Manual

CONCRETE RIB CONSTRUCTION METHOD

Patent US 8,429,876 B2

PREFACE

At the current times, building a dwelling is becoming a challenge.
The traditional construction using lumber, is not a safe solution. Thousands of houses destroyed by tornados and hurricanes, other thousands are destroyed by fire. People are losing every thing, even some times their own life.

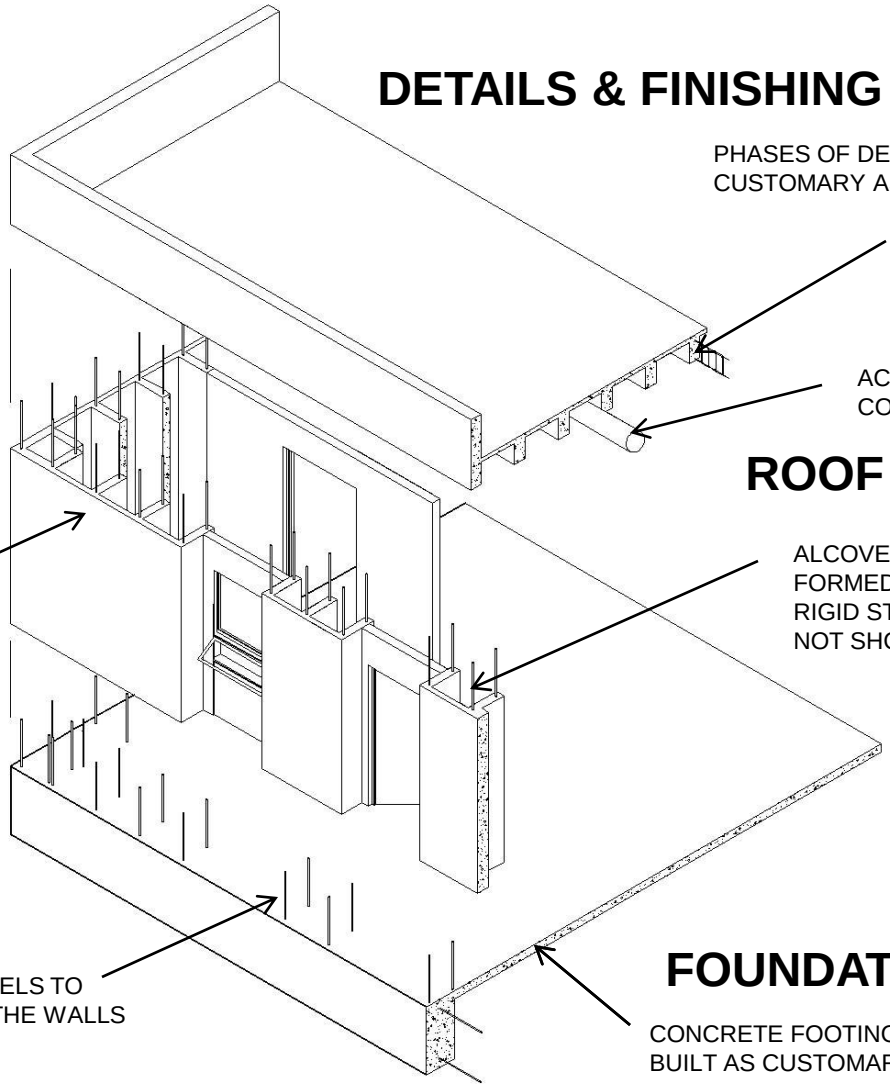
But there is a solution**: CONCRETE**, the material used by Romans about 3,000 years old, but now improved highly by the engineering technology and described in this Manual, how to achieve a strong structure capable of resisting natural disasters, and be free of termites and mold.

CONCRETE RIB CONSTRUCTION METHOD, (**CRCM**) uses the engineering technology to design the elements structural's to handle the loads originated by climatic and or geographical location of the project. The cost is managed by supervision of non skilled laborers, following the recommendations in this Manual.

The study and thoughtful of this Manual give to Developers and Builders, the tools to build desirable dwellings to satisfy the open market of structures from afordables to luxurious, with the advantage of savings of energy thanks of the high values of insulation which start by a R value of 56 to any required by the market in walls and roof.

But, the Manual can be helpful to anybody planning to build by himself, or somebody to manage the workers and buy the materials by themselves.

THE CRCM FIVE PHASES.



DETAILS & FINISHING PHASES 4 & 5

PHASES OF DETAILS AND FINISHING ARE CUSTOMARY AS DESIRED BY OWNER

T-BEAMS ROOF SHOWING R-BAR REINFORCEMENT, COFFERING SPACE FORMED BY EPS NOT SHOWN PER CLARITY.

AC DUCTS CAN BE RUN IN THE COFFERING SPACE

ROOF PHASE 3

ALCOVE IN EXTERIOR WALLS FORMED BY EMBEDDED RIGID STYROFOAM BLOCKS NOT SHOWN PER CLARITY

WALLS PHASE 2

T-BEAM WALLS CONNECTED TO FOUNDATION AND TO ROOF TO BECOME A RIGID FRAME

TYPICAL DOWELS TO HOLD DOWN THE WALLS

FOUNDATION PHASE 1

CONCRETE FOOTINGS AND SLAB BUILT AS CUSTOMARY

THIS IS AN OVERVIEW OF THE CONCRETE RIB CONSTRUCTION METHOD

CODE DISCUSSION

CHAPTER 17

SPECIAL INSPECTIONS AND TESTS

SECTION 1701
GENERAL

1701.1 Scope. The provisions of this chapter shall govern the quality, workmanship and requirements for materials covered. Materials of construction and tests shall conform to the applicable standards listed in this code.

1701.2 New materials. New building materials, equipment, appliances, systems or methods of construction not provided for in this code, and any material of questioned suitability proposed for use in the construction of a building or structure, shall be subjected to the tests prescribed in this chapter and in the *approved* rules to determine character, quality and limitations of use.

CRCM means **C**oncrete **R**ib **C**onstruction **M**ethod, the word "Method" , can create confusion, because the ICC IBC uses such word in the **Section 1701.2 New Materials**. As shown in the Code excerpt at the left.
But CRCM uses concrete a material used more than 3,000 years ago by the old builders, structures which still are, now as touristic attractions.
Some Plan Checkers need be aware of CRCM is in compliance with the Code, ask them than please look at the **Chapter 19 Concrete**, which show about the accepted practices for design and construction , which are truly considering in the use of CRCM as an accepted Construction Method. .

