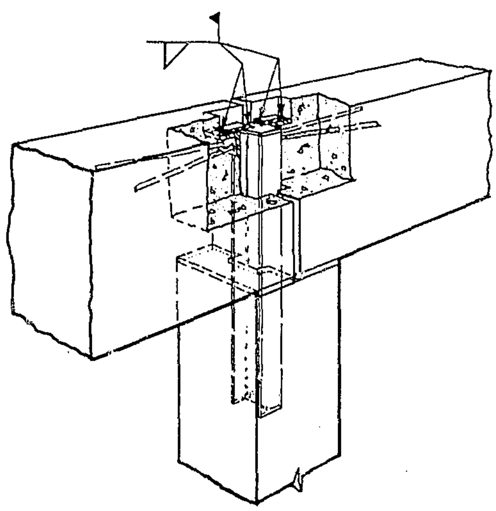
Fig. 19 Column to Column or Foundation Connections.



A. BEAMS FRAMING INTO MULTI-STORY COLUMNS BEAR ON ELASTOMERIC PADS WITH A WELD CONNECTION AT TOP. RECESSED HAUNCH CONNECTIONS ARE POSSIBLE.

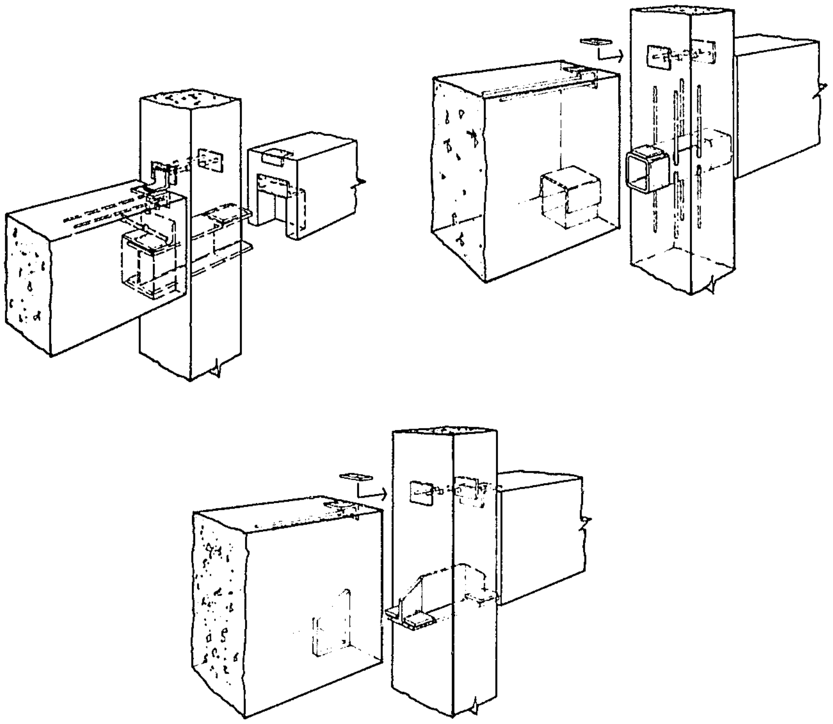


B. A COMMON METHOD OF ATTACHING BEAMS TO ONE-STORY COLUMNS IS WITH GROUTED DOWELS OR BOLTS. ELASTOMERIC BEARING PADS ARE PLACED AT THE INTERFACE.

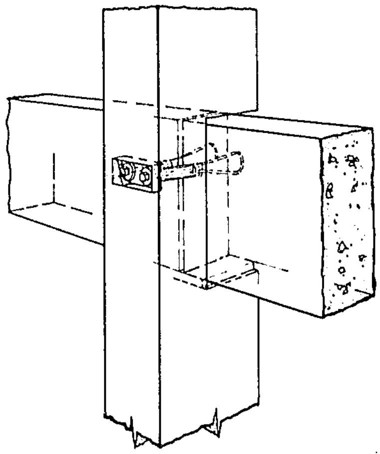


C. A STEEL SHAPE PROJECTING UP FROM THE COLUMN IS CAPPED WITH A PLATE WHICH IS WELDED TO PLATES CAST IN THE BEAMS. THE BEAMS ARE NOTCHED TO SURROUND THE PROJECTION.

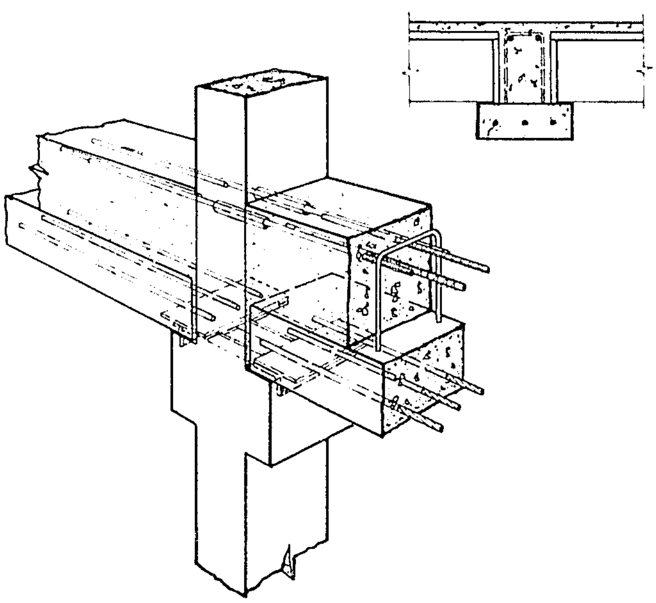
Fig. 20 Beam to Column Connections.



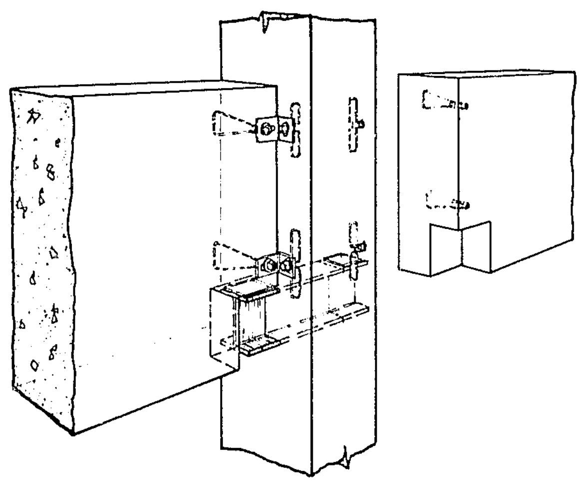
D. BEAMS FRAMING INTO MULTI-STORY COLUMNS MAY BE SUPPORTED ON A VARIETY OF PROJECTING STEEL HAUNCHES. THE BEAMS SIT ON ELASTOMERIC PADS AND A TOP WELD PLATE PROVIDES STABILITY.



F. EXTERIOR SPANDREL BEAM MAY BE BEARING OR NON-BEARING. A BEARING SPANDREL COULD BE AN "L"-SHAPED GIRDER, IF THE GIRDER IS ON THE OUTSIDE FACE OF THE COLUMN, IN WHICH CASE THE BOLTS SHOULD BE NEAR THE BOTTOM.

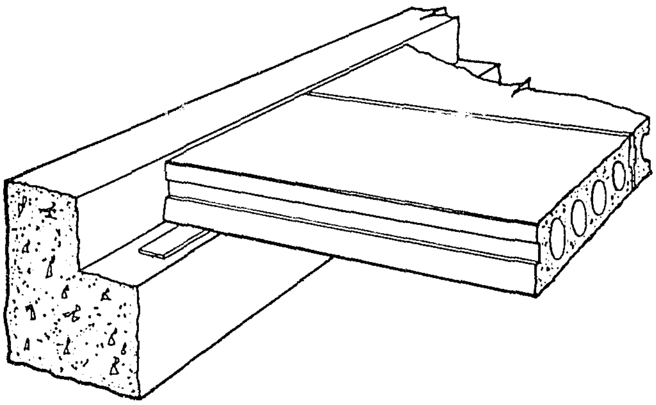


E. COMPOSITE BEAMS CAN BE USED TO PROVIDE CONTINUITY WITH REINFORCEMENT IN THE CAST-IN-PLACE PORTION. THE RECTANGULAR BEAMS MAY SUPPORT DOUBLE TEES, HOLLOW-CORE OR SOLID SLABS. SHALLOW BEAMS MAY REQUIRE SHORING.

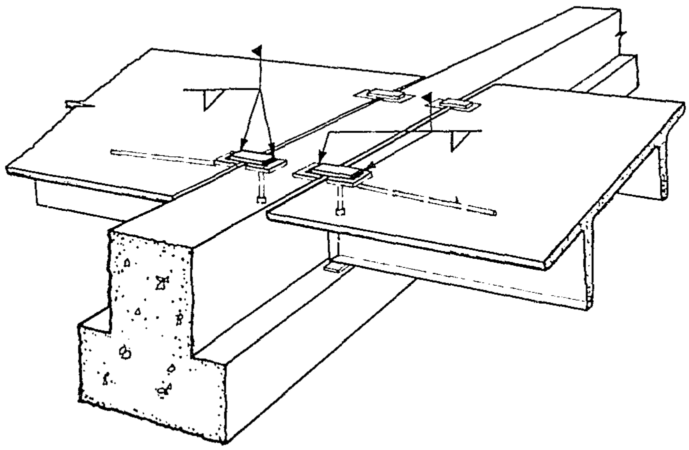


G. IN THIS EXTERNAL SPANDREL CONNECTION, NOTCHED BEAMS REST ON A HAUNCH PROJECTING FROM THE COLUMN. THE HAUNCH COULD BE A STEEL SHAPE OR REINFORCED CONCRETE. BOLTS COMPLETE THE CONNECTION.

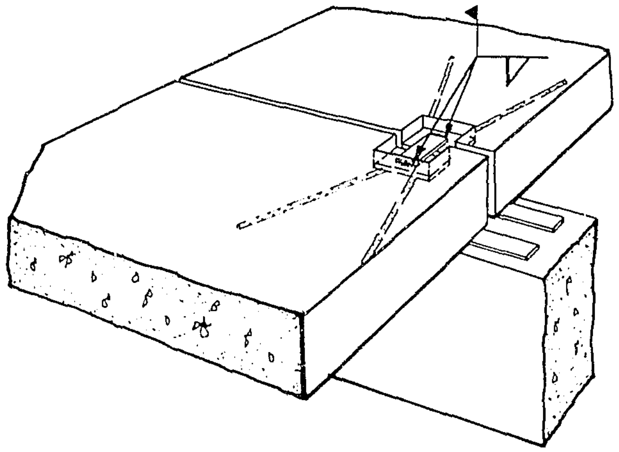
NOTE: *THE BEAMS SHOWN IN THESE SKETCHES ARE RECTANGULAR, BUT THEY COULD ALSO BE INVERTED TEE BEAMS OR L-BEAMS.*



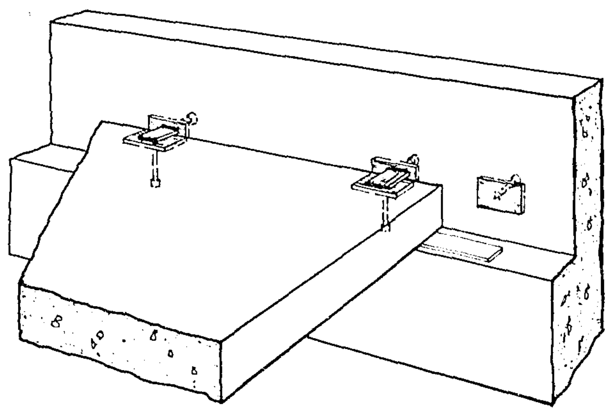
A. SLABS SHOWN HERE ARE HOLLOW-CORE BUT COULD ALSO BE SOLID. SLABS REST ON HIGH DENSITY PLASTIC OR HARDBOARD BEARING STRIPS.



B. DOUBLE TEES REST ON ELASTOMERIC PADS ON LEDGE OF INVERTED TEE BEAM. WELD PLATES AT TOP ALLOW ROTATION TO ACCOMMODATE VOLUME CHANGES.

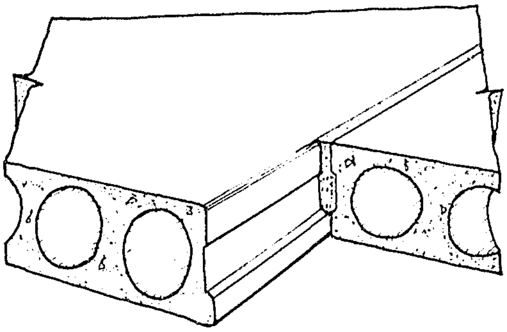


C. A RECESSED WELD PLATE MAY BE USED ON UNTOPPED FLOOR SLABS.

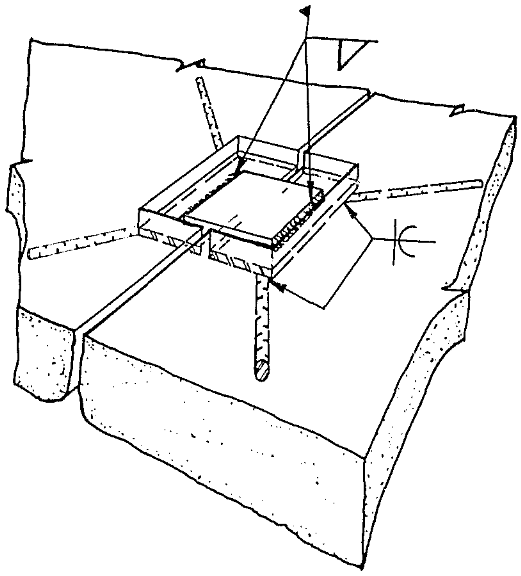


D. SOLID SLABS REST ON BEARING STRIPS WITH TOP WELD PLATE CONNECTIONS. FOR SHORT SPANS, AS IN CELLS, SLABS DO NOT REQUIRE BEARING STRIPS.

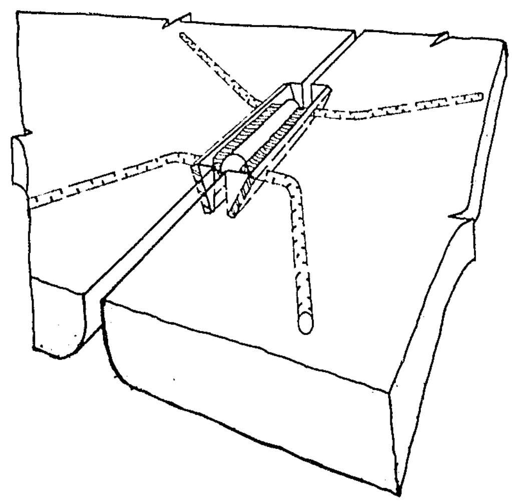
Fig. 21 Slab to Beam Connections.



A. HOLLOW-CORE OR SOLID SLABS ARE CONNECTED TO EACH OTHER BY GROUT KEYS.

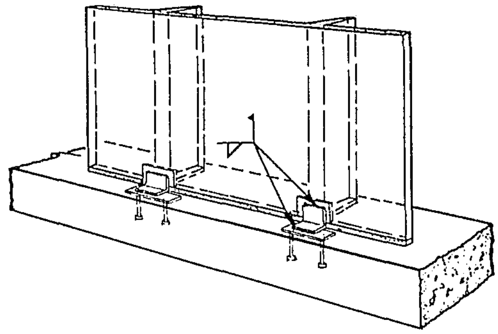


B. UNTOPPED SLABS CAN BE WELDED AS SHOWN. EDGES OF SLABS MAY HAVE A BEVEL TO HOLD A HIGH STRENGTH GROUT. RECESSES ON THE TOP EDGE ALLOW GROUT TO SMOOTH OUT SLIGHT DIFFERENCES IN SURFACE ELEVATION.



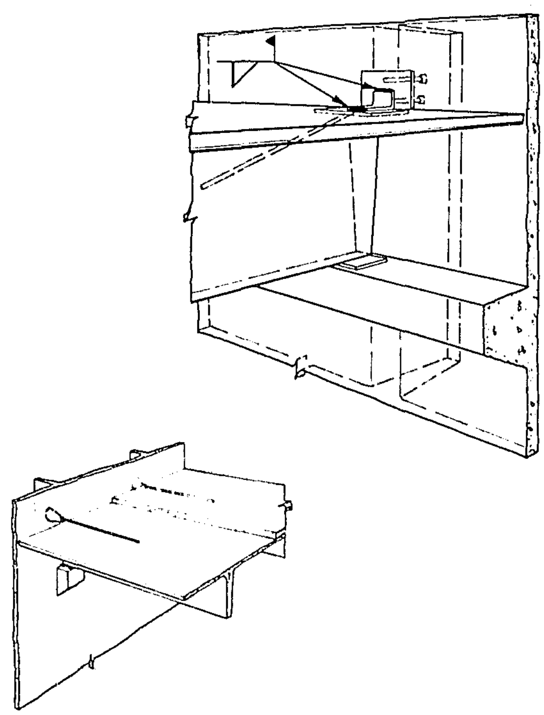
C. THIS WELD PLATE AND BAR DETAIL CAN BE USED IN LIEU OF THE CONNECTION SHOWN IN 'B'. THIS DETAIL IS NORMALLY USED TO CONNECT ADJACENT DOUBLE TEE FLANGES.

Fig. 22 Slab to Slab Connections.



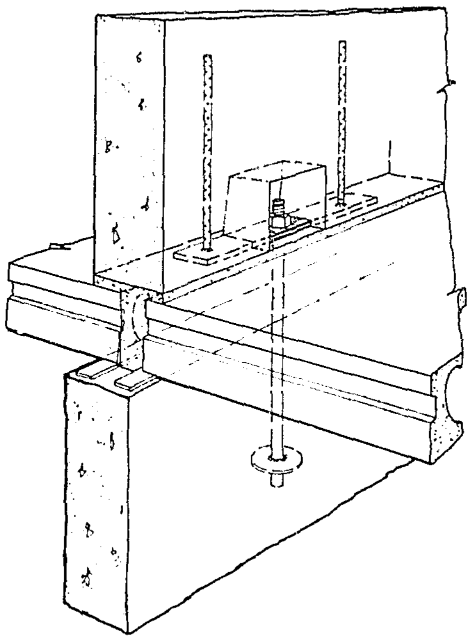
DOUBLE TEE WALL PANELS, BEARING OR NON-BEARING, USUALLY ATTACH DIRECTLY TO FOOTINGS.

Fig. 23 Wall to Foundation Connections.

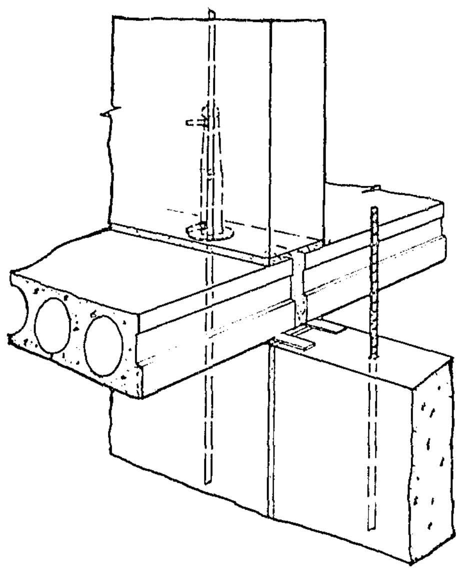


DOUBLE TEES MAY REST ON CONTINUOUS OR INTERMITTENT HAUNCHES. ELASTOMERIC PADS ARE USED ON FLOORS AND ROOFS. WELD PLATE CONNECTIONS ARE APPROPRIATE FOR ROOFS BUT EMBEDDED DOWELS MAY BE USED FOR FLOORS, WHERE TOPPING IS ALMOST ALWAYS SPECIFIED.