CRCM comment in area yellow filled

Chapter 19 Concrete. This chapter provides minimum accepted practices to the design and construction of buildings and structural components using concrete-both plain and reinforced. Chapter 19 is formatted to parallel American Concrete Institute (ACI) 318, *Building Code Requirements for Structural Concrete*. The chapter also includes references to additional standards. Structural concrete must be designed and constructed to comply with this code and all listed standards. There are specific sections of the chapter addressing concrete slabs, anchorage to concrete, shotcrete, reinforced gypsum concrete and concrete-filled pipe columns.

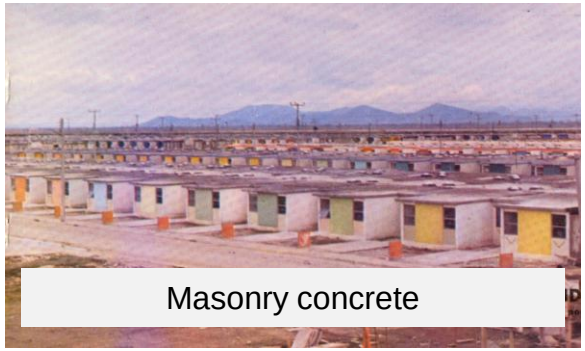
2012 INTERNATIONAL BUILDING CODE®

ABOUT CRCM

CRCM is an innovative method of building structures resisting natural disasters, is the result several years of exploration from rammed earth, to prefabrication, masonry concrete with 7,500 units in Mexico City where earthquakes are frequent, hotels of several stories in Cancun (hurricanes). Such exploration looking to find a method to build low cost structures capable of resisting fire, tornados, flooding, even termites and mold, but highly insulates to save energy, keeping a comfortable area, to live safe with all your belongings, pets, and memorabilia

experimenting with rammed earth

prefabrication



Masonry concrete

Masonry concrete

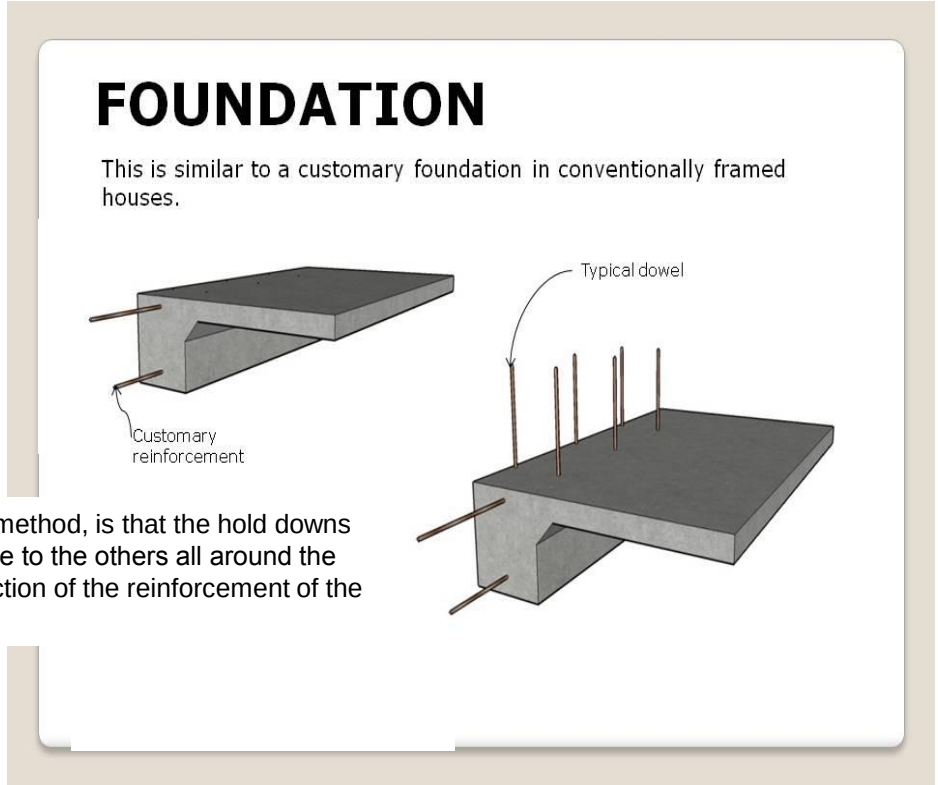
CRCM concept is based in concrete pour in place, no sophisticated equipment or machinery, only labor.
The walls are concrete columns attached to the footings every two feet, and holding one to each other by a continuous wall in the back, acting as diaphragm, all shaped by formwork.
The roof same as the walls embedded blocks of extruded polystyrene, connecting the walls to roof concrete rafters with a concrete slab on top supported by ridge beam ,becoming a strong monolithic structure.

FOUNDATION

For a new construction, starting building requires to have the area where the building graded, some times soils reports are required.

A grading company with the machinery and equipment necessary need to execute the work following the General Notes and specifications in the document provided by the engineer who did the Grading Plan.

The CRCM foundation only difference to the use for traditional method, is that the hold downs are rebars shaped in an “U” shape to be set every 24 inches one to the others all around the Perimeter of the exterior walls. Named dowels, are the connection of the reinforcement of the exterior walls.



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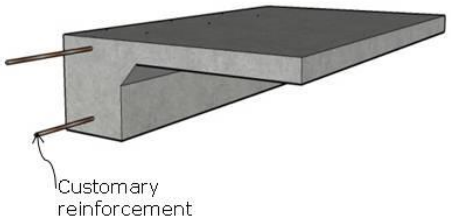
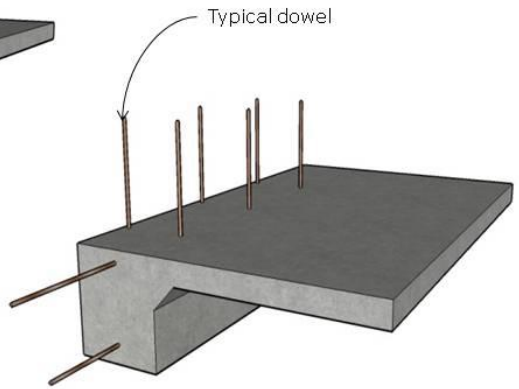
CRCM FOUNDATION

This is similar to a customary foundation in conventionally framed houses.

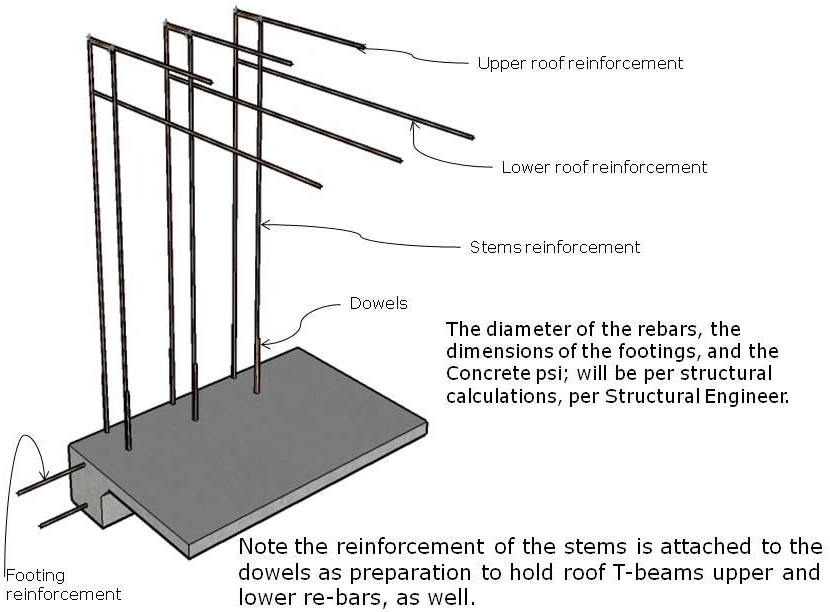




The above shows a typical foundation as used in wood framing

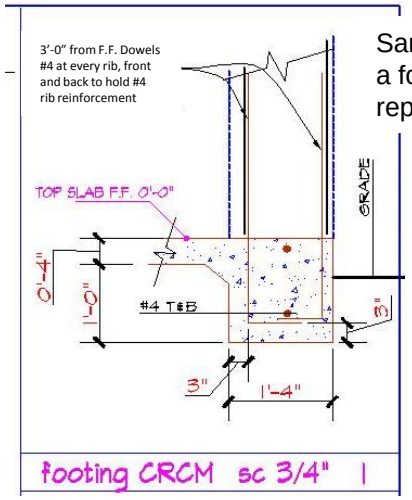
The sketch at the left shows a CRCM foundation the one which uses dowels embedded in the footing, to hold the walls to the foundation. Such dowels are designed by the structural engineer, placed as shown in the structural plans .
Note than wood framing uses expensive hold downs, and anchor bolts to hold the walls to the footings, not shown in the picture, but costly..

Dowels requires to be a minimum of 3 ft above the top of the floor slab, cutting in half a rebar of 20ft gives enough length greater than 3ft . The steel reinforcement of the walls which is part of the roof reinforcement is attached to the dowels, making the monolithic structure of CRCM. Bending the rebars is fast with the right tool.



The diameter of the rebars, the dimensions of the footings, and the Concrete psi; will be per structural calculations, per Structural Engineer.

Note the reinforcement of the stems is attached to the dowels as preparation to hold roof T-beams upper and lower re-bars, as well.



Sample of a section detail showing a footing. Note brown lines represent dowels

setting the dowels is an important task, such dowels are per conditions of the formwork to be at 24 inches of distance, except the dowels at corners, which need to be as required by the thickness of the walls. In the sample walls will be 16" thick, then the corners will be 16"x16. See detail at left. See the attached structural detail of a foundation.

The next three pages have photos as follow:

Photo #1 – Depicts the lumber used to mark the perimeter of the foundation, customary use of 2x6 set using wood stakes.

2 – using the perimeter of the lumber, proceed with the excavation for the footings.

3 - shows the dowels in place; note to keep the dowels at 24", temporary rebars horizontal.

#4 the ready mix truck delivering the concrete;

5 workers placing the floor slab,

#6 doing the finish of the slab.

#7 footings and floor slab done, note the comment which can give and idea of cost, by calculate the CY concrete to be used and the salary of the workers, in your project.

8 the preparation,

9 the final results.

CRCM foundation is similar to the traditional foundation for wood framed Construction, differences are in the size of the footings, which are set by the Structural Engineer based in soils resistance and the loads, which are different to walls and roof of wood framing.
Such difference are which keeps the structures on the ground in case of tornados, and Hurricanes.
Besides concrete is waterproof, if flooding occurs no bends or damage in the structure happens by moisture

Trenches to accommodate the size of the footings.

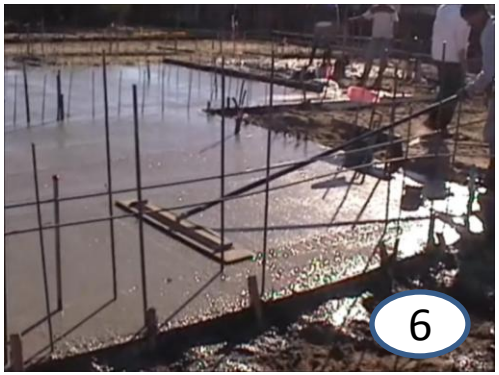
With plumbing pipes and electrical placed under the future floor slab. The site will look similar to the one shown. The perimeter forms are lumber in the dimensions to have above grade as many inches is required by City requirements, the picture is with 2x5 , placed by flat metal stakes 3/8x1.1/2" in the length required to hold firmly the lumber wood bracing as necessary.

When the trenches are done, the plumbing and electrical under ground are in place, and the re-bar reinforcement was approved by the City Inspector, is the time to start pouring.

When the concrete is deliver, footings and slab pouring will go. Noted than it is done by the 3 laborers, under the boss direction.

Floor slab reinforced with fiber glass, when concrete is mixed with an additive which seal cracks with moisture, no sand and waterproof membrane are required, by **Exception (R506.2.2 Base** A base course is only required when the slab is below grade.
2013 RESIDENTIAL CALIFORNIA CODE, Verify the governing code in your location.

Note than visqueen membrane and steel reinforcement are not used, because fiber glass was added to the premix concrete.



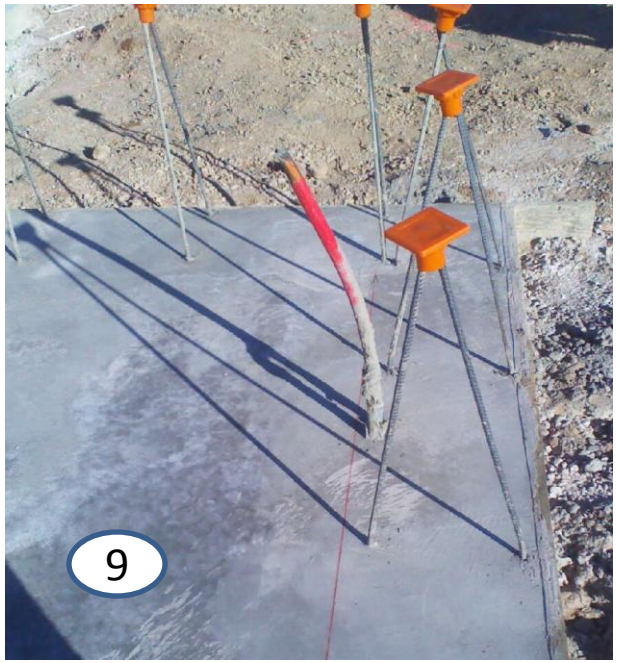
The finishing by the finisher guy was hand made done, easy with no interruptions.