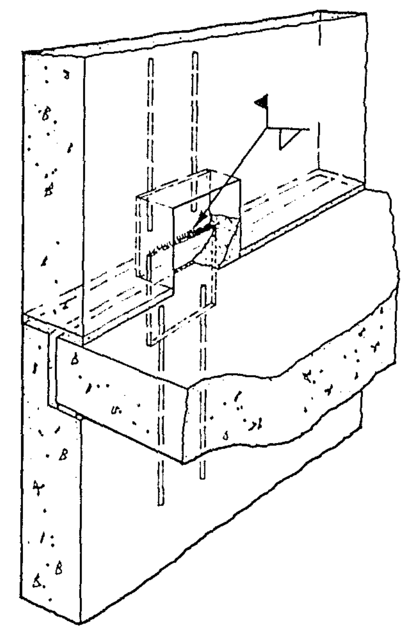
Fig. 24 Slab to Wall Connections.



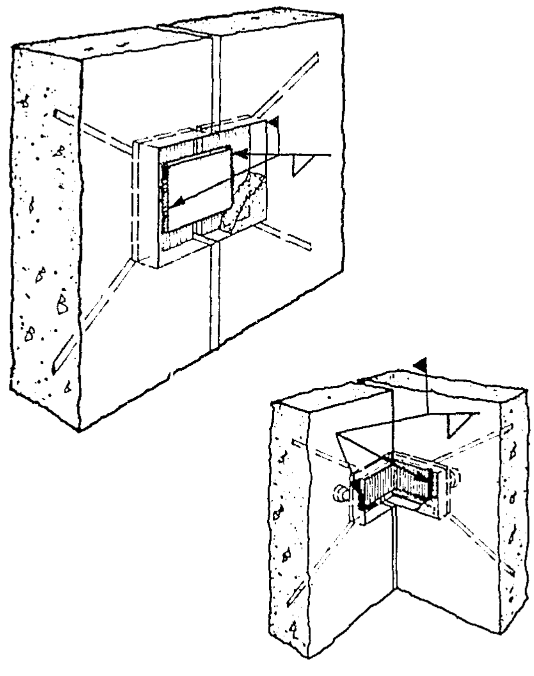
A. BOLTED CONNECTIONS BETWEEN WALL PANELS CAN BE USED IF THE BLOCK-OUTS ARE FILLED WITH HIGH STRENGTH GROUT. THE FLOOR SLABS MAY BE SOLID OR HOLLOW-CORE. FOR CELLS, THE SLABS ARE USUALLY SOLID AND THE BEARING STRIP MAY BE OMMITTED SINCE THE SPANS ARE SHORT.



C. METAL GROUT SLEEVES MAY BE PREFERRED IN SEISMIC REGIONS. WITH THIS METHOD THE CONNECTION HAS THE SAME STRENGTH AND DUCTILITY AS THE VERTICAL REINFORCEMENT.



B. WELDED CONNECTIONS ARE SIMPLE, ECONOMICAL AND CAN EASILY ACCOMMODATE DIMENSIONAL VARIATIONS DURING ERECTION.



D. HORIZONTAL WALL TO WALL CONNECTIONS ARE NORMALLY NOT NECESSARY BETWEEN LEVELS EXCEPT AT CORNERS, AS SHOWN IN THE LOWER SKETCH. WHERE PANELS ARE JOINED TOGETHER FOR GREATER LATERAL LOAD RESISTANCE WELDED CONNECTIONS CAN BE USED, AS SHOWN ABOVE.

Fig. 25 Wall to Wall Connections.

Mechanical-Electrical Subsystems

Mechanical and electrical subsystem integration is important to maximize cost savings and construction speed. Cell units often require the following services:

– Cold water	– Air conditioning
– Hot water	– Electrical distribution
– Plumbing vent	– Sprinklers
– Waste drain	– Smoke detection
– Heating	– Special security items (intercom, locks, etc.)
– Ventilation	

These services are provided by a mechanical chase, usually shared with two cells (Fig. 7). The chases can be located on the building exterior wall or interior wall. The interior corridor wall is generally preferred for maintenance access convenience. Mechanical chases can be triangular, rectangular or trapezoidal in plan.

The size and shape of the chase requires careful planning. Local plumbing code requirements may dictate the size of chase required. Obviously, any area given to the chase subtracts from the cell area. Decisions should be made about which devices will need periodic maintenance and whether they can be serviced by leaning in through the access door or will require space to work within the chase.

In order to speed construction and reduce costs, it is desirable to prefabricate as many of the mechanical and electrical conduits as possible. It is even more desirable to have them installed in the structural subsystem prior to delivery. At the time of erection, the conduits between all levels are attached together then later connected to the main distribution sources.

Plumbing Fixtures

Stainless steel water closet and lavatory fixtures are attached to precast concrete walls in the same manner as for cast-in-place or block walls. A typical combination fixture and mounting hardware is shown in Fig. 26 and 27. The fixtures are bolted to the wall from inside the chase. Space should be allowed in the chase for removal or repair. A wall mounted back-outlet water closet is preferable to a floor-mounted fixture. The cleanout should be accessible from the chase door in order to unstop blockages. For minimum and medium security facilities, many corrections officials prefer regular porcelain fixtures since they are less expensive and may be easily replaced by local suppliers.

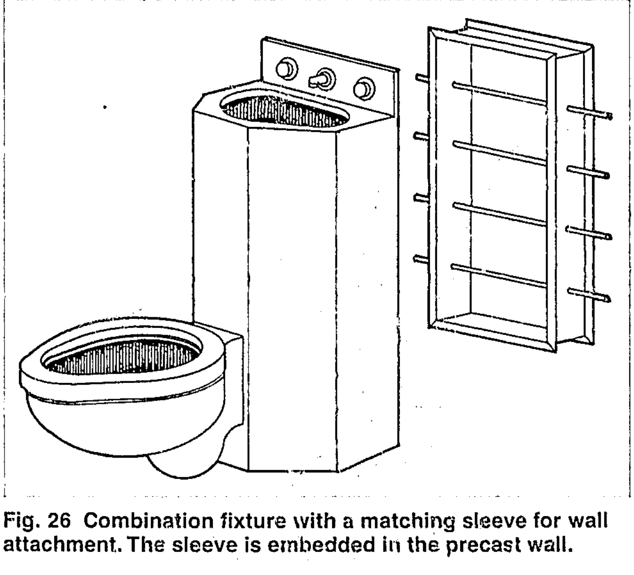


Fig. 26 Combination fixture with a matching sleeve for wall attachment. The sleeve is embedded in the precast wall.

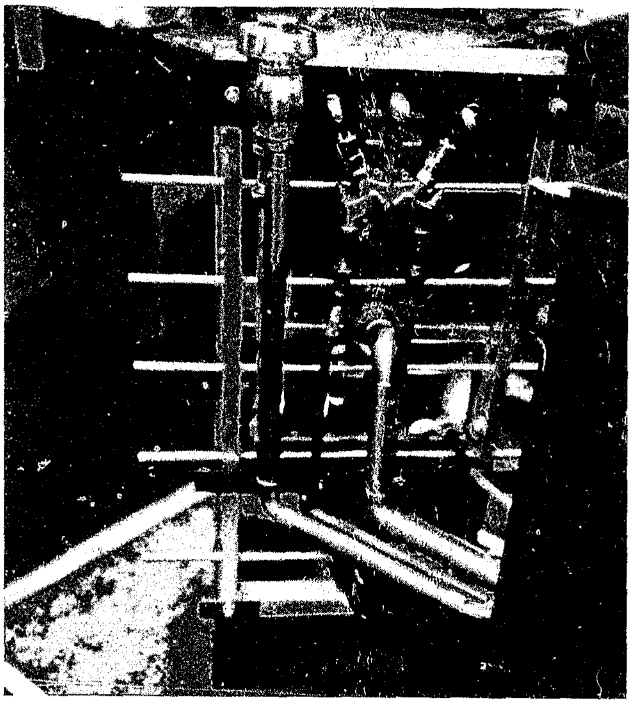


Fig. 27 Combination fixture with plumbing hardware attached.

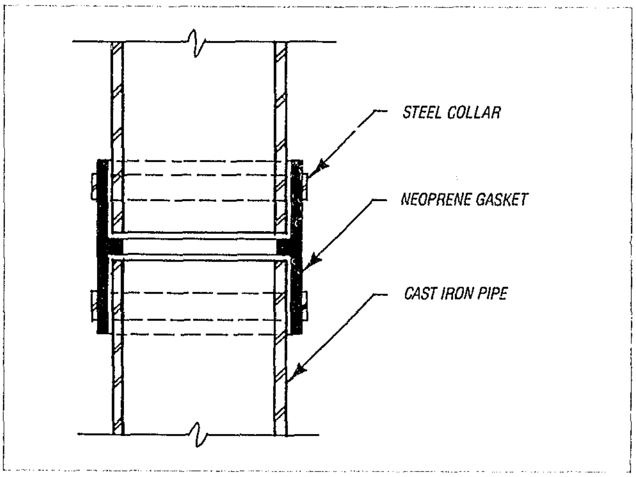


Fig. 28 A common waste or vent stack connection. The steel collars are tightened with a hand torque wrench.

Supply, Waste and Vent Stacks

The hot and cold water supply can use conventional sweated copper or threaded steel pipes. Since these pipes are small, providing space for them in the plumbing chase is not usually a problem. The horizontal feed to the mechanical chase for the cells should be located where there is no danger of pipes freezing.

Special planning is required to integrate the waste stacks into the confined area of the plumbing chase. Two water closets may share common waste and vent stacks on every floor. An entire DWV (drainage-waste-vent) assembly can be prefabricated at the precast plant and then installed in the precast chase component. Connections between floors are best made using a "no-hub" type coupling as shown in Fig. 28.

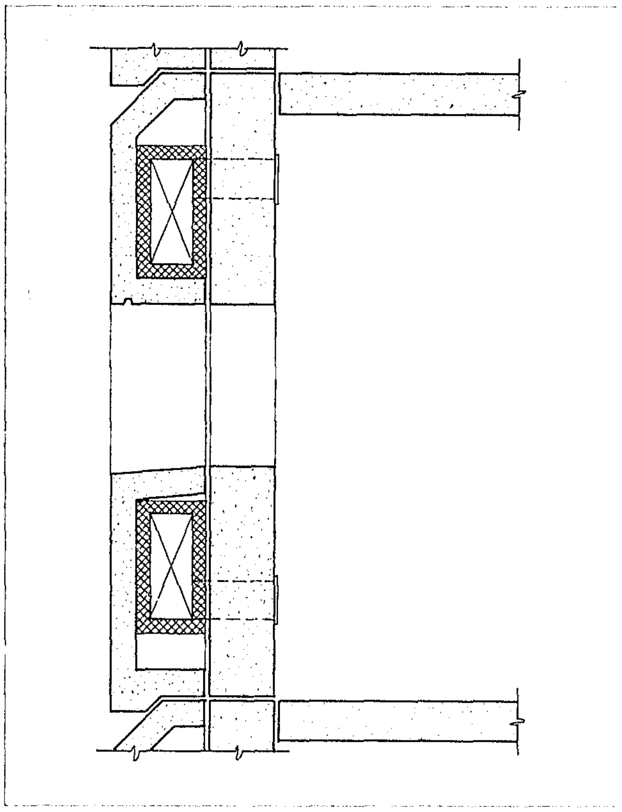


Fig. 29 Ductwork placement for Santa Clara County Hall of Justice, San Jose, California.

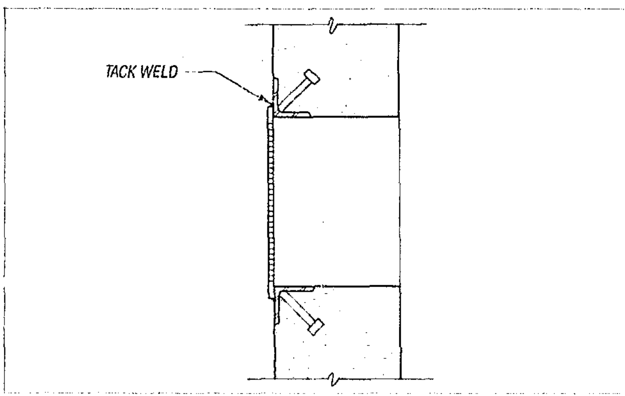


Fig. 30 Security vent grille is welded to cast-in-steel angles.

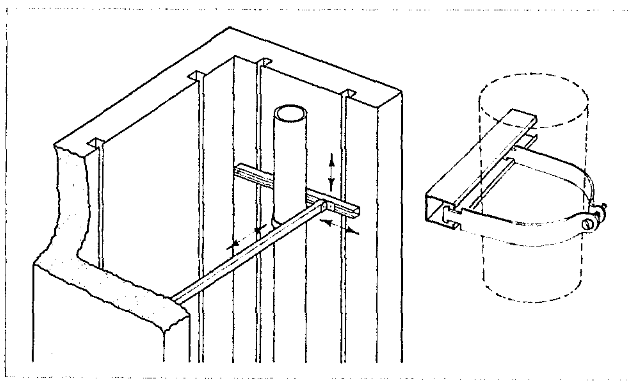


Fig. 31 Channel struts allow precise positioning of the chase plumbing and ductwork.

Heating, Ventilation and Air Conditioning

Individual cells require an HVAC supply vent and a combined exhaust-recirculation return vent. The required ductwork can take up a lot of space in the chase when more than three or four stacked cells are fed vertically. An alternative for this case is to feed the cells laterally from the exterior wall panels. The ductwork is placed between the inner and outer panels (Fig. 29). Vent grillages can generally be welded to cast-in steel plates or angles framing the vent opening (Fig. 30). The grilles can also be mounted by back access fittings inside the chase.

Electrical

Electrical conduits and boxes are normally embedded in the precast components at the plant. Coordination with the electrical contractor is required to insure that the conduits are fabricated correctly and furnished on time.

Electrical runs and conduit assemblies should be standardized. If this is not done, the number of precast panel types required will increase dramatically, which has a direct impact on cost, production schedules and overall quality assurance. For example: if a box is specified at 5 ft from the end of a panel on one floor, but is specified at 6 ft from the end on another floor, confusion and possible misalignment can result. Using a 5 ft-6 in. dimension for both floors is an obvious solution.

Standardization of electrical hardware is more important with precast construction than with many other types of construction. Corrections in the field can not be made easily. With prefabricated construction, design professionals should not expect the tradesman in the field to plan conduit runs and make adjustments for unanticipated conditions.

Fire Detection and Control

Experience with fires has shown that there is more loss of life from smoke inhalation than from the flames. Therefore, controlling the spread of smoke in correctional housing areas is very important. Often fire or smoke dampers are installed in the HVAC system wherever it passes through a fire-rated floor or wall. Maintenance of dampers in the chase HVAC ducts can be a nuisance because of the tight quarters within the chase. Access to dampers in air ducts should be located and oriented so they can be conveniently reached by maintenance people.

Conduit for the security and smoke detection system can be embedded in the precast concrete panels. Sprinklers can also be incorporated into the precast components. Coordination with the suppliers is necessary to ensure that the hardware is ready to install when the panel is cast.

Installation Techniques

When using precast components, options are available to install the plumbing and HVAC in the mechanical chase at the plant or at the job site. If the site installation option is used, recognize that the work may have to be done at exactly the same time as precast erection. With some methods of construction, the mechanical and electrical trades may be able to work after the structure proceeds. With a total precast concrete structure, some mechanical and electrical services may have to be installed as panels are being placed, otherwise the extra move-ins for trucks, cranes and crews will increase costs and cause schedule delays. Erection of precast components takes very little time, usually only a few weeks, so the mechanical and electrical contractors should be prepared to act during this short, crucial period.

When the off-site installation option is used, the mechanical and electrical contractors do some of their work at the precasting plant. Casting the cell chase as a two-story unit is recommended to reduce the number of structural, mechanical and electrial connections in the field. The chase would be laid on its back while the mechanical contractors install the required piping and ductwork. A second crew at the site would make the connections between units and to the main distribution inlets or outlets.

Channels can be embedded in the chase wall to use for attaching ductwork and piping (Fig. 31). These channel struts allow 3-dimensional adjustment so that precise alignment of the conduits and fittings can be attained. If a chase floor is required for maintenance access, metal grating can be welded to these channels at each floor level. To provide a fire-rated floor or smoke barrier a fine wire mesh can be placed over the channels at floor level and then covered with an insulating concrete.

In order to conveniently make the connections between the plant installed vertical conduits, it is best to leave a gap between the ends for the splices. The amount of gap will depend upon access requirements and the type of conduit being joined. Mechanical contractors may have individual preferences for different connection methods. Fig. 28 illustrates a popular method for connecting waste and vent pipes. Water pipes can be spliced with flexible threaded couplers or by soldering. Rectangular ducts can be spliced with conventional sheet metal clamping bands or by bolted flange coupling sections or by flexible boots.

Prior to production, a plywood mock-up of the chase should be constructed with all mechanical and electrical systems installed. Various repair procedures should be tried out on this mock-up until it is established that the layout will work.

Security Hardware

Security hardware required for corrections facilities can represent a large portion of the building program budget. In addition, a long lead time is normally required when ordering this special type of hardware. The level of security required determines the "hardness" and the cost of the system employed. A minimum security facility most closely resembles a college or military dormitory. Normal commercial hardware and fixtures can be used instead of the more expensive and austere security hardware. Medium security corrections institutions are the most prevalent. Individual cells, each with a lavatory and water closet, are used in this type of facility. Security hardware predominates in medium and maximum security institutions.

Cell Doors

There are two basic types of security doors—swinging and sliding. A sample sliding door installation is shown in Fig. 32. The door frame and tracks are welded to embedded plates or angles in the precast cell front panels. The door can be operated electrically by a guard from a remote location. An open cell front with bars is sometimes used in high security areas where a better view into the cell is desired. This assembly would attach to the cell front, which may be a beam-column frame or a wall panel system (see Components and Structural Systems).

Current trends in cell design show increasing use of swinging doors. Hinged doors have more of a residential character, which is felt to be a positive psychological benefit. They are also more economical to install than sliding doors. Installation is similar to that of a conventional steel door with the security frame welded to plates embedded in the precast cell wall or by grouting of the door frame.

Significant economy can result by installing the cell

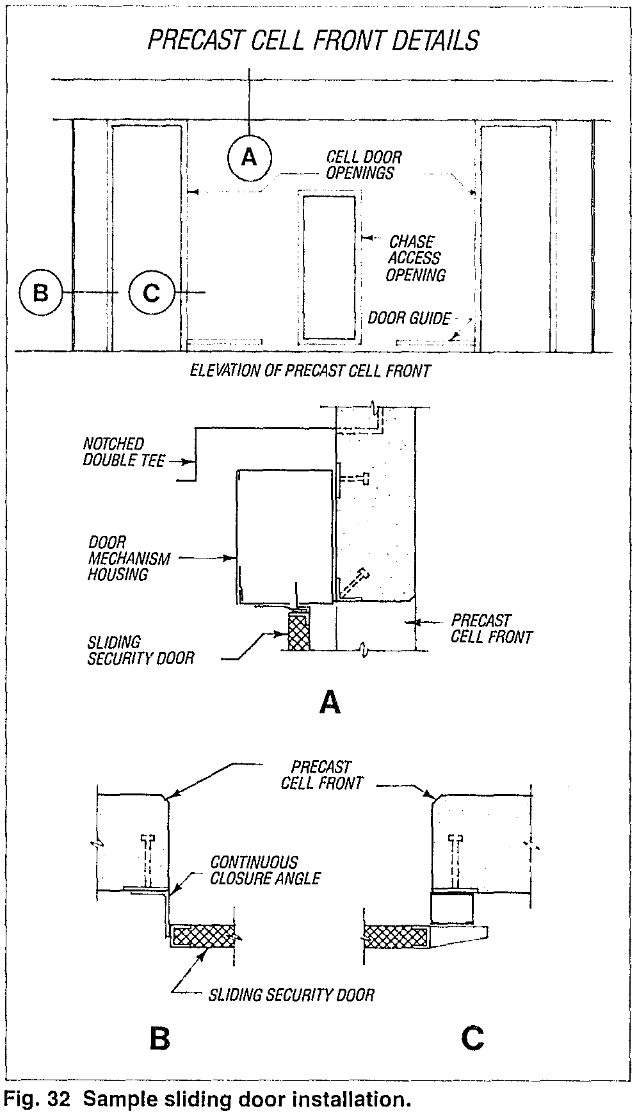


Fig. 32 Sample sliding door installation.