Is interesting to know than 4 people on 4 days of work was an area of 2,870 sf, pouring 27CY on footings, and 29CY for floor slab with fiber glass.

We insist in the dowels because are a crucial item to have a cost reduced with improved performance of the structure in case of tornados, hurricanes, and earthquakes. The function of the dowels is creating a monolithic body of the foundation, walls, and roof; characteristic of the CRCM,

At left a trench showing the footing reinforcement and the placement of dowels.

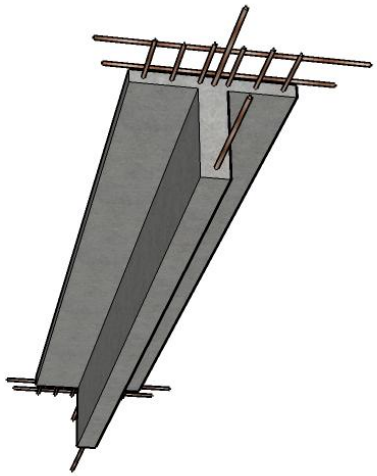
The right location of the dowels is as shown in plans every 24 inches on center, in perpendicular direction to the length of the footings, the exact location will be established by the structural calculations.
To keep the 24 inches in between dowels, is good practice to use temporary rebars above the floor slab to wire the dowels at the correct distance, as shown on the above photo; the shape of a dowel is an “u”, the lower part is wired to the lower bar reinforcement, the upper bar is hang to horizontal braces on the temporary rebars, which are removed after concrete poured in place.



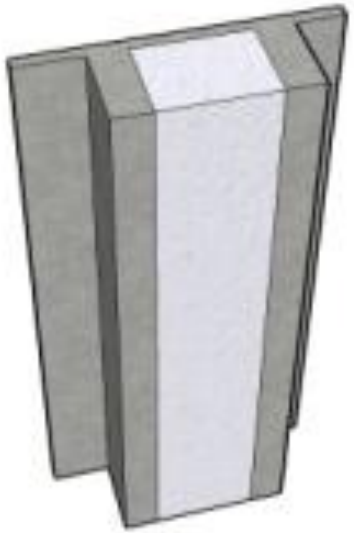
CRCM WALLS & ROOF

The structural concept to use CRCM is based in the T-beam shape T-beams can handle heavy weights and have big spans .
T-beams advantage is that requires a minimum of concrete and steel reinforcement. The ones on use in parking buildings, are prefabricated, which means need to be made in a factory, delivered to the construction site, shipping, plus heavy equipment used to set in place, skilled workers required, result: expensive cost.

But can be used for dwellings CRCM as a practical patented method, low cost thanks to the process of forming, and pour in place, the CRCM use “T-beams” for walls and roof. To create the T shape, CRCM uses blocks of Polystyrene making the structure highly insulated, which can be as desirable by design of the size of the block and its density.
CRCM uses the T-beams horizontal or slanting for the roof, and in vertical manner to create the walls.

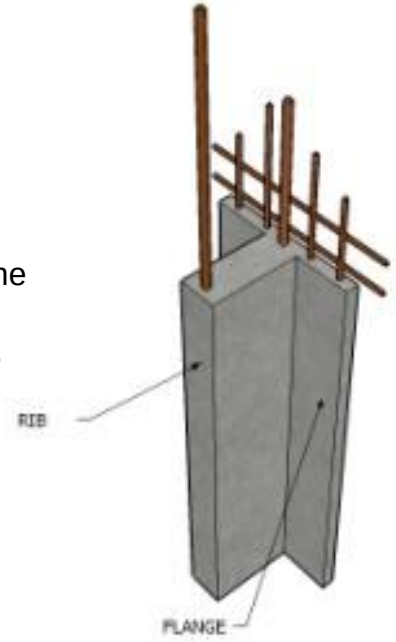


A T-BEAM SHOWING THE STEEL REINFORCEMENT

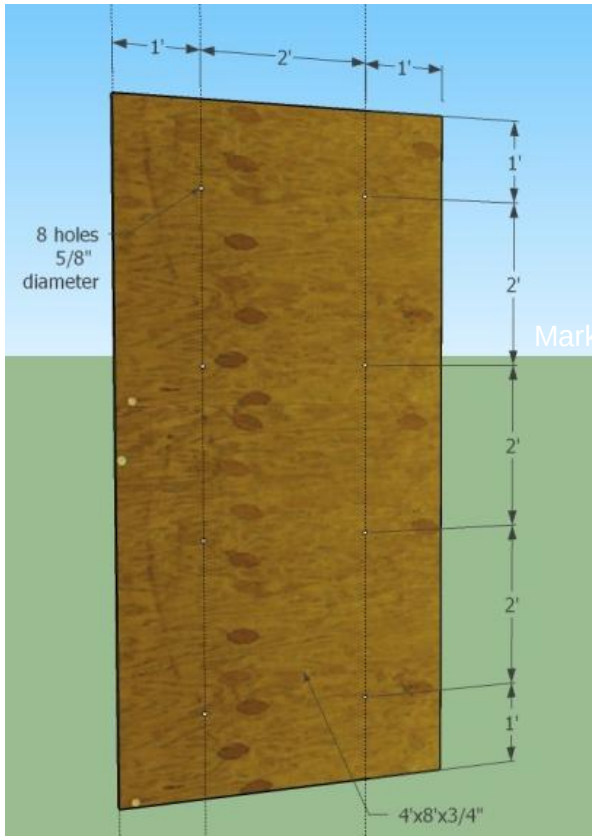


At left two wall T-beams with a block of polystyrene as forming, which remains encased in concrete, the CRCM way of building T-beams cast in place.

At right a vertical T-beam, steel reinforce shown.



WALLS



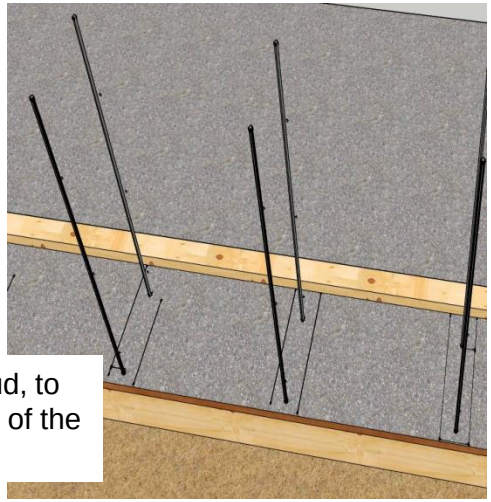

Marking where to drill

Use ¾" BB Plyform 4x8 FT one on top of the other in a pile of 6, align the sides in the way of match the 4 sides. Measure by the sketch in the working documents, drill the holes with a bit of 5/8". Take the top one as a jig for drilling the rest of the panels.


The tool

Note than the holes on the panel are meant to facilitate the use for taller walls, keeping the two upper rows of ties in the concrete and use them to hold the panel to a higher position, it makes very convenient CRCM to have no restrictions for taller walls, or walls under gable roofs, using the same form work for any variances in heights.

Ounce the footings and floor slab are done, chalk mark, following the construction documents the position of the wall ribs as well the interior face of the wall.

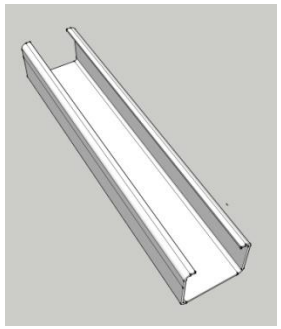


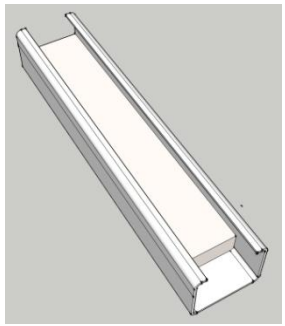
Use the line of the face of the wall and ¾ inch behind place a flat 2x4 wood stud, to make room for the plywood formwork. Such 2x4 will be holding the lower part of the plywood formwork, at the pouring time.

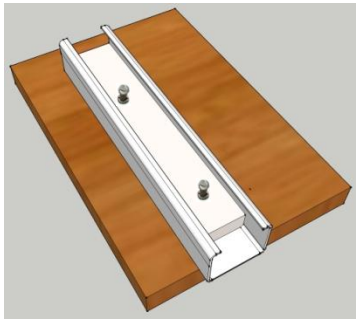
Considering that such flat 2x4 is will be only temporally used, we recommend the use of 2 nails in a drill thru the 2x4 and one inch in the concrete slab, every two feet. One of the nails shall be 2 heads to make easy to pull them out and reuse the 2x4.

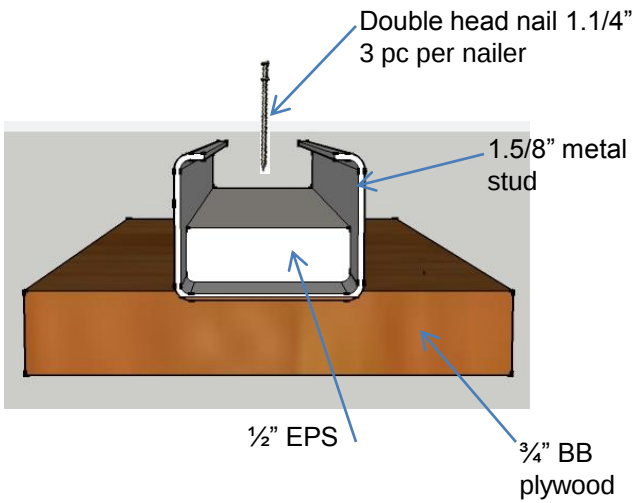
ABOUT CRCM NAILER

The CRCM nailer should be attached to formwork @ 2'-0" o.c. matching with the center of the stem.
2head nails are used to nail the CRCM nailer, the function of the 2head nailers is to hold in the concrete to liberated the formwork to the poured wall or roof. The stud by the bends remains attached to the stem.