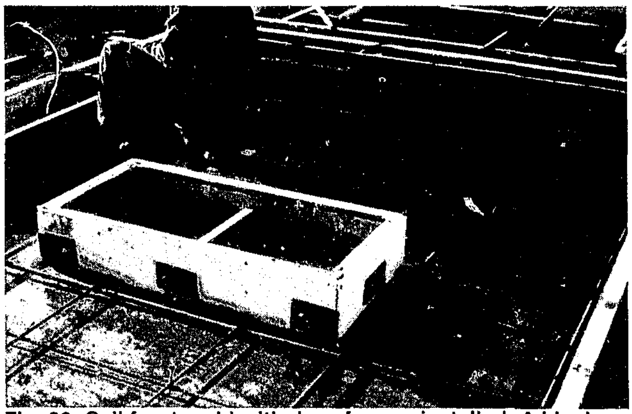


Fig. 33 Cell front mold with door frames installed. A block-out for the cell chase door is in the center.

door frames in the panels at the precasting plant. The frame can be placed in the form prior to casting. Studs welded to the frame anchor it to the wall panel. Of course, coordination with the security hardware supplier is required to ensure that the door frames will be available when the panels are cast. In addition, tolerances in door operations must be coordinated with tolerances in precast concrete production and erection to ensure proper performance.

A door is also necessary for maintenance access to the plumbing chase between cells (Fig. 32 and 33). Door size and placement can best be determined by building a plywood mock-up of the plumbing chase and checking clearances for various repair or maintenance operations (see Mechanical-Electrical Subsystems). The door should be hinged and lockable.

Security Windows

A variety of window types are available for detention/correction facilities. Installation procedures for these windows follow similar patterns. Frames are usually welded to cast-in plates along the blocked-out rough opening (Fig. 34). The window frames can be conveniently placed in the panel form at the precasting plant and cast integrally with the panel. In some cases the entire window can be cast into the panel at the plant. Again, close coordination with the window supplier is necessary to avoid holding up panel production.

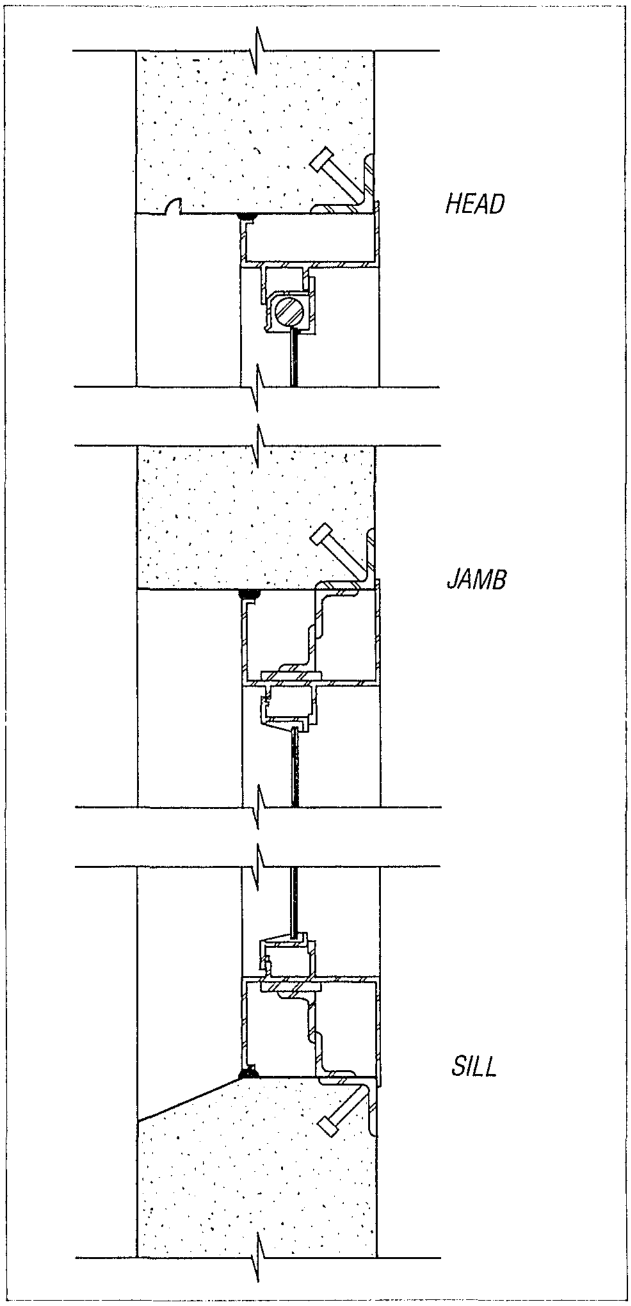


Fig. 34 A security window is welded to cast-in-steel angles along the blocked out rough opening.

Case Studies

The following case studies represent a wide range of justice facilities buildings, each selected for their unique application of precast/prestressed concrete building components. The individual design background for each case study varies greatly in the types of precast elements used, the exterior finishes specified, the selected systems, and unique design and detail application. The cost information provided is given as a base of information for each particular project. The selection of various precast finishes, structural systems and other influential elements will affect the actual price of the precast portion of the work.

Case Study 1
Louisville Division of Police
6th District Station
Louisville, Kentucky

Architect/Structural Engineer
Joseph & Joseph Architects & Engineers
Louisville, Kentucky

General Contractor
Sullivan & Cozart, Inc.
Louisville, Kentucky

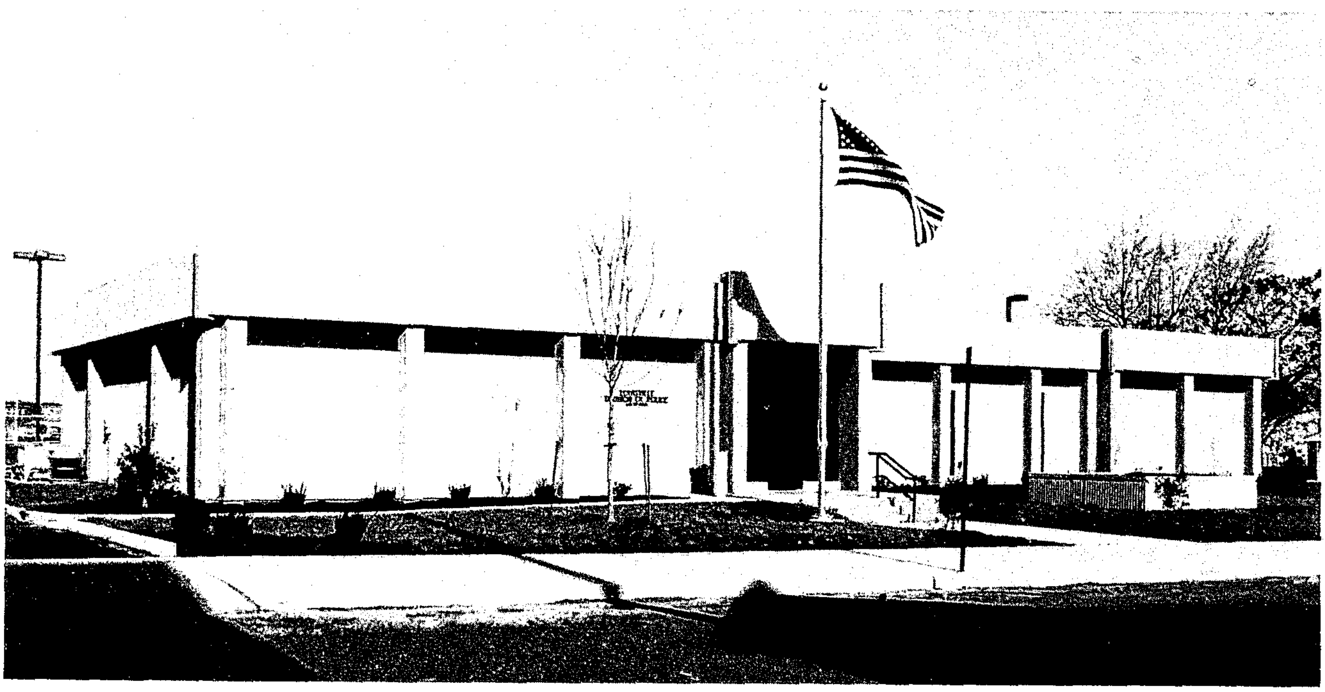
Owner
Louisville Division of Police
Louisville, Kentucky

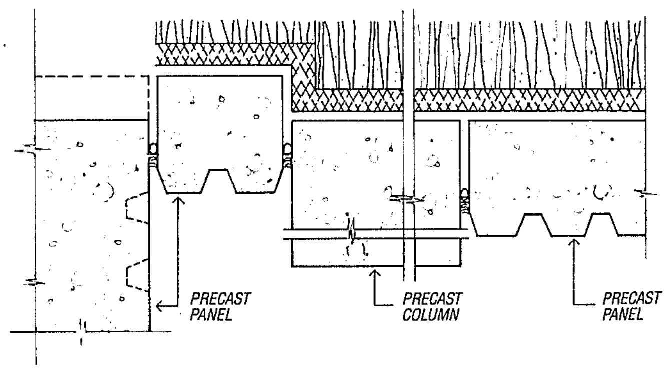
This new Police Station used 26 precast concrete wall panels as an exterior cladding system. Each panel measured 9 ft high, with widths varying from 8 to 16 ft. The precast wall panels were cast with a vertical rib appearance. The parapet was also constructed of precast panels designed to match the walls.

The building incorporated a precast column system and prestressed double tee sections for the roof system. Precast concrete panels were also used for planter walls and stair handrails.

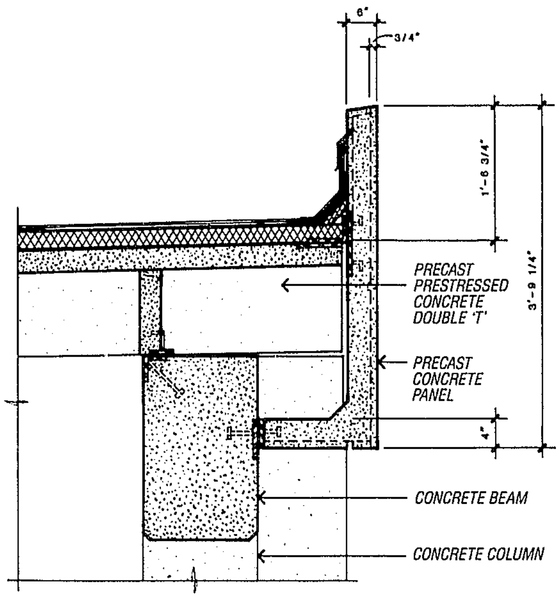
The small vehicle buildings located to the rear of the main building used precast panels for both the walls and the parapet. Precast prestressed concrete double tees were used for the roof structure.

The two structures total 8,264 gross sq ft and were built for a total cost of $484,686 (1976).



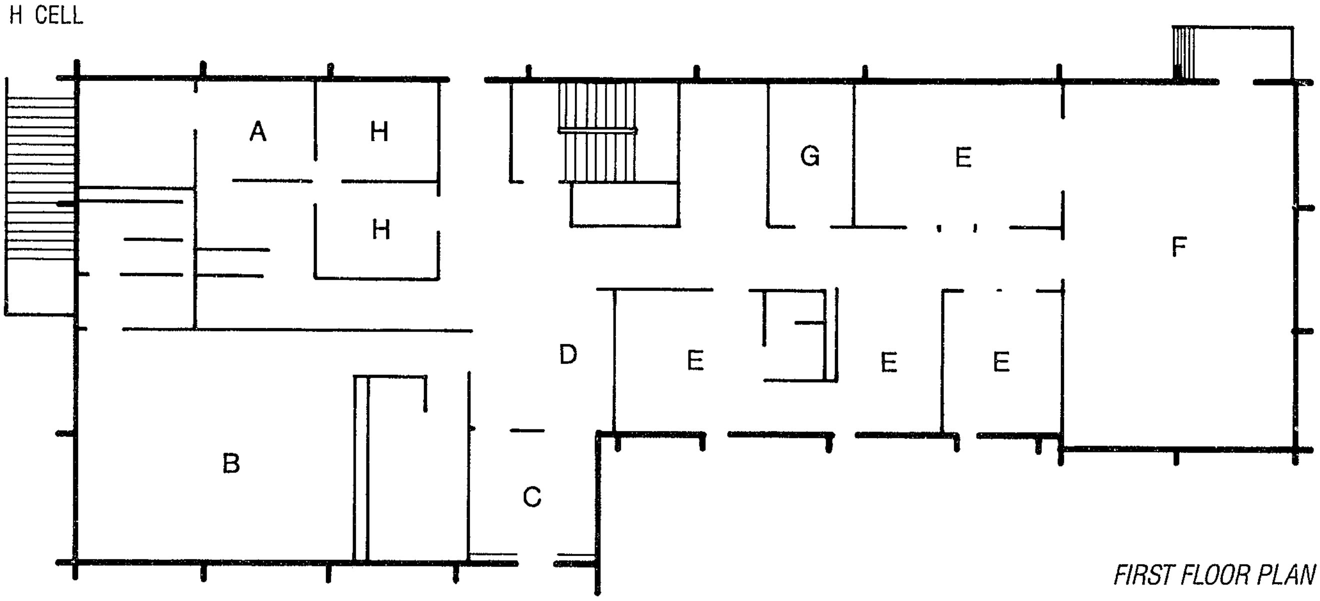


DETAIL OF COLUMN AND PANEL CONNECTION



PRECAST PARAPET PANEL DETAIL

A STAFF LOCKERS WOMEN
B STAFF LOCKERS MEN
C ENTRY
D CONTROL
E OFFICES
F ASSEMBLY ROOM
G ARMORY
H CELL



FIRST FLOOR PLAN

Case Study 2
Bibb County Law Enforcement Center
Macon, Georgia

Architect/Structural Engineer
Dennis & Dennis Architects and Engineers
Macon, Georgia

General Contractor
Gulf Contracting, Inc.
Sarasota, Florida

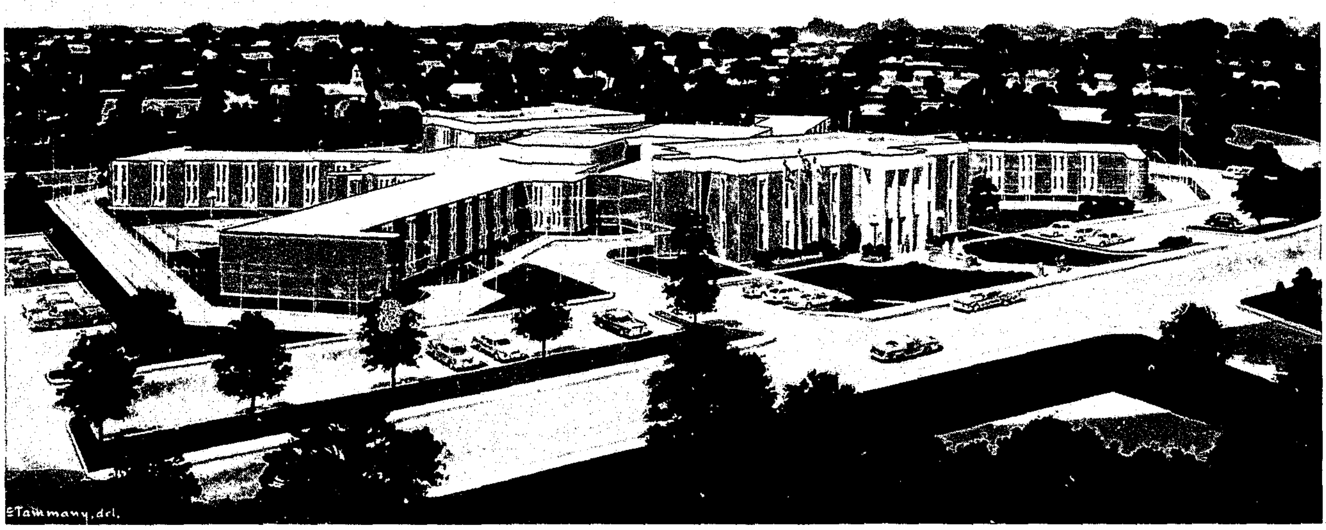
Owner
Board of County Commissioners
Bibb County
Macon, Georgia

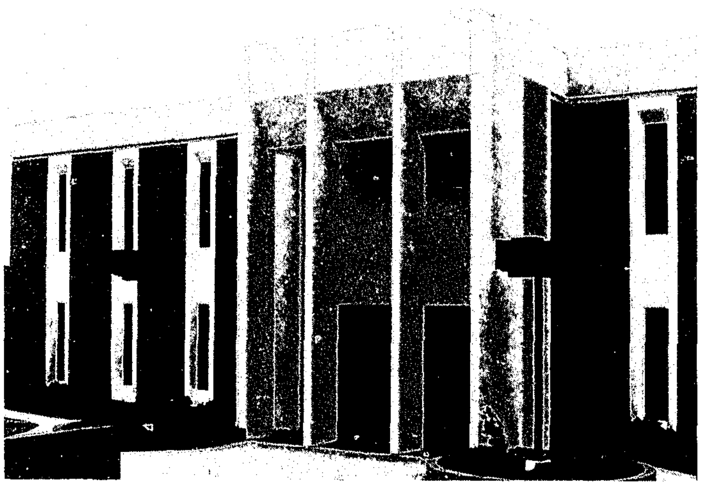
This 104,870 sq ft county owned facility is a two story structure consisting of a central core, an administration wing, and four inmate housing wings. The Law Enforcement Division occupies approximately 15,000 sq ft with the remaining area providing various support spaces for a 312 bed county jail.

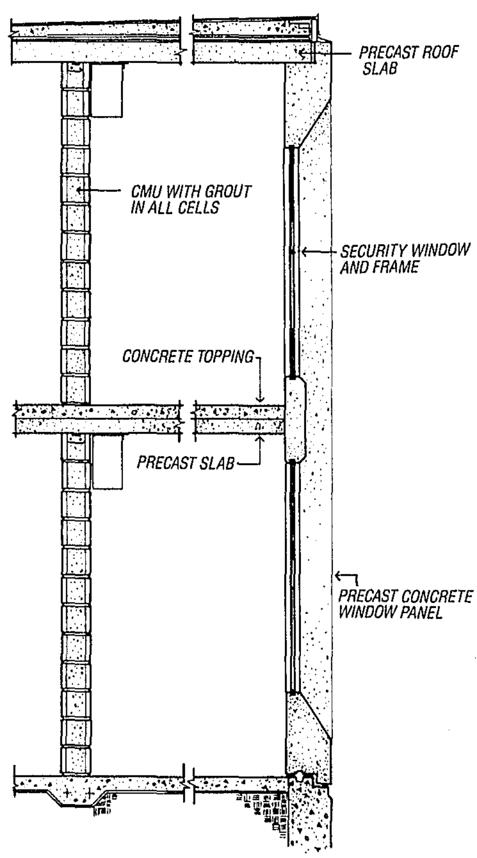
The structural shell is a combination of precast prestressed concrete and steel. All interior walls were constructed of masonry. Double tees (8 ft x 24 in.) were used for the long span floor and roof areas. Flat slabs (4 and 6 in. deep) were used on the shorter spans. A total of 537 precast pieces (76,214 sq ft) were used for the entire project. Major mechanical ducts were installed between the double tees.

A unique precast window unit was used in the prisoner housing areas. The narrow window design presents a public facade that appears relatively humane, but does not sacrifice the important security considerations.