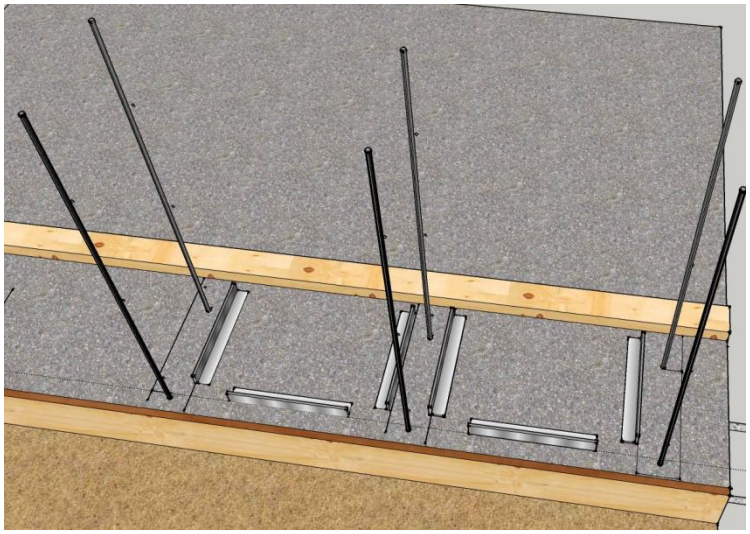


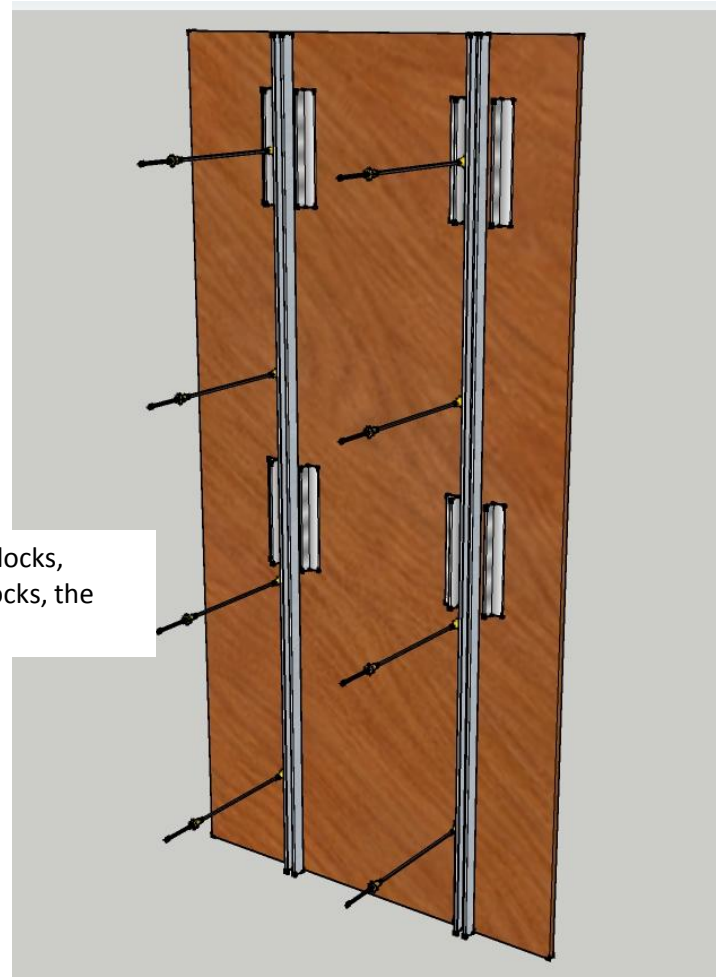




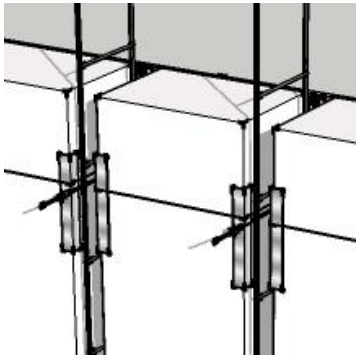
The CRCM nailer once attached to formwork and the ties placed.
The interior of the wall formwork will look as shown at the lower left picture

It is very important to keep the blocks of Styrofoam right in the place shown in the construction drawings: the foam's back shall be against the wood formwork which be at the interior face of the wall, the opposite side of the foam at two inches of the exterior face of the wall, such two inches are used for the diaphragm to take shear stresses for the wall in case of horizontal forces of wind or earthquake; the other two sides of the foam shall be in between of the stems of the T-beam wall, additional support in the medium and the top of the EPS block is shown below at the right..



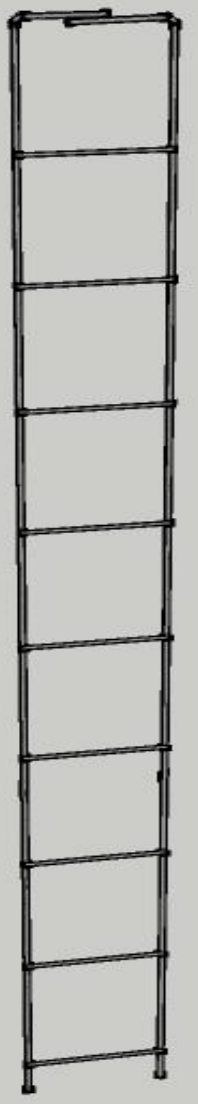


The sketch at right shows one formwork panel with the angles holding the EPS blocks, noted than the blocks will be wired to the forms which requires angles on the blocks, the sketch is also showing the nailers, and the ties.



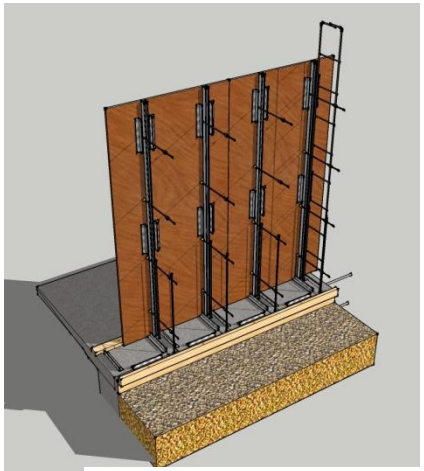
At left EPS wired and protected by angles at the matching area of the angles on the formwork.
Note angles on the slab need concrete nails, the ones on the form common nails, the ones protecting foam: no nails.

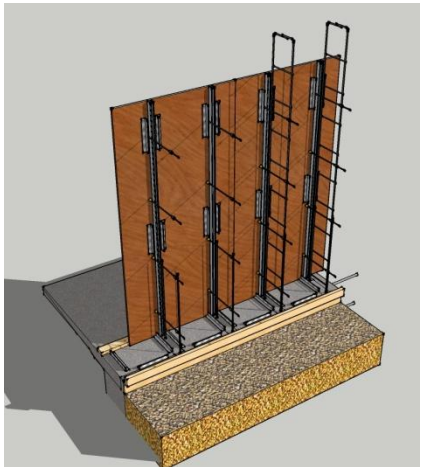
Simple, but effective low cost operation.

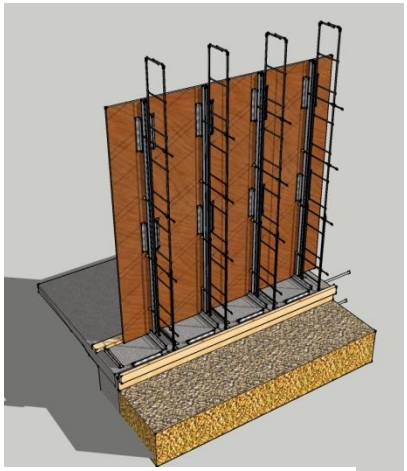


At left a sketch of the steel reinforcement of the stem (rib) where rebars and stirrups are designed by structural calculations, to take the loads and stress depending of the conditions of the location of the building.

This sketch depicts the placing one of the interior formwork

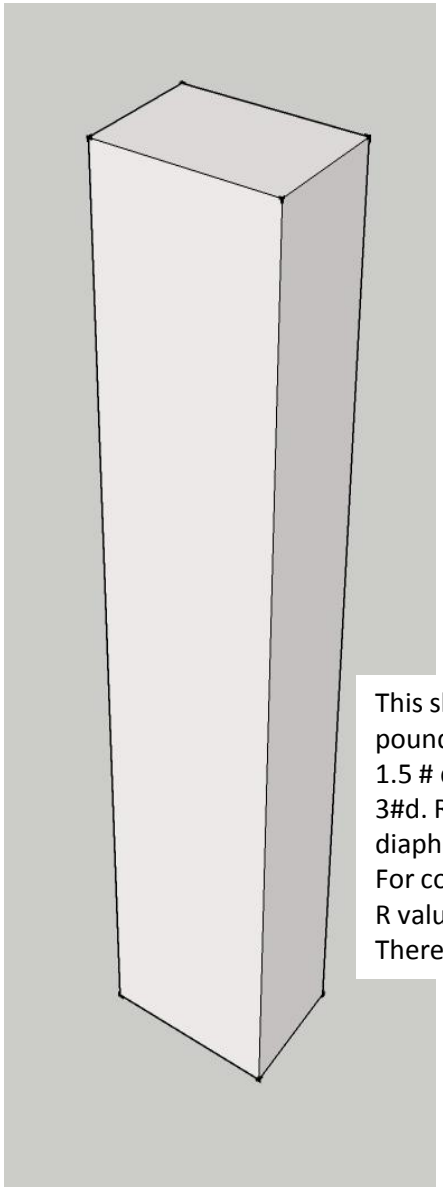






Next step is to wire the reinforcement of the T-beam ribs (stems) to the dowels; the wall becomes firmly attached to the foundation and when the roof is attached to the top of the walls, the structure will be monolithic, strong to resist the forces of nature, no buildings flying if hurricanes or tornados appear, besides building with concrete the structure become fire resistant. And all done with low wages laborers.

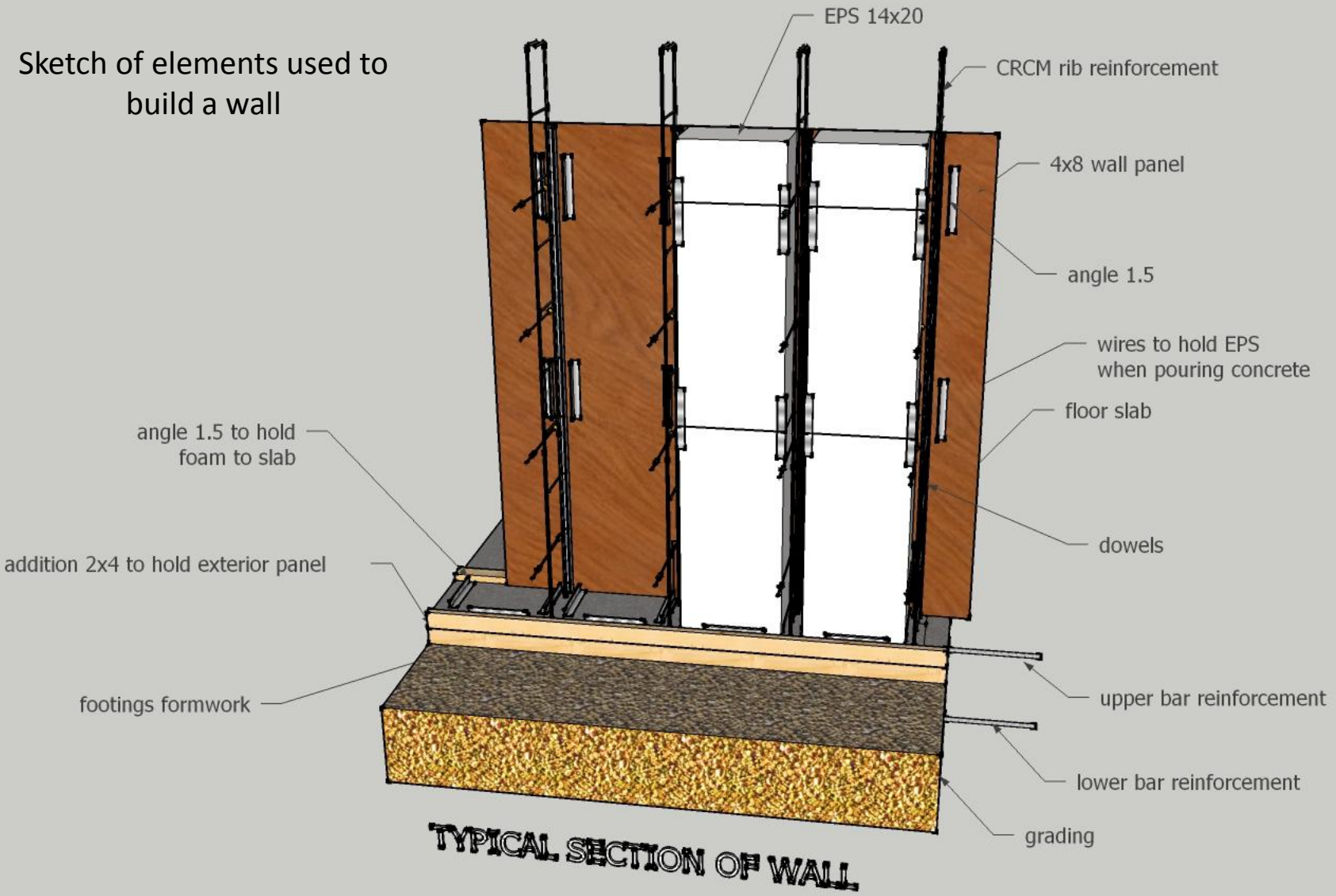
ACCESSORIES USED BY CRCM

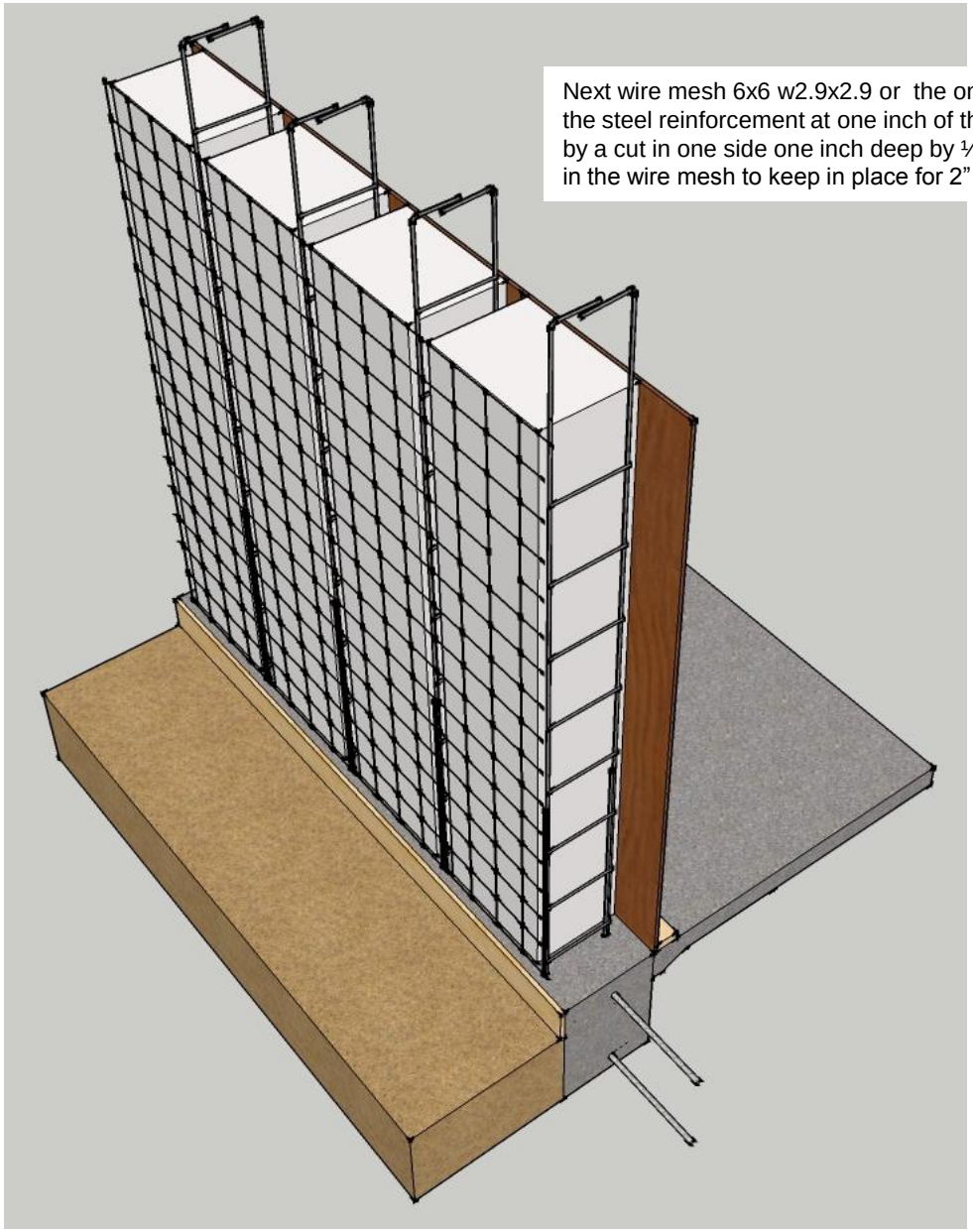


This sketch refers to EPS (extruded polystyrene) nominal 1 pound density has an R factor of 4.17 per inch.
1.5 # density R=4.55 in. 2# density R=4.35 2.3 # d. R=4.85 3#d. R=5.05. Which means for walls 16" thick with 2" diaphragm can be from 58.38 R to 119 R.
For colder conditions a thicker wall can be used to make the R value as necessary.
There are no limits using CRCM.

Brackets are Jahn Type A and C, can be rented by month,

Sketch of elements used to build a wall

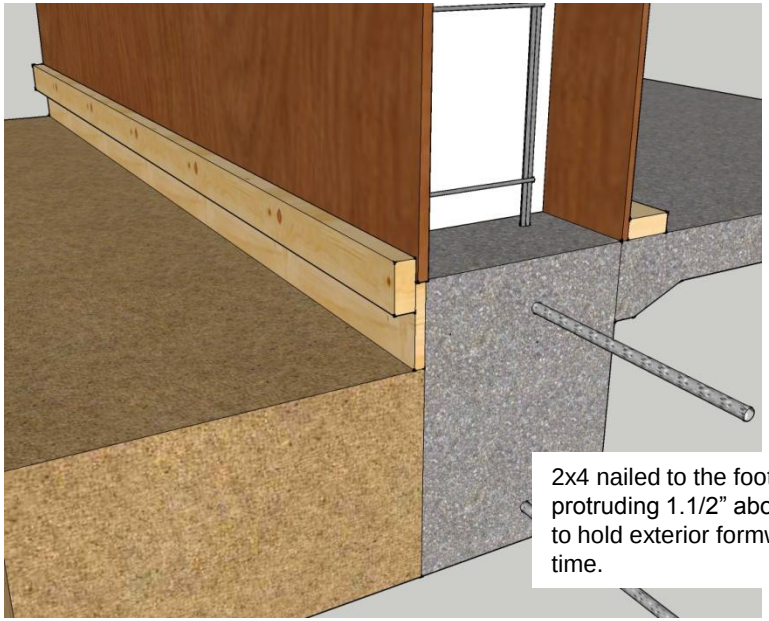




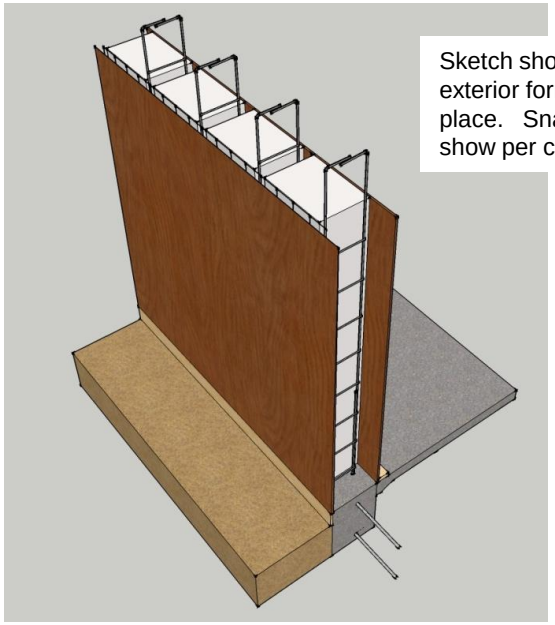