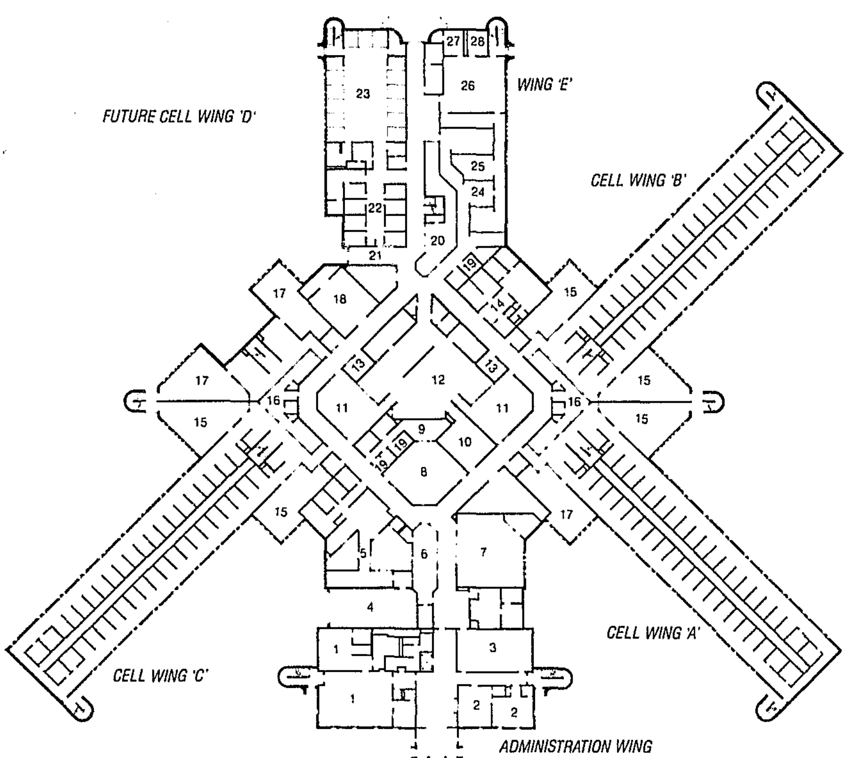
Construction cost for this project was $5,139,217 (1976). The facility was completed in 1979.







WALL SECTION THRU CELL WING



1 SHERIFF'S DIVISION OFFICE AND LOCKERS
2 SHERIFF'S OFFICE
3 COURT HEARING ROOM
4 PRISONER TRANSPORT ENTRY TRAP
5 BOOKING & CLASSIFICATION
6 MASTER CONTROL
7 LIBRARY
8 CHAPEL
9 LINE-UP
10 STAFF DINING ROOM
11 PRISONER CAFETERIA
12 KITCHEN
13 PRISONER COMMISARY
14 INFIRMARY
15 PRISONER DAY ROOM
16 CELL WING CONTROL ROOM
17 FUTURE DAY ROOM
18 LAUNDRY
19 PRISONER INTERVIEW ROOM
20 CONTROL NO. 3
21 SERVICE ENTRY
22 WOMEN'S INDIVIDUAL CELLS
23 WOMEN'S DORMITORY
24 VISITATION—PRISONER SIDE
25 VISITATION—VISITOR SIDE
26 VISITOR WAITING ROOM
27 MEN'S REST ROOM
28 WOMEN'S REST ROOM

Case Study 3
Jackson County Adult Detention Center
Pascagoula, Mississippi

Architect/Structural Engineer
Slaughter & Allred
Pascagoula, Mississippi

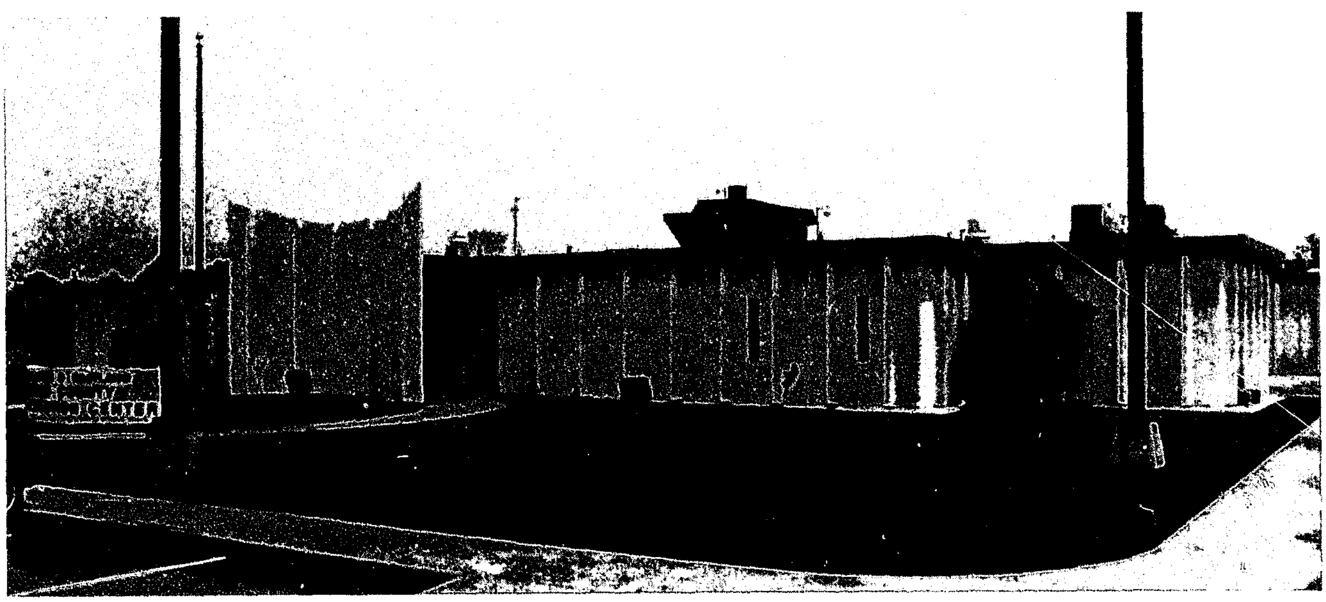
General Contractor
Fletcher Construction
Pascagoula, Mississippi

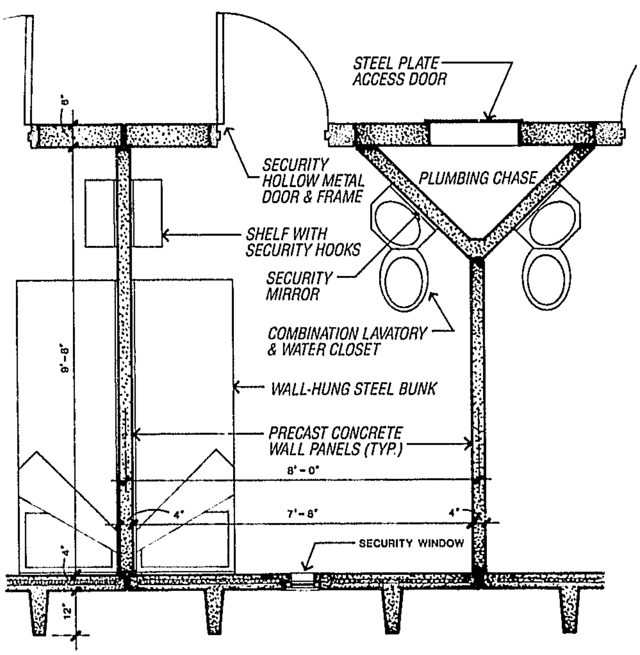
Owner
Board of Supervisors
Jackson County
Pascagoula, Mississippi

The 79 bed, 22,078 sq ft jail facility was completed in 16 months, from January, 1978 to May, 1979. The totally precast concrete system was selected to make an attractive and secure facility.

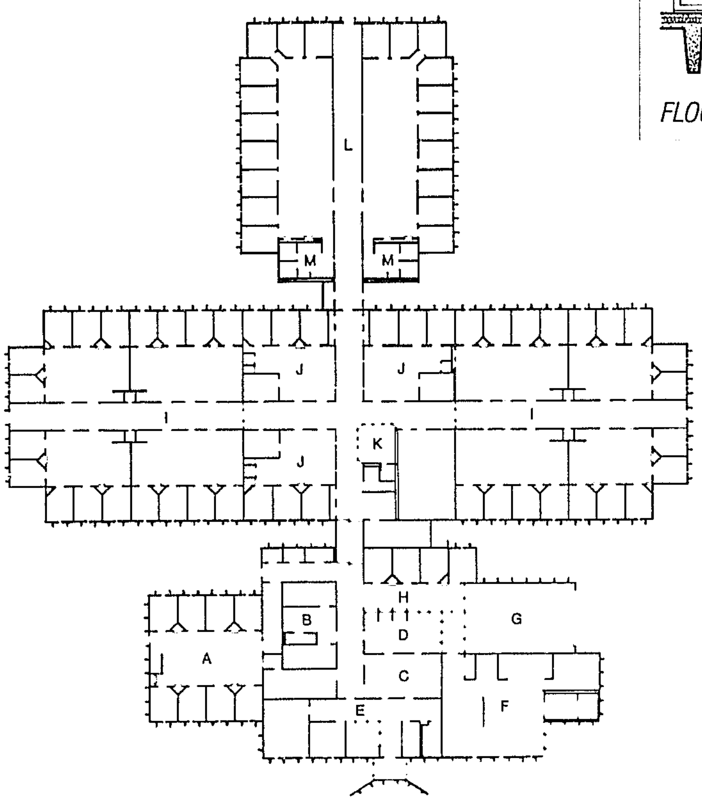
The roof system consists of 4 in. and 6 in. prestressed flat slabs which are supported by precast beams and columns. The precast interior walls vary in thickness from 4 in. to 7 in. The exterior wall system is composed of insulated 15 in. deep prestressed, double tees and some masonry bearing walls. The triangular pipe chase spaces located between the inmate cells were also precast. The plumbing was installed during the erection process, prior to the placement of the precast cell front assembly. The precast cell walls incorporated the necessary special anchorage systems for the detention door and window frames.

The total construction cost was $1,362,291. The precast structural system and enclosing envelope comprised approximately 18% of this cost.





FLOOR PLAN OF CELL WITH PRECAST PANELS



A FEMALE HOUSING
B MEDICAL
C VISITING
D CONTROL
E ADMINISTRATION
F KITCHEN
G SALLYPORT
H BOOKING
I MEDIUM SECURITY HOUSING WINGS
J MAXIMUM SECURITY
K OFFICES / CONTROL
L MINIMUM SECURITY HOUSING WING
M TOILETS

Case Study 4
Medium Security Facility and Dining Hall
Lexington Assessment and Reception Center
Lexington, Oklahoma

Architect/Engineer
The Benham Group
Oklahoma City, Oklahoma

General Contractor
Canam Construction Company, Inc.
Edmond, Oklahoma

Owner
The State of Oklahoma
Department of Corrections

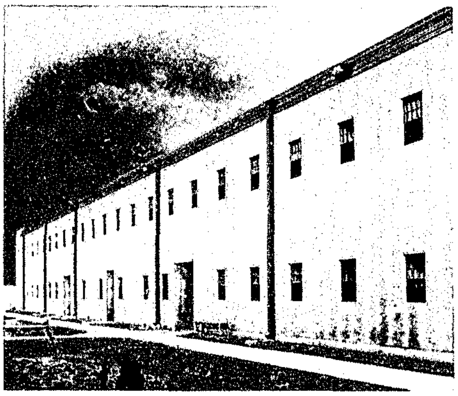
This 90-bed medium security facility contains two levels of prisoner housing, divided into two 45-bed modules, complete with central dayroom activity spaces. A central control room separates the two modules.

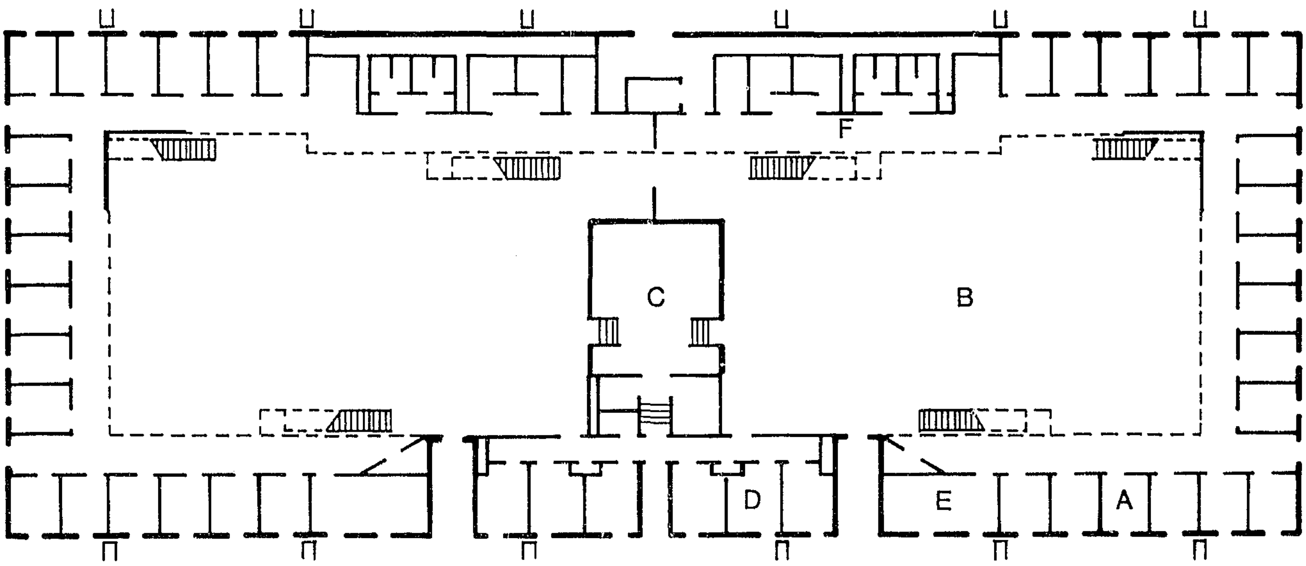
Insulated precast concrete wall panel components are used to clad the entire structure. The exterior wall consists of 11 in. thick precast panels, consisting of 3 in. exterior wythe, 2 in. rigid insulation and 6 in. structural wythe. A raked finish was applied to the exterior wall panels.

The second floor and roof system consists of precast concrete. The floor is a 6 in. flat slab and the roof is a 24 in. deep double tee system. A concrete topping was applied to both systems.

A separate 4,600 sq ft dining facility for 60 people was placed adjacent to the housing unit. Food service is provided via a cart system supplied from the main central kitchen at the institution. The structure consists of insulated precast concrete walls and double tee roof.

Actual construction cost of both buildings was $1,851,708 (1982) which was approximately 2% below the architect's estimate. Total square footage for the 90-bed facility is 23,600.





FIRST LEVEL

A TYPICAL CELL
B DAYROOM FIRST LEVEL ONLY
C CONTROL MID LEVEL
D HOLDING CELLS
E COUNSELING
F TOILET / SHOWERS

Case Study 5
Parchman Detention Center
Parchman, Mississippi

Architect
The Design Collective
Jackson, Mississippi

Structural Engineer
McDardaman Jones, Ltd.
Grenada, Mississippi

General Contractors
Carothers Construction Company
Water Valley, Mississippi
(Housing Units)

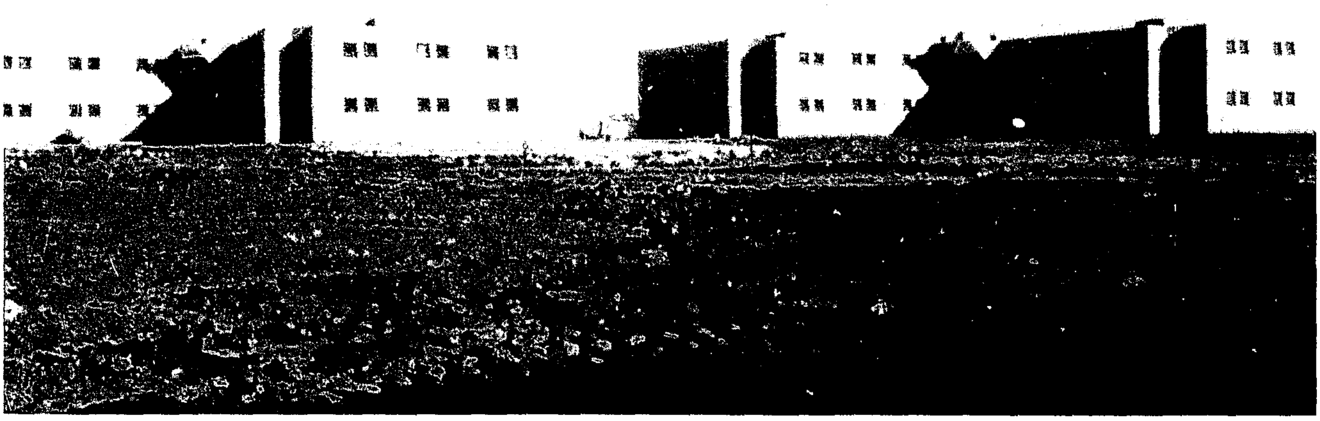
JESCO, Inc.
Tupelo, Mississippi
(Support Facilities, Site Work & Utilities)

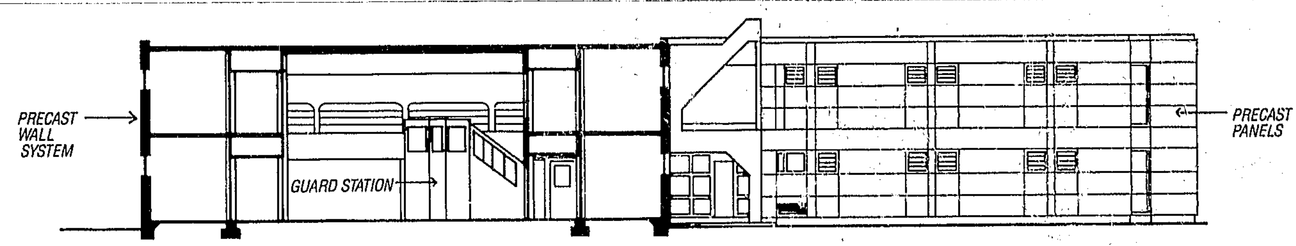
Owner
Mississippi State Building Commission
Jackson, Mississippi

This facility provides housing and support space for 820 minimum and 500 medium security inmates. Predominantly two-story, the building structures were built completely of precast components; columns, beams, slabs, insulated exterior wall panels, and roof members. A total of 4,160 prestressed and precast concrete components were used throughout the entire project.

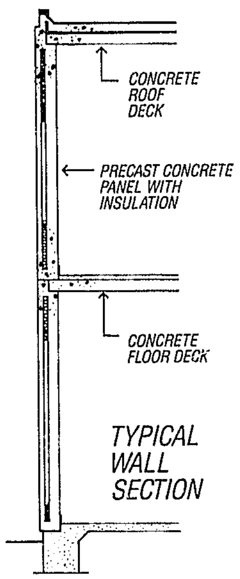
The repetitive design elements in the 12 dormitory housing units and the 5 support buildings made this facility an ideal candidate for precast concrete. This resulted in a completed facility built in much less time and cost than with conventional construction techniques.

The project construction cost was $17,600,000 (1979). Precast concrete building components represented approximately 14% of the construction costs.

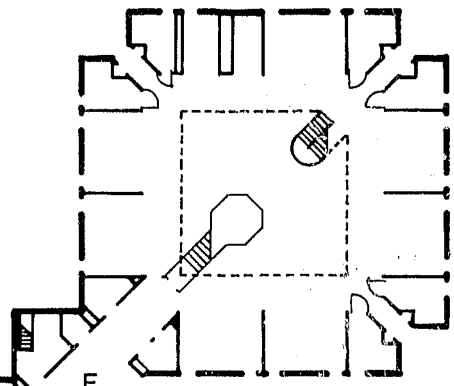
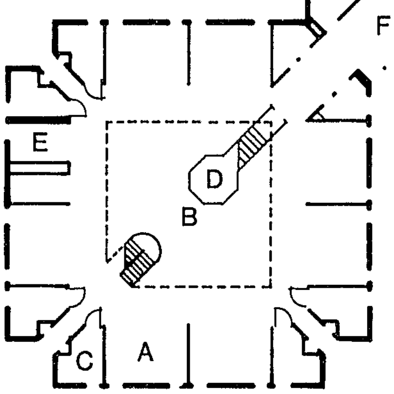




BUILDING SECTION / ELEVATION



TYPICAL WALL SECTION

FIRST LEVEL
A MULTI OCCUPANCY CELL (OPEN CELL FRONTS)
B CENTRAL DAYROOM
C INDIVIDUAL CELL
D CONTROL
E SHOWERS / TOILET
F ENTRY / PROGRAM SPACES
G MECHANICAL

Case Study 6

Las Cruces Correctional Complex
Medium Security Facility
Las Cruces, New Mexico

Architect
W.C. Kruger & Associates
Albuquerque, New Mexico

Structural Engineer
Robert Krause Engineering Company
Santa Fe, New Mexico

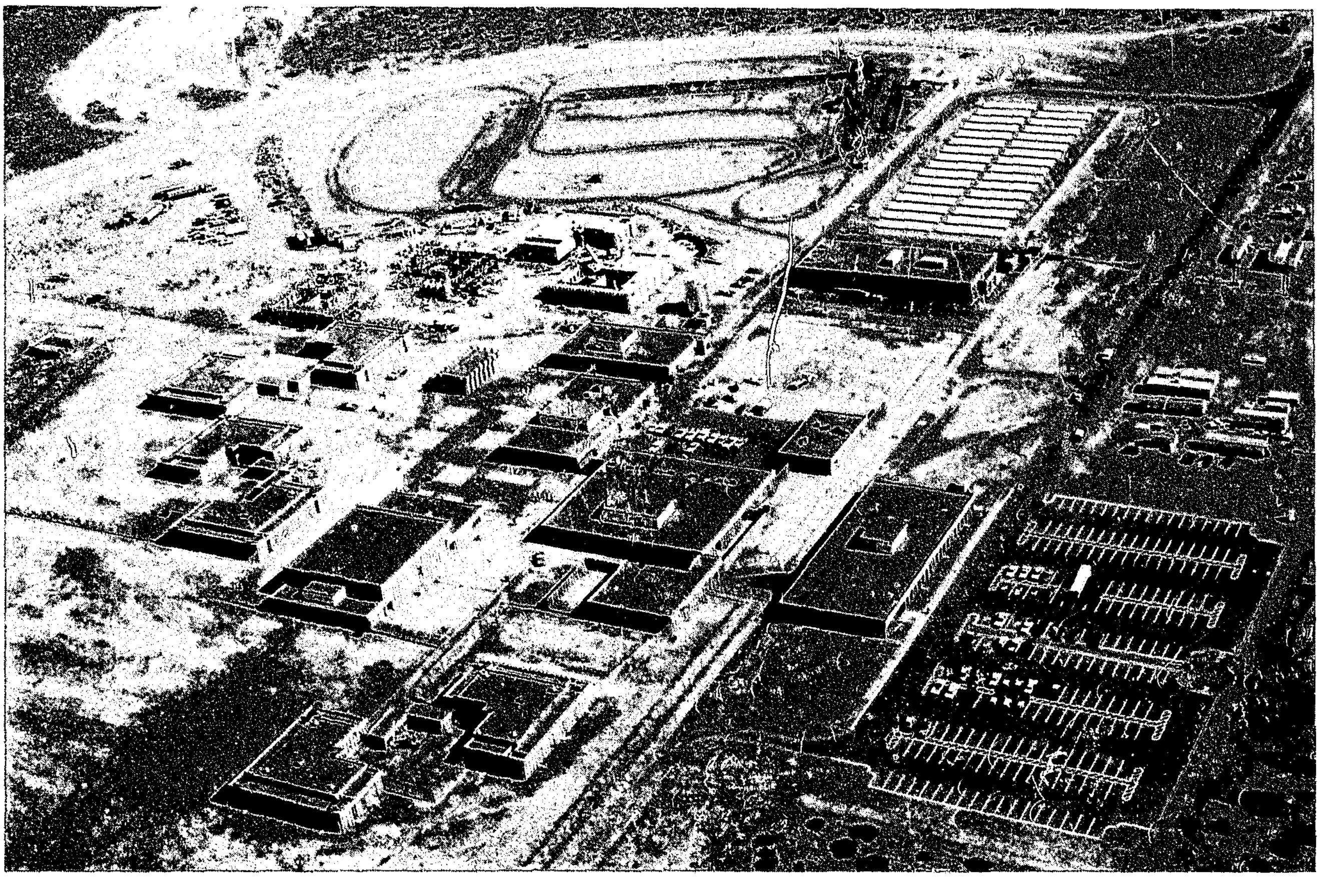
Construction Manager
Morrison-Knudsen Company, Inc.
Boise, Idaho

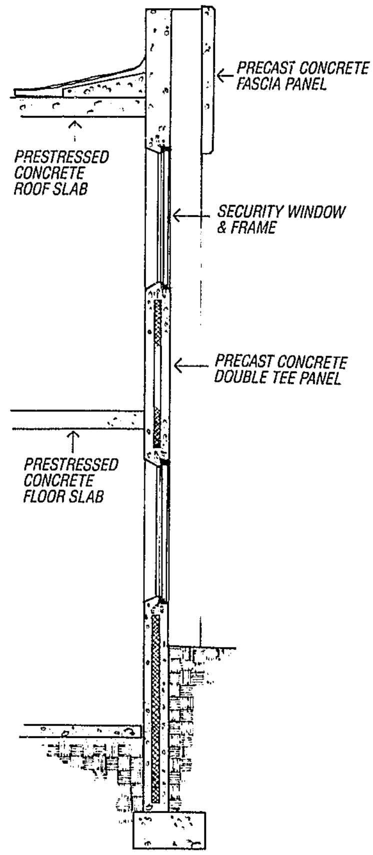
Owner
State of New Mexico
Department of Corrections

Consisting of five basic housing compounds and ten support buildings, this 480-bed correctional complex is constructed mostly of precast, prestressed concrete building components. The roof structures are composed of double tee sections of various depths and lengths manufactured to accommodate the building design. The exterior wall system is a basic double tee with 2½ in. of rigid insulation and a 3 in. concrete cover. Both the roof and wall panel components are 8 ft wide to provide a uniform module. Precast fascia panels and scuppers were used as architectural design elements.

The prestressed concrete design was selected for the purpose of reducing the number of interior columns and to eliminate exterior columns. Minimizing the number of interior columns allows for greater design flexibility of the interior spaces.

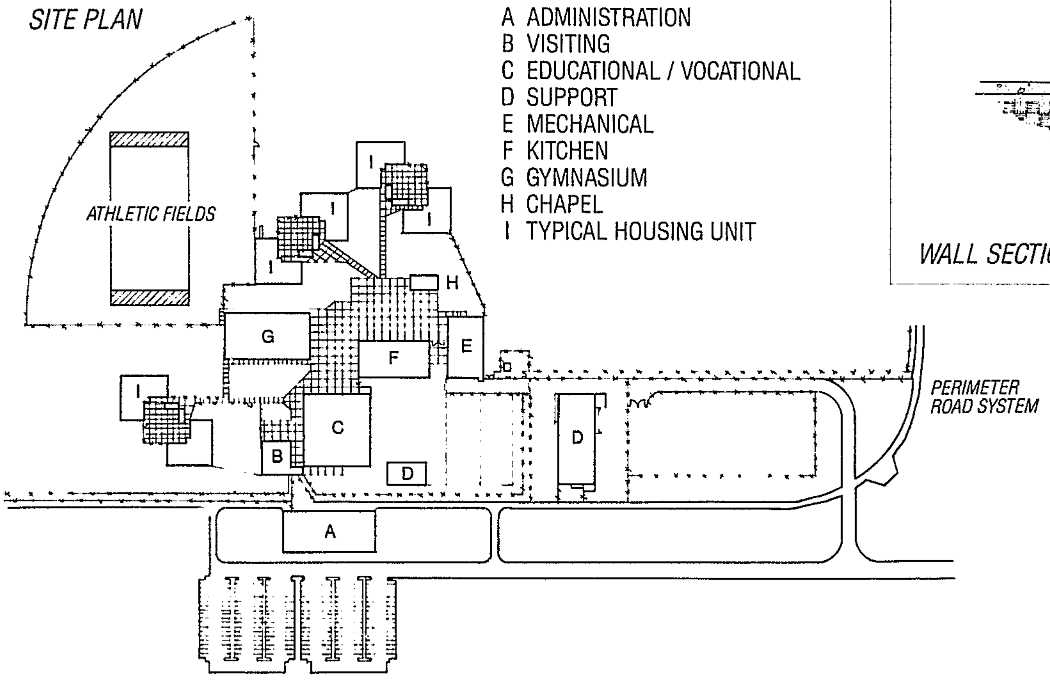
Economy and time were also major considerations for choosing precast concrete. Construction on this 240,000 sq ft complex began in December of 1982 at an approximate cost of $27,000,000.





WALL SECTION

SITE PLAN



A ADMINISTRATION
B VISITING
C EDUCATIONAL / VOCATIONAL
D SUPPORT
E MECHANICAL
F KITCHEN
G GYMNASIUM
H CHAPEL
I TYPICAL HOUSING UNIT

Case Study 7
Medium Security Institutions Nos. 2, 3, and 4
Commonwealth of Virginia

Architects
Oliver, Smith, Cooke/Lindner
Richmond, Virginia

Henningson, Durham & Richardson
Dallas, Texas

Structural Engineer
The Consulting Engineers Group, Inc.
Glenview, Illinois

Construction Manager
Morrison-Knudsen Co., Inc.
Burkeville, Virginia
(MSI-2 & MSI-3)

Gilbane Building Co., Inc
Craigsville, Virginia
(MSI-4)

Owner
Commonwealth of Virginia
Department of Corrections

A prototypical design was used on these three correctional projects. Each facility contains space for 512 single cells and related support function structures.

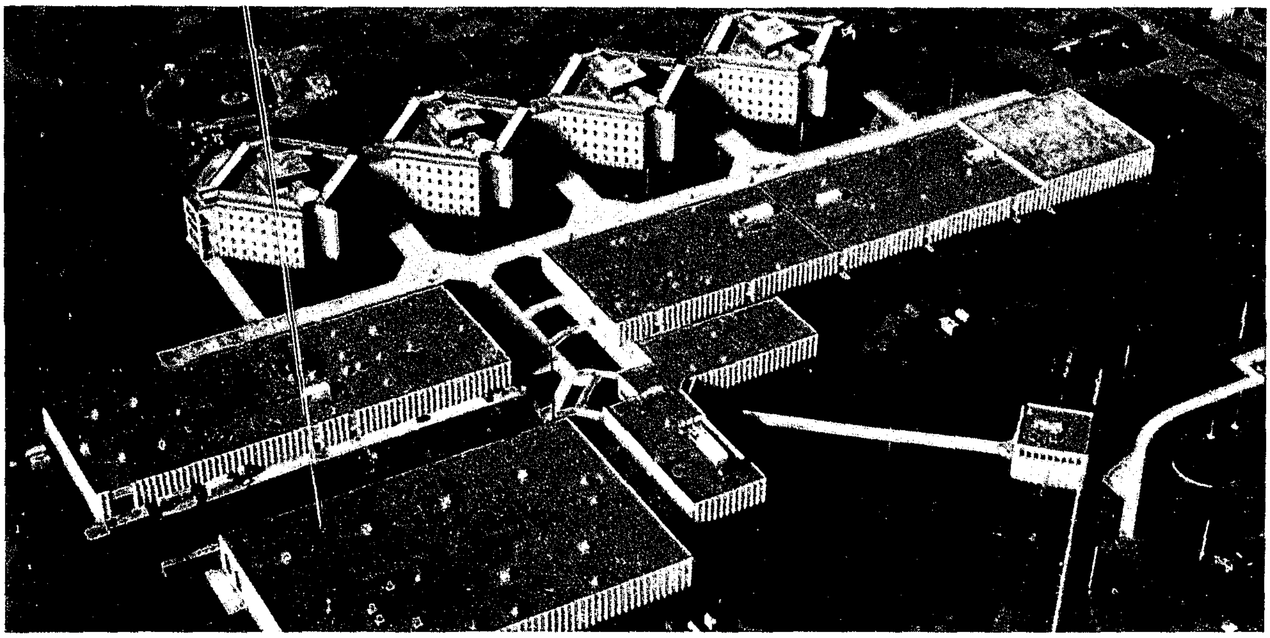
The housing units consist of four square shaped structures, 4 stories high, linked together at the corners by short corridor connectors. The central portion of each housing unit contains an officer's station and a two level dayroom. The six service/support buildings include space for visiting, administration, reception, food services, medical, maintenance and various industrial, vocational, recreational and educational program functions.

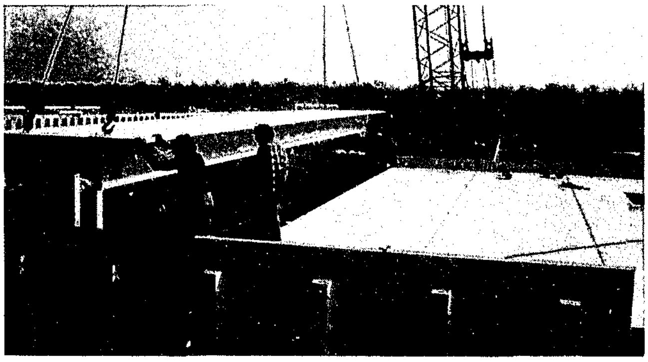
The support buildings were constructed with design solutions similar to typical precast concrete commercial and industrial warehouse buildings. The roof framing consisted of 24 in. double tees, 32-40 in. inverted tee beams, 16x16 in. precast columns and 20½ in. deep insulated load bearing double tee wall panels. The typical bay sizes were 24x48 ft and 24x72 ft offering maximum flexibility of arrangement or rearrangement of space.

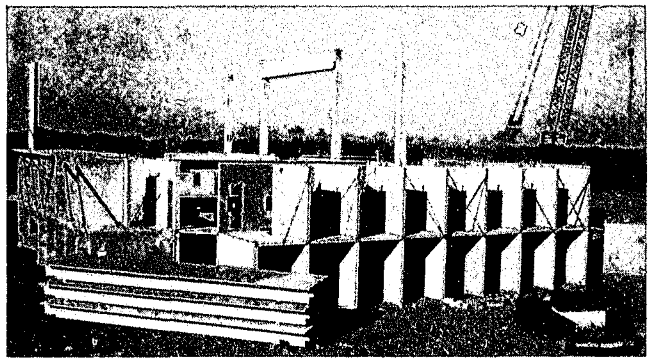
The housing units employed 6 in. thick interior load bearing partition walls, the same 20½ in. deep insulated exterior wall panels, 5 in. thick roof and floor slabs, and 24 in. double tee roof and floor members for the dayrooms.

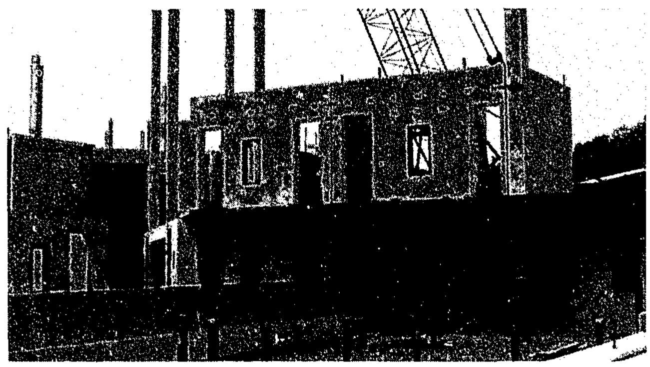
Precast concrete was selected to take advantage of the speed of construction and first cost savings over conventional masonry and cast-in-place construction. An all-precast facility (MSI-3) was completed in 20 months, less than one half the time of a similar sized masonry and cast-in-place concrete prison (MSI-1) which was started two years earlier.

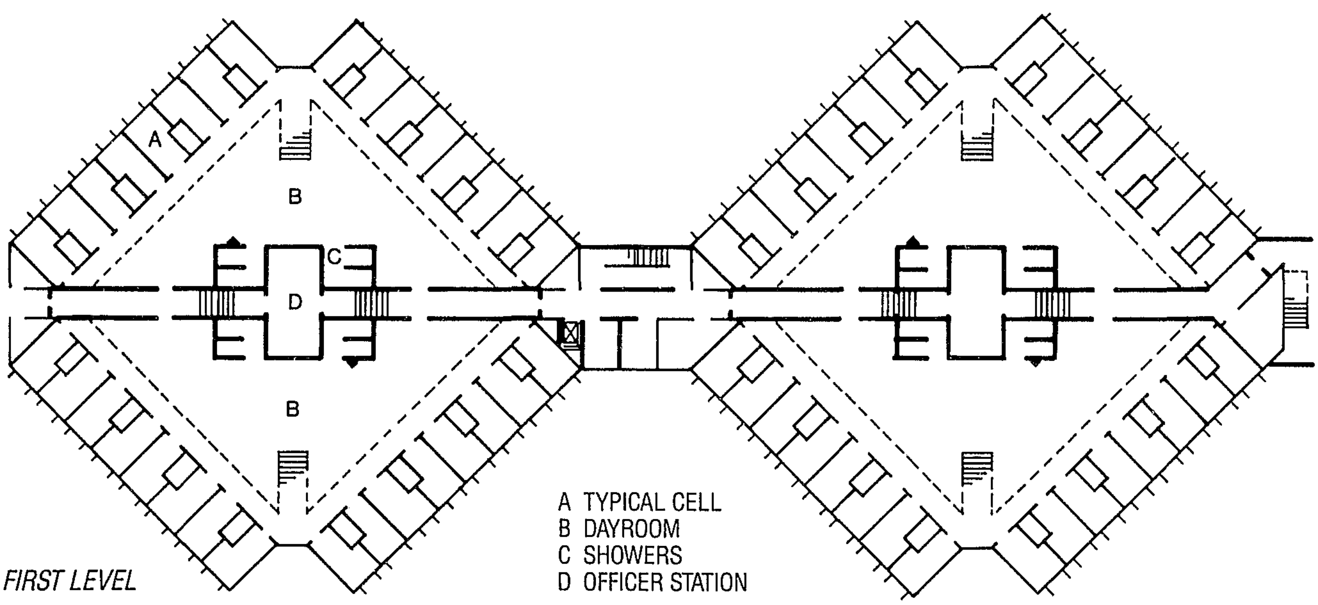
Based upon this success, MSI-2 was also designed all-precast and was completed in 18 months. MSI-4 is also precast and is similar in design to the MSI-2 and MSI-3.











FIRST LEVEL

Case Study 8
Feliciana Forensic Facility
East Louisiana State Hospital
Jackson, Louisiana

Architect
Lasseigne & Legett, AIA
Baton Rouge, Louisiana

Structural Engineer
Perrault & Perrault
Baton Rouge, Louisiana

General Construction
Taylor-Samaha Construction
Baton Rouge, Louisiana

Owner
State of Louisiana
East Louisiana State Hospital

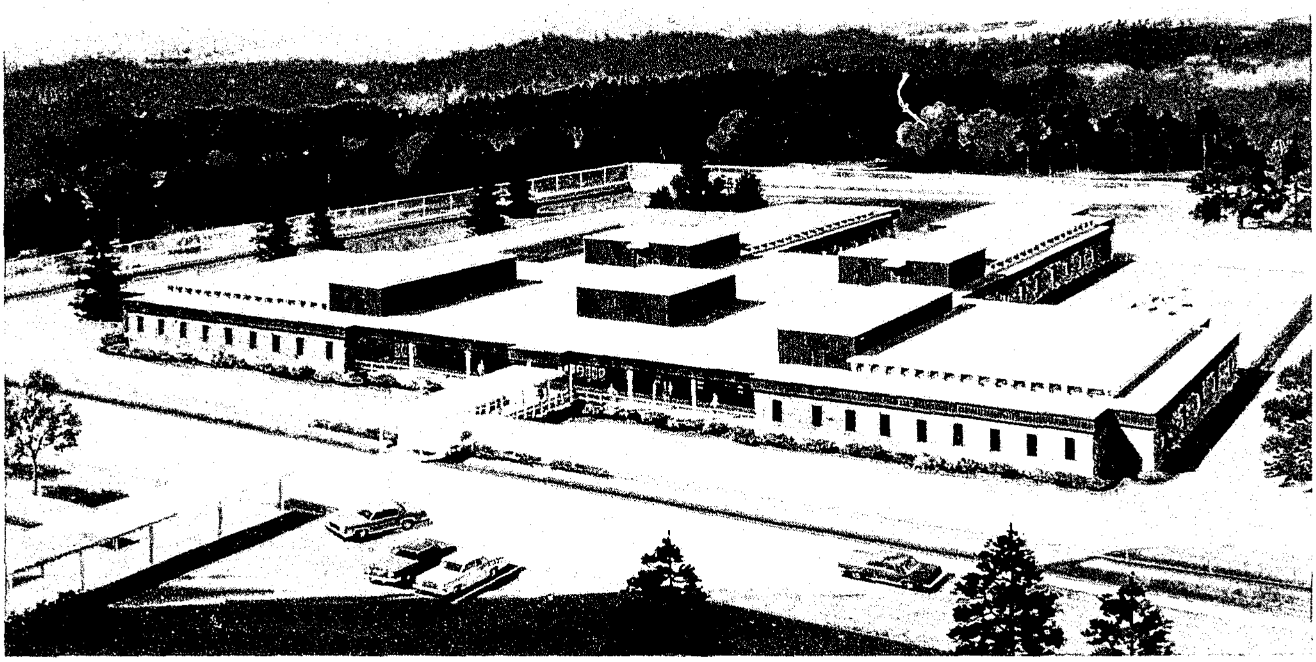
The single most important element of this project was the use of a precast concrete cell box unit (8′-0″ W x 10′-0″ D x 8′-0″ H). These units were precast in a plant and then delivered and set in place. By employing two opposite-hand forming systems, the 75 single cells were produced in only three months. The remainder of the building was built around this core unit.

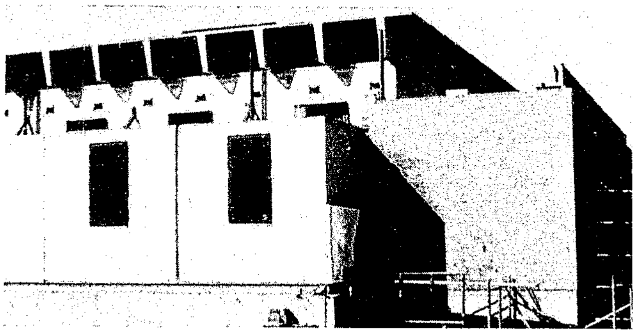
The precast concrete modules serve as support for the double tee roof structure over the central dayroom areas of this new 75-bed forensic institution.

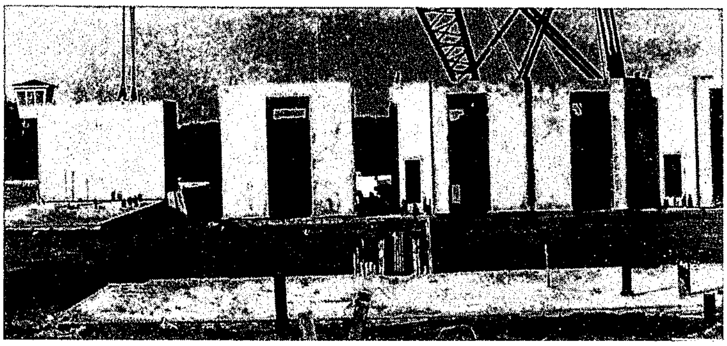
Interface with security hardware was accomplished by having the precaster place the hollow metal door frames into the modules during the manufacturing process. A triangular mechanical chase located between the precast cell units reduced the installation time of the security toilet fixtures in the field. Frames with security bars were cast in concrete cell units.

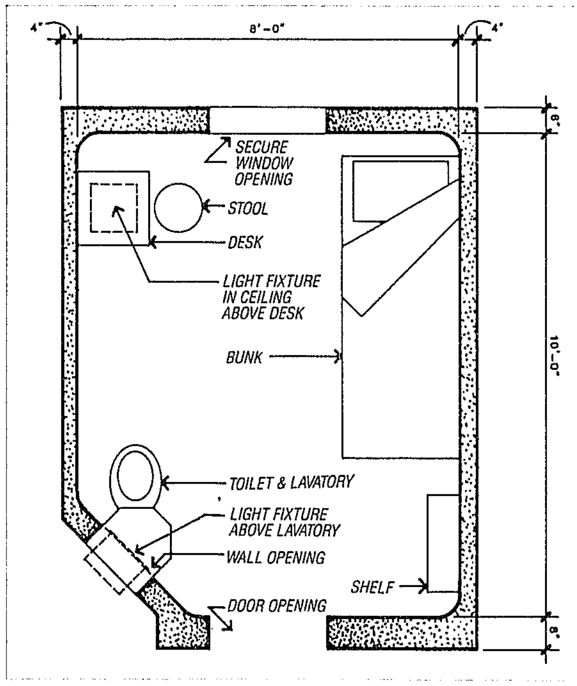
By enclosing the interior space quickly, with the use of a precast structure, the general contractor was able to proceed simultaneously with the interior finish work and the exterior facade.

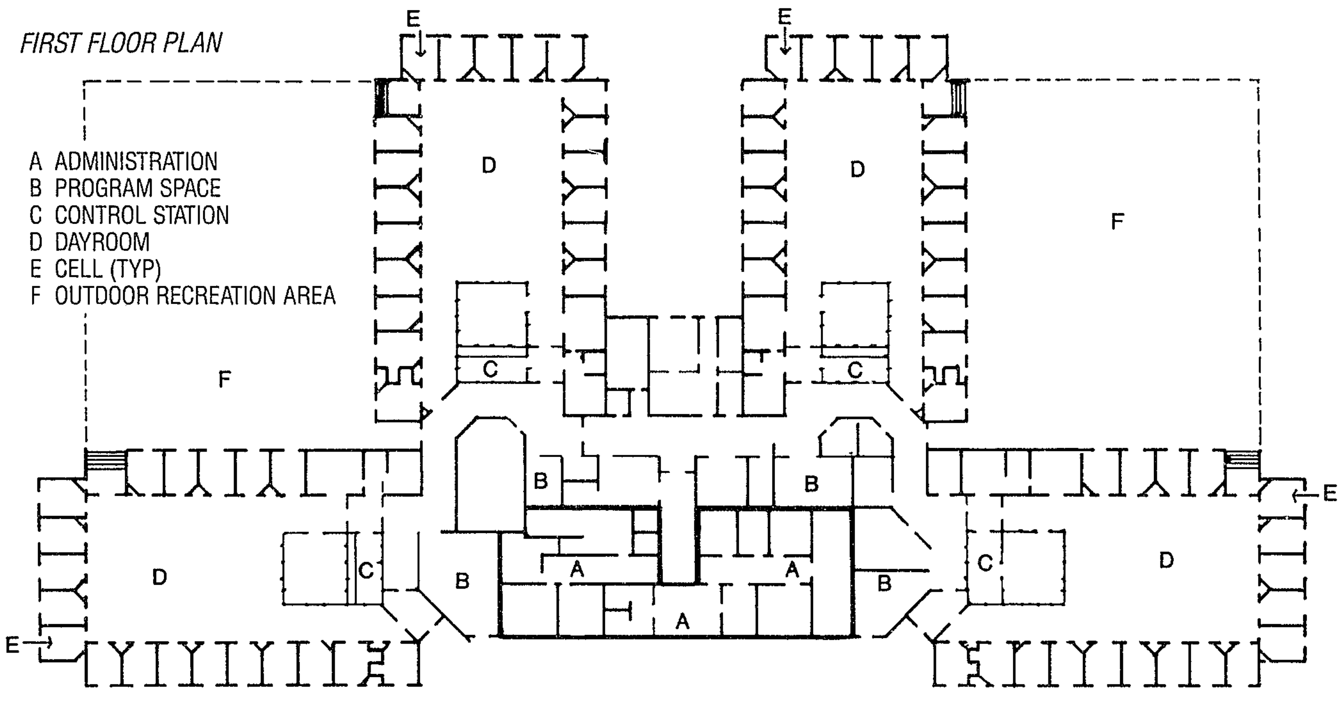
Precast concrete was selected because it afforded high quality and durability. Total construction cost for this 75-bed facility was $3,628,000 (1981). Construction required 21 months.








4"
8'-0"
4"
8"
SECURE WINDOW OPENING
STOOL
DESK
LIGHT FIXTURE IN CEILING ABOVE DESK
BUNK
10'-0"
TOILET & LAVATORY
LIGHT FIXTURE ABOVE LAVATORY
WALL OPENING
SHELF
DOOR OPENING
8"


FIRST FLOOR PLAN
A ADMINISTRATION
B PROGRAM SPACE
C CONTROL STATION
D DAYROOM
E CELL (TYP)
F OUTDOOR RECREATION AREA

Case Study 9
Wyoming State Penitentiary
Rawlings, Wyoming

Architect
Deines, Myrick & McLain
Casper, Wyoming

Structural Engineer
Volk & Harrison
Casper, Wyoming

Construction Manager
Warren J. Foster & Associates
Lakewood, Colorado

Owner
State of Wyoming
Board of Charities & Reform

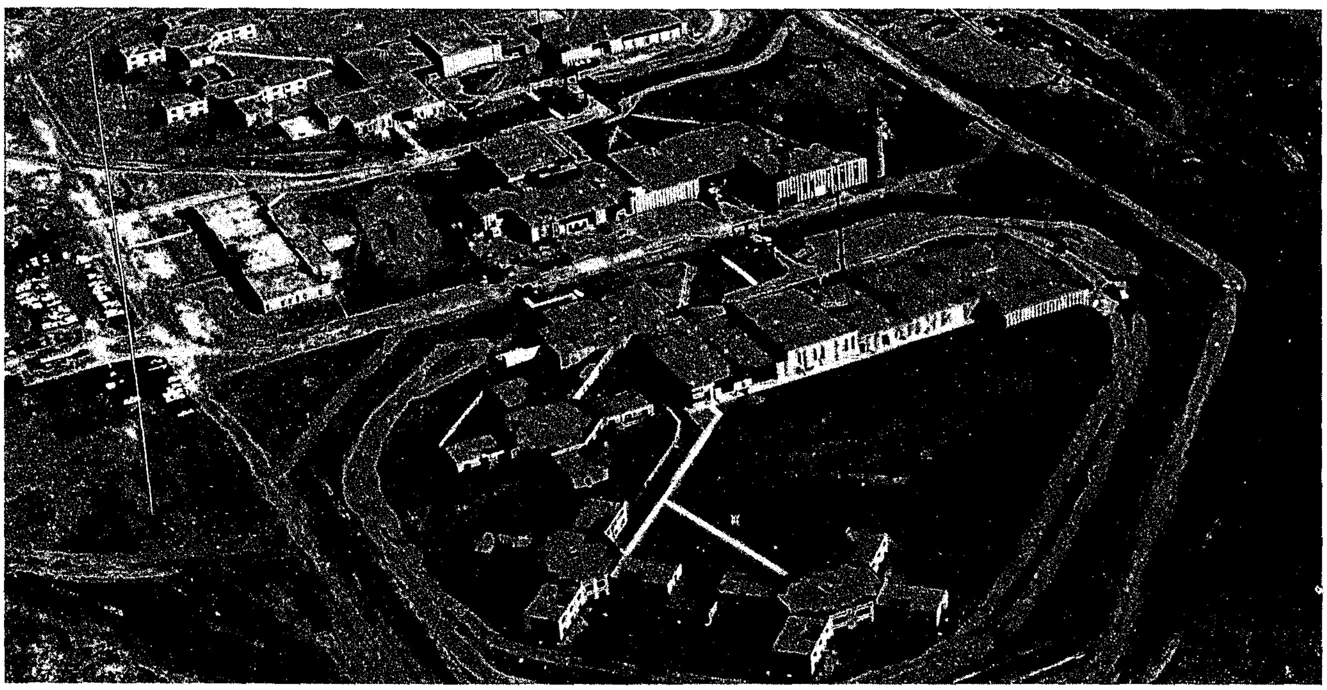
A total of ten buildings (covering 400,000 sq ft) provide housing and support facilities for this 472-bed maximum/medium security institution. Inmate housing was provided by using 236 double-cell box modules measuring 11x16x9 ft and weighing 25 tons each.

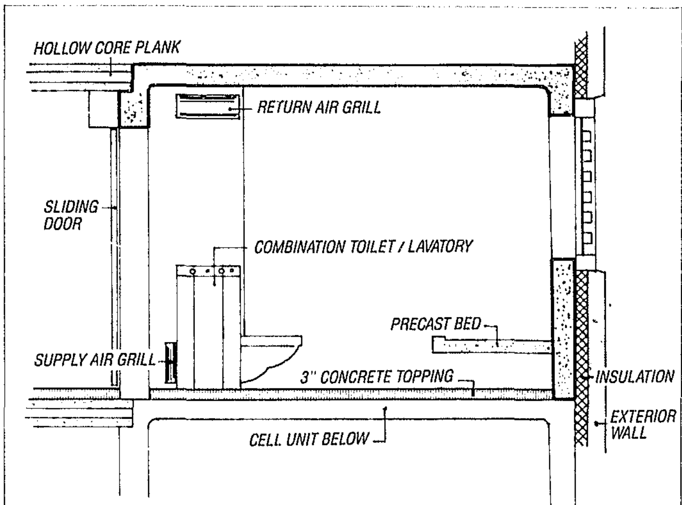
Each housing module contained cast-in electrical conduit, mechanical grilles, and connections for specialty security hardware and fixtures. Standardization of the cell modular units made it feasible to do this work at the precast manufacturer's plant. Plumbing connections were accomplished in a triangular pipe chase cast into the module unit between each cell. The precast cell units even included a precast bed and work counter, all installed prior to shipment to the job site 50 miles away.

When delivered and installed at the site, the precast modules were sheathed with an outer skin of textured concrete panels. A layer of rigid insulation was placed between the precast concrete module and the outer skin.

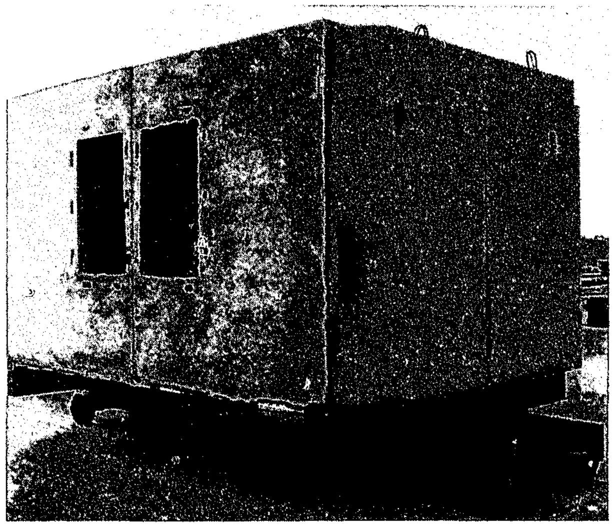
Support facilities were built using standard precast double tees, beams, columns, and textured exterior walls, similar to an industrial warehouse structure. Security requirements and the need for fast, inexpensive construction were key considerations in selecting the precast, prestressed concrete building materials. It was the desire of the prison officials to have construction continue through the severe winter weather. Utilizing factory precast components helped to accommodate this requirement and keep the project on schedule.

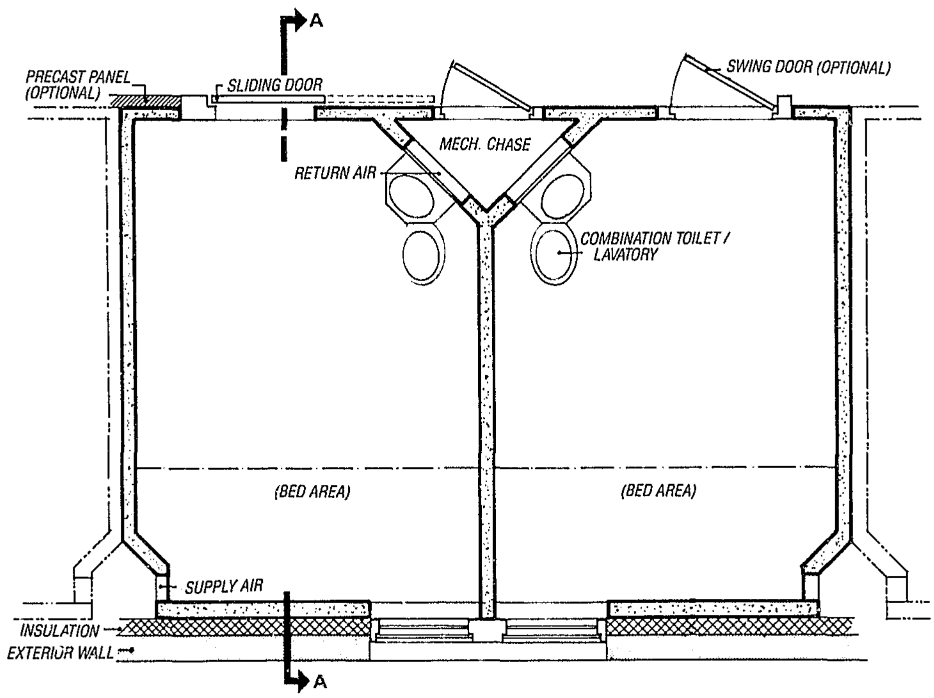
Constructed during 1979, the precast structural shell was erected for $7/sq ft, representing less than 10% of the total cost of the $30 million facility.





SECTION A - A





TYPICAL CELL UNIT FLOOR PLAN

Case Study 10
Pinellas County Medium Security Jail
Largo, Florida

Architect/Engineer
Watson & Company
Tampa, Florida

General Contractor
Peter R. Brown Company, Inc.
Clearwater, Florida

Owner
Board of County Commissioners
Pinellas County, Florida

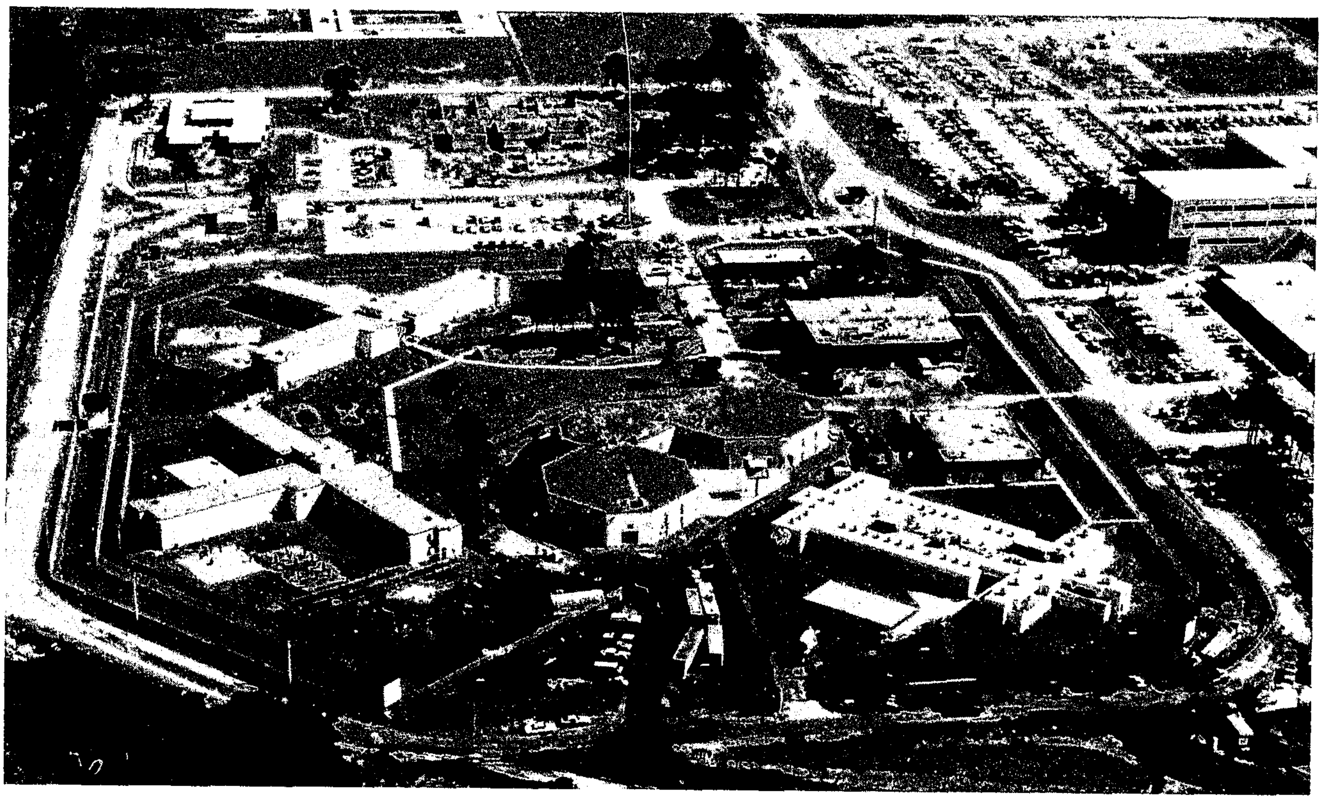
This new 192-bed facility has the distinction of being the first jail in Florida to be built of precast concrete box modules. The concrete modules were precast in a plant and then shipped to the site for erection. Using this method resulted in a savings of both time and money. Total casting time for the modules was 2½ months. Erection took 14 days.

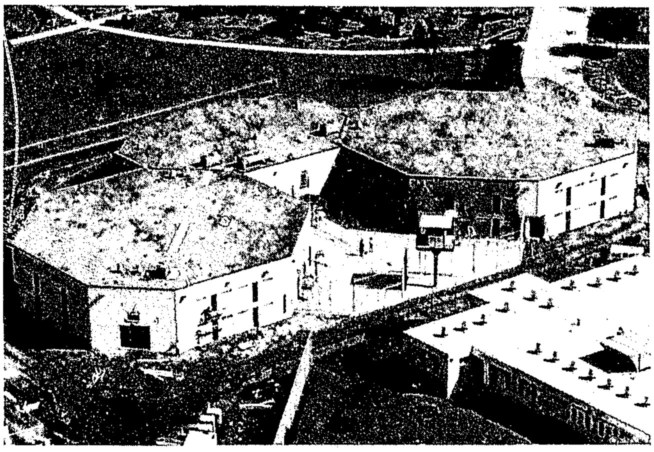
While the precasting was being done at the manufacturing plant, site preparation, foundations, and mechanical/electrical rough-ins were being completed at the site.

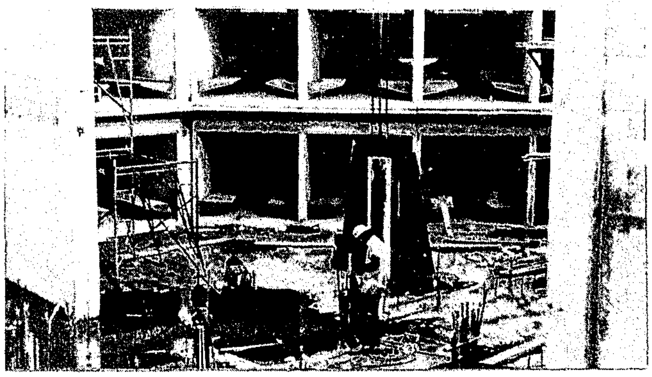
The precast concrete cells for the inmate housing areas were built with only one ceiling joint. This was filled with an epoxy mortar (stronger than the concrete itself). This is in contrast to the conventional method of using concrete masonry, where multiple joints are exposed in the cell areas. A prestressed concrete roof was installed on the pods after the modules were installed.

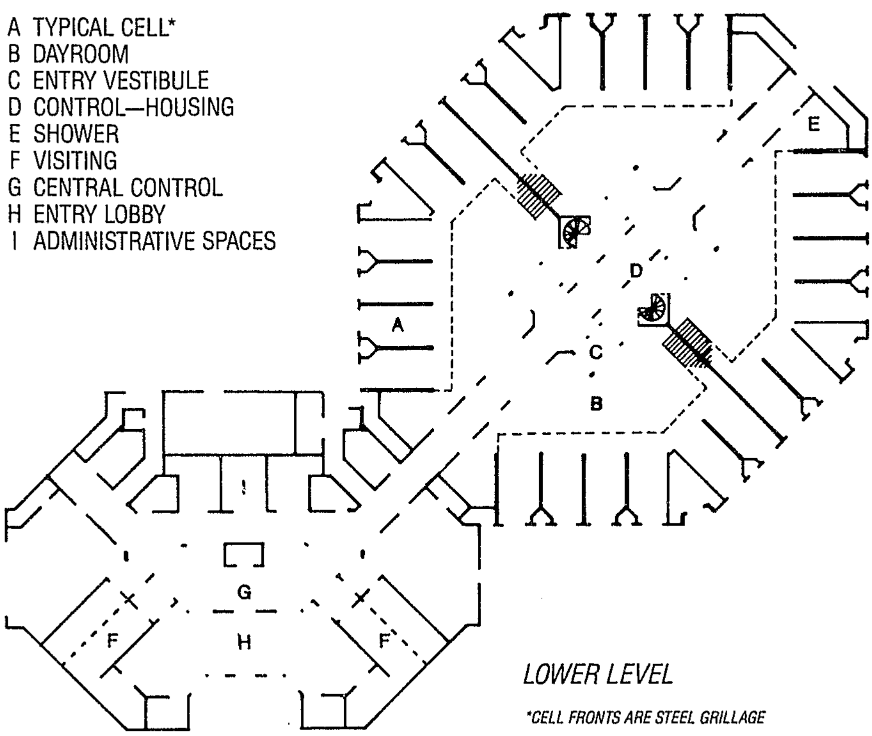
The floor plan consists of two identical octagonal housing pods connected by a central support core. Each housing pod contains living quarters, dayroom space, showers, and a control station for 96 men (double occupancy cells). The central support core contains visitation areas, medical, program activity spaces, public lobby, and mechanical room.

The entire jail complex was bid at $2,922,000. Total construction time was eight months.



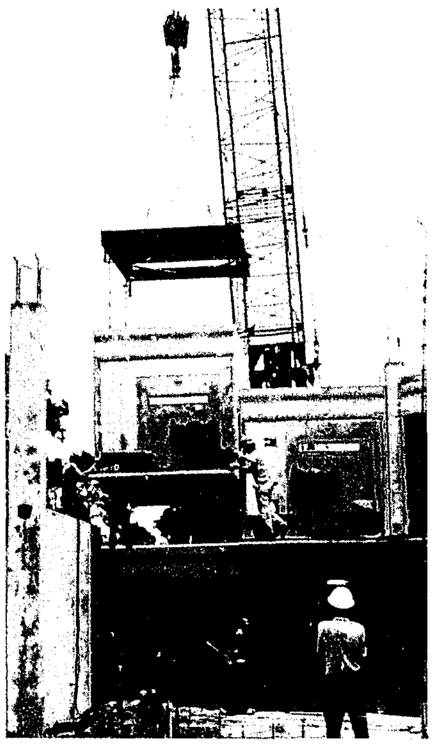






LOWER LEVEL

***CELL FRONTS ARE STEEL GRILLAGE**



Case Study 11
Federal Correctional Institution
Butner, North Carolina

Architect
Middleton, McMillan, Architects, Inc.
Charlotte, North Carolina

Structural Engineer
Frank B. Hicks Associates
Charlotte, North Carolina

General Contractor
Tandy Construction Company
Charlotte, North Carolina

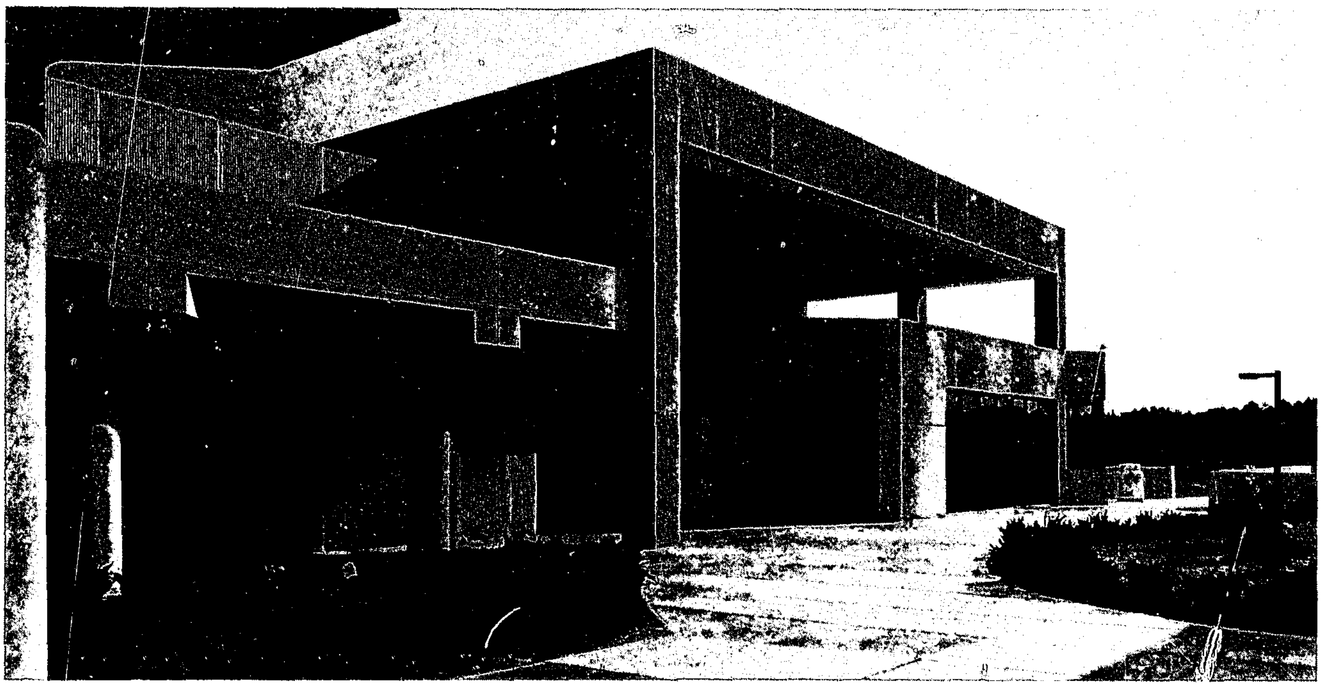
Owner
United States Department of Justice
Bureau of Prisons

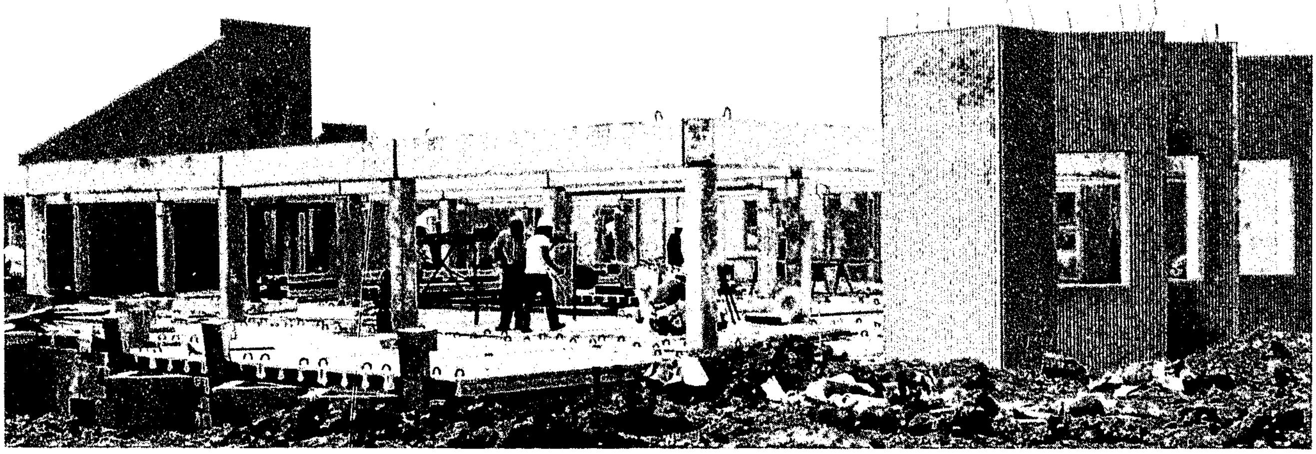
Originally designed to house medium to high security mentally disturbed prisoners, this facility now operates as a regular high security prison expanded to house twice the number of prisoners as originally programmed. The precast column and beam structure designed in the original facility provided the necessary flexibility needed to make the change easy and economical. Using a precast modular building system proved to be a basic advantage in the facility design, given the constantly changing needs of our Federal correctional system.

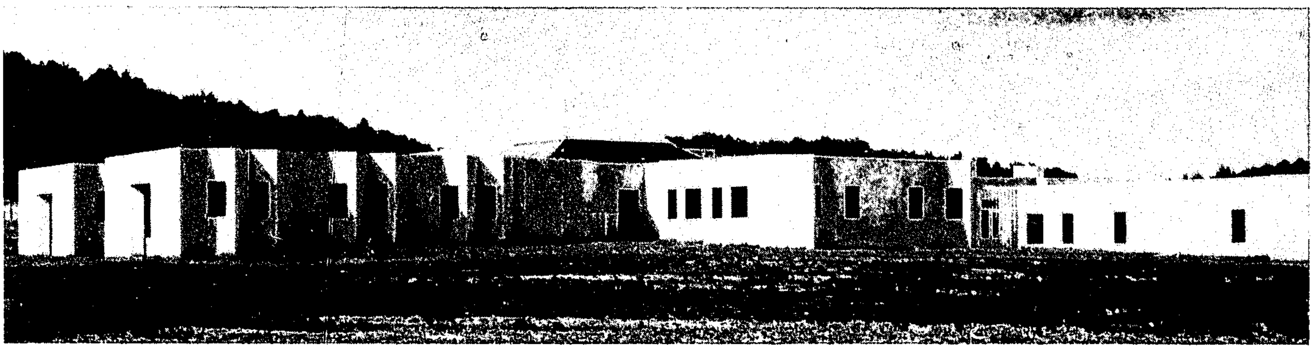
All buildings are one story, except for the shop areas. Basic construction consists of a perimeter bearing wall and precast concrete frame structure supporting hollow-core floor and roof systems. Precast components enabled the construction period to be shortened. When needed, the plant precast components were trucked to the site and set in place. Using this method, the contractor was able to employ two separate construction crews; one excavating and preparing foundations; the other erecting the precast building components.

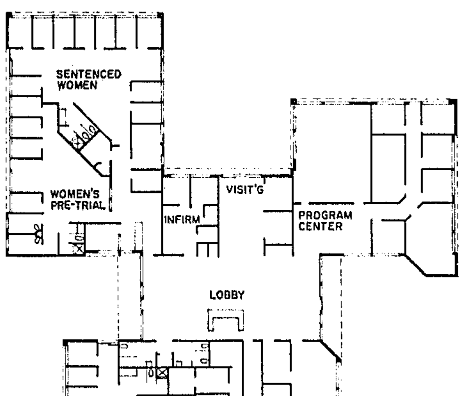
Design simplicity combined with off-site precast components resulted in a completed facility produced with significant savings in both time and money.

This 300 bed institution contains 225,000 sq ft and was built for a cost of $11,700,000 (1976).

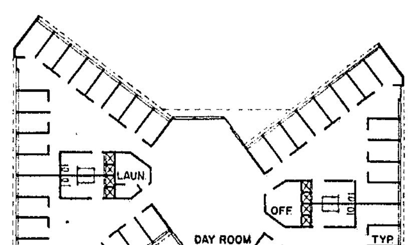








PROGRAM CENTER



TYPICAL HOUSING UNIT

Case Study 12
Oklahoma State Penitentiary Maximum Security Prison McAlester, Oklahoma

Architect/Engineer
(A Joint Venture)
Fell Brusso Bruton & Knowles, Inc.
Architects - Engineers - Planners
Tulsa, Oklahoma

Noftsger Lawrence Lawrence Flesher
Architects - Engineers
Oklahoma City, Oklahoma

Gruzen and Partners
Architects Planners Engineers
New York, New York

General Contractor
Depco Construction
Shawnee, Oklahoma

Owner
State of Oklahoma
Department of Corrections

Constructed almost entirely of precast concrete components, this correctional facility provides maximum security housing and related program space for 304 inmates in a single cell occupancy configuration.

Vertical services to the individual cell areas were successfully addressed by utilizing a U-shaped precast concrete section for the pipe chase that is typically shared by two cells. Within this 2'-0" x 4'-2" space are supply/return air ducts, electrical/TV conduit and connections, plumbing stacks, water supplies, mounting brackets for the combination security type lavatory/toilet fixture, and a recess shelf unit.

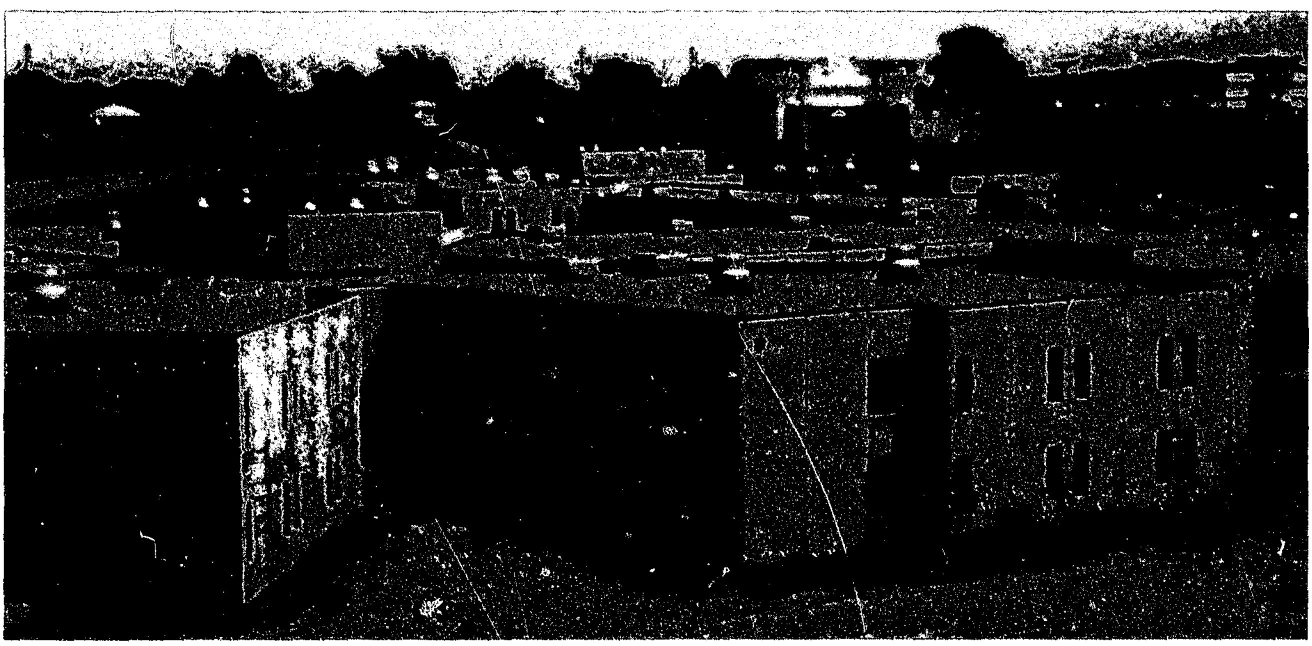
Double tees span across a wide dayroom space to bear on the cast-in-place load bearing cell front walls. Double tees also span the industry areas and were designed with special sleeves cast into the legs at 4 ft centers to support the various manufacturing equipment.

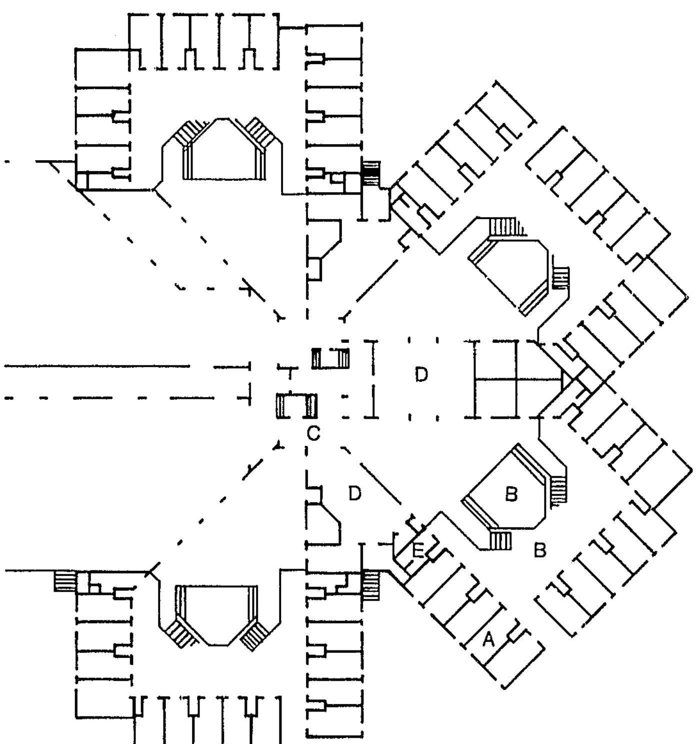
Precast concrete exterior wall panels, constructed of a 5 in. structural wythe, 2 in. of insulation and a 3 in. exterior wythe, provide two-story load bearing walls to support the precast 6 in. flat roof slabs at each cell.

Grout was used to seal all inside joints and eliminate contraband hiding areas.

Respecting a limited construction budget, the design team selected precast double tee wall panels (40 ft high) for the supporting structure of two guard towers. Four double tees (8 ft wide x 24 in. deep), with legs facing outward, were welded together and support a 16 x 16 ft top flat slab.

Preliminary site work was bid in November of 1978, with the building construction beginning a year later. Total construction cost was approximately $14,000,000 (1979).





PARTIAL FIRST LEVEL

A TYPICAL CELL
B DAYROOM
C CONTROL
D PROGRAM SPACES
E SHOWERS

Case Study 13
California State Prison
Solano County at Vacaville

Architect
Giffels/Del Campo & Maru
San Francisco, California

Structural Engineer
Forell-Elsesser Engineers
San Francisco, California

Construction Manager
Obrien & Kreitzberg
San Francisco, California

Owner
Department of Corrections
State of California

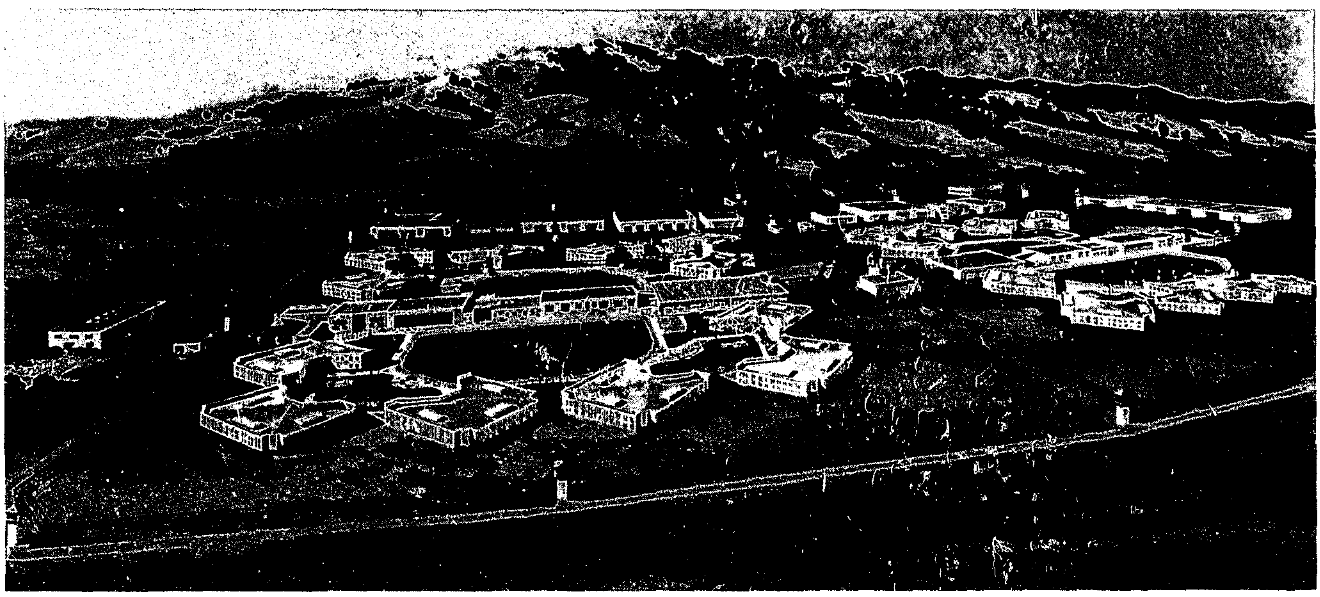
The first increment in California's $1.2 billion prison expansion program began with the construction of a new prototype prison design for a 2400-bed medium security complex located on the California State Prison site in Vacaville, California.

The new $140 million Vacaville Prison is scheduled to go from preliminary design to completion in only 17 months. Phase I (6 housing units) was built in 9 months to allow for early occupancy based upon shared usage of existing support facilities at the adjacent prison.

The overall site plan includes six 100-bed housing units, separated from another six identical units by a central support services spline. This arrangement forms half of the total 2400-bed complex. Separate support buildings for this new complex will be completed at a later date in the construction schedule.

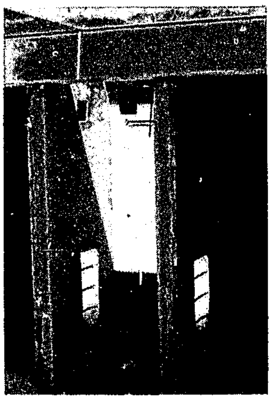
The basic building blocks of the facility are the 100-bed housing units, which consist of the standard "podular" concept of placing inmate cells around a common dayspace. The basic housing unit for medium security is designed around a 135 ft square floor plan, consisting of 100 cells (double bunked) measuring 6 x 12 ft each, located on two levels (first floor and mezzanine). One side of the square is indented at 45° angles which meet at a two level central control room. Optional partitions separating the cells can be installed within the common dayspace to make the housing unit maximum, medium, or minimum security, depending on the number of classification/segregation levels required.

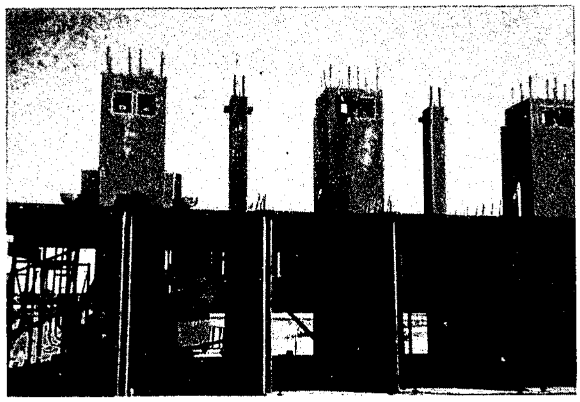
After the foundations are cast, workers put up two-story precast columns along the inner cell wall line to support second-floor and roof girders. The first floor U-shaped utility chases are installed midway between columns. Partitions butting into the utility chases are next, tied into the chases to eliminate the need for temporary bracing. Other partitions are set and braced.

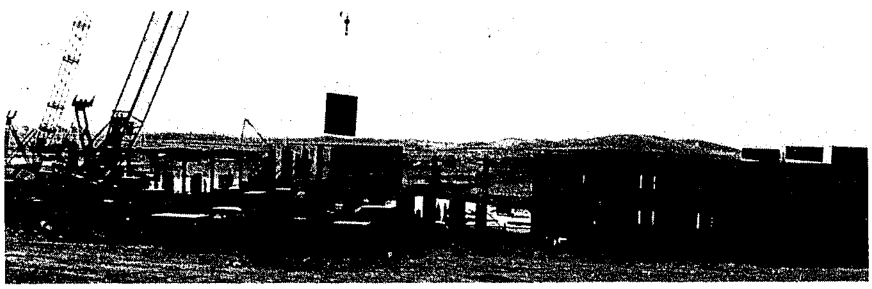


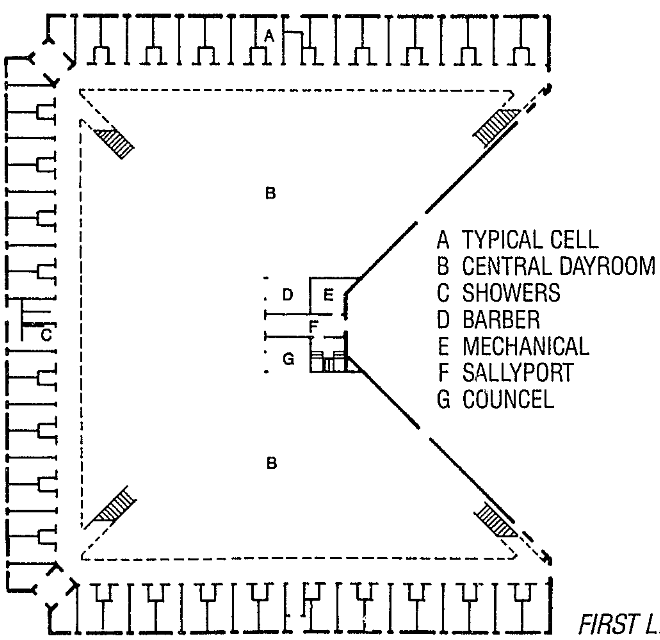
When the second-floor girders are in place, the floor plans are installed, supported by the girders and partitions but otherwise simply resting on neoprene pads. Then the two-story exterior wall panels go into place. When the shell is up, ductwork is installed and reinforcing steel set so that the topping slabs at floor and roof levels can be placed and vertical closures grouted. Concrete block walls facing the common day room carry wiring for security.

Precasting for the facility was accomplished by a joint venture arrangement of two specialty subcontractors. Together they had 60 days to fabricate and erect 2,800 precast units. Precasting started in early April and erection was underway by the middle of the month. Total erection time for the first 6 housing pods (concrete components only) took less than 42 working days.

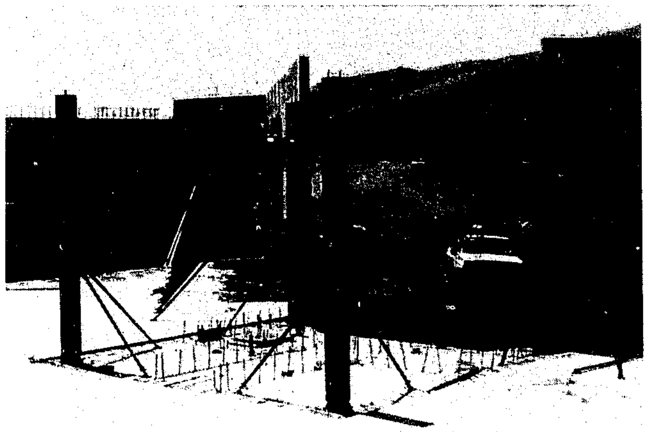








FIRST LEVEL



Case Study 14
Northampton Jail and House of Correction
Northampton, Massachusetts

Architect/Engineer
Reinhardt Associates, Inc.
Springfield, Massachusetts

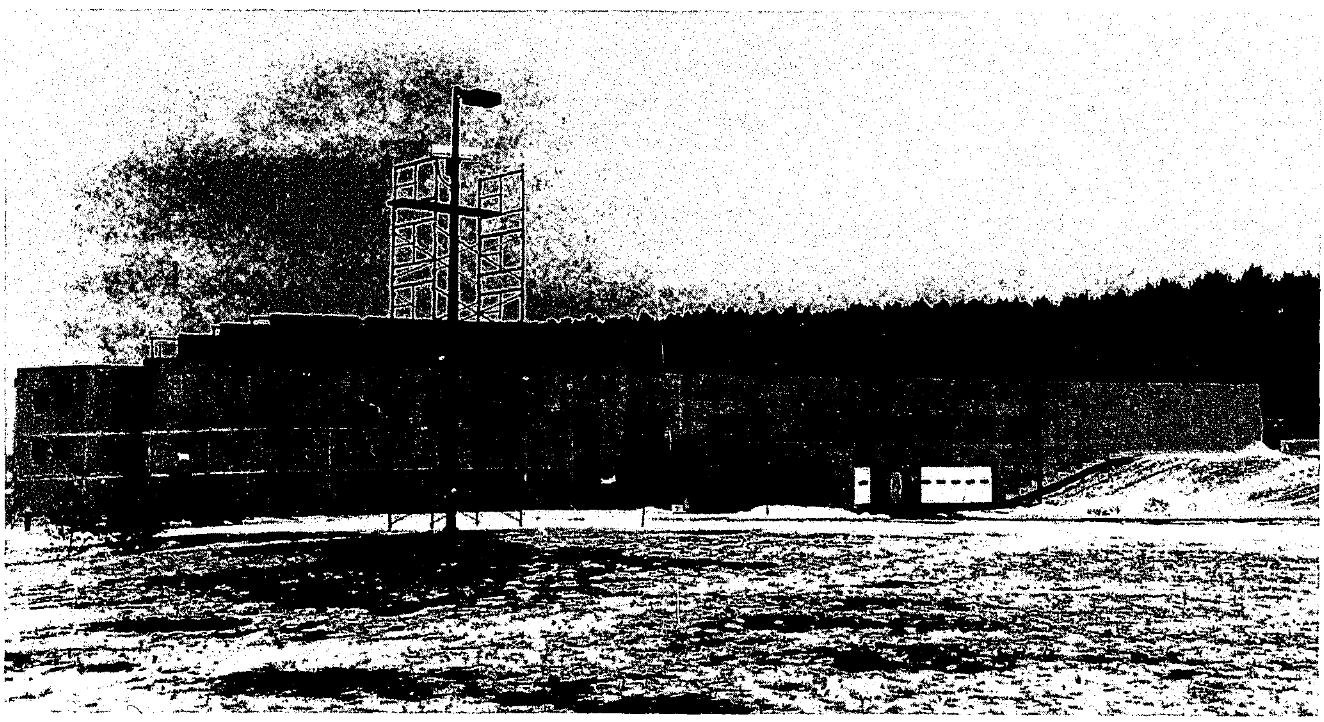
General Contractor
Peabody Construction Co., Inc.
Braintree, Massachusetts

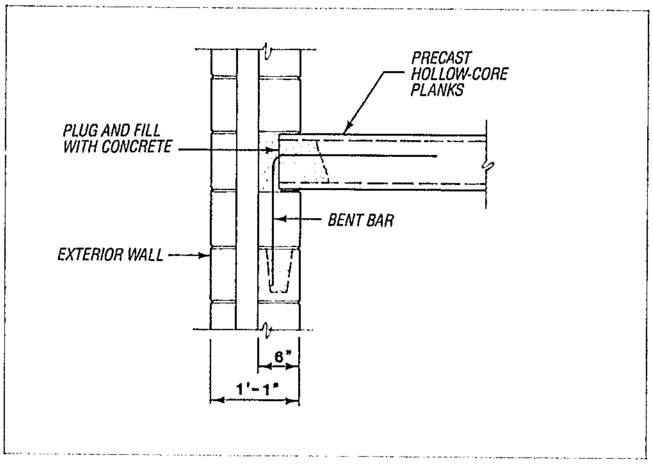
Owner
Hampshire County
Northampton, Massachusetts

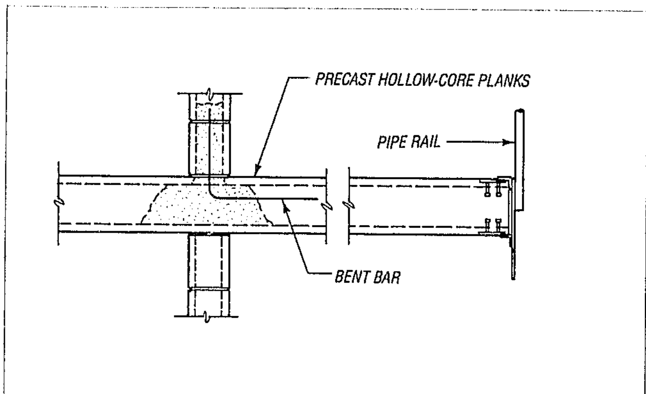
The basic construction for this 135 bed, 59,000 sq ft jail and correctional facility consists of concrete masonry bearing walls supporting precast hollow-core floor and roof elements. Precast, prestressed double tees were used to accommodate the longer roof span of the gymnasium area. The cell groups, or "pods", for the pretrial and sentencing wings consist of an upper and lower tier. The hollow-core slabs were cut to various lengths and end shapes to accommodate the irregular plan layout of the cell groups. The 8 in. thick precast floor slabs were untopped except for a thin levelling course.

The all-precast floor and roof system allowed the total construction time to be significantly shortened. Construction began in April 1983 and was completed in December 1984, approximately 4½ months ahead of the scheduled completion date.

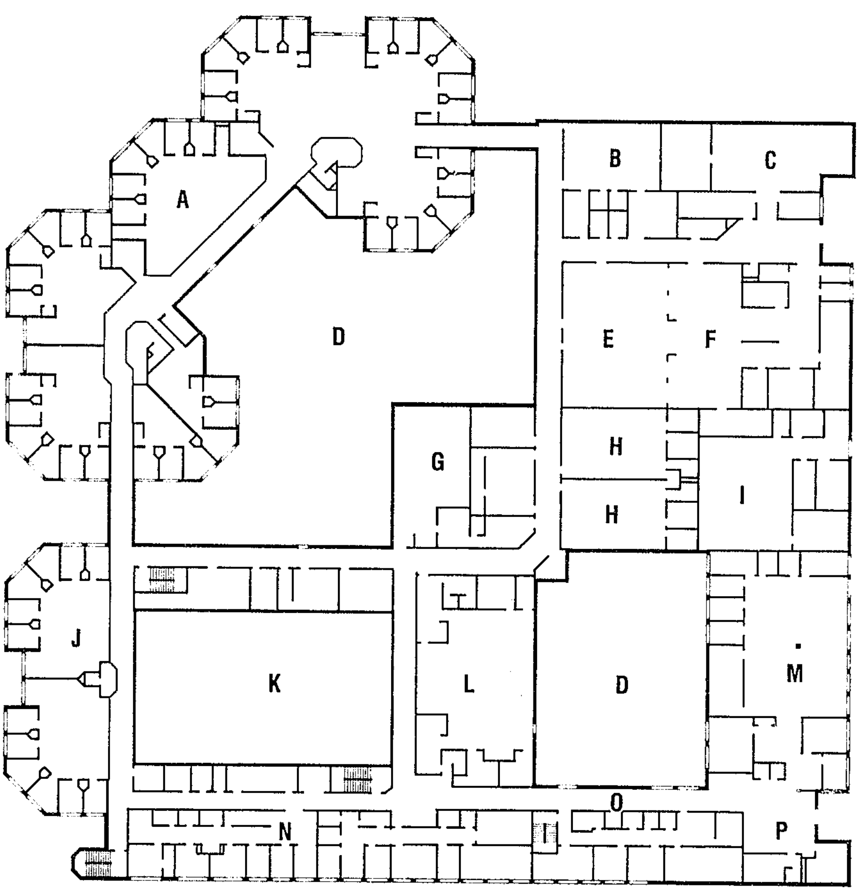
Design simplicity of the masonry bearing walls combined with the precast floor and roof system resulted in a completed facility produced with significant savings in both construction time and money.







MEZZANINE SECTION



A CORRECTIONAL HOUSING
B LAUNDRY
C WAREHOUSE
D COURTYARD
E DINING
F KITCHEN
G LIBRARY
H VOCATIONAL LAB
I MECHANICAL
J JAIL HOUSING
K GYMNASIUM
L VISITOR CENTER
M COUNSELING
N HEALTH
O ADMINISTRATION
P LOBBY

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