Next wire mesh 6x6 w2.9x2.9 or the one in the structural drawings to be attach to the steel reinforcement at one inch of the face of EPS, dobies 2x2 in. customized by a cut in one side one inch deep by ¼ inch at the center, to be placed inserted in the wire mesh to keep in place for 2" diaphragm.

Shows placing 2x2 dobies

Actual photo of formwork with nailer and angles, EPS blocks Snapties, and diaphragm wire mesh.



2x4 nailed to the footing form work, protruding 1.1/2” above floor slab level to hold exterior formwork at pouring time.



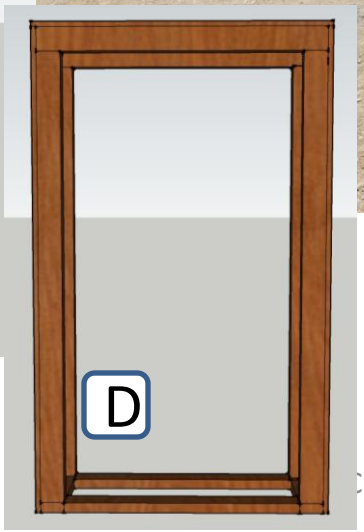
Sketch showing the exterior formwork in place. Snapties not show per clarity.

2x4 wale hold by a Jahn “A“ bracket hold by a Brigade Snap tie short end, hex-head.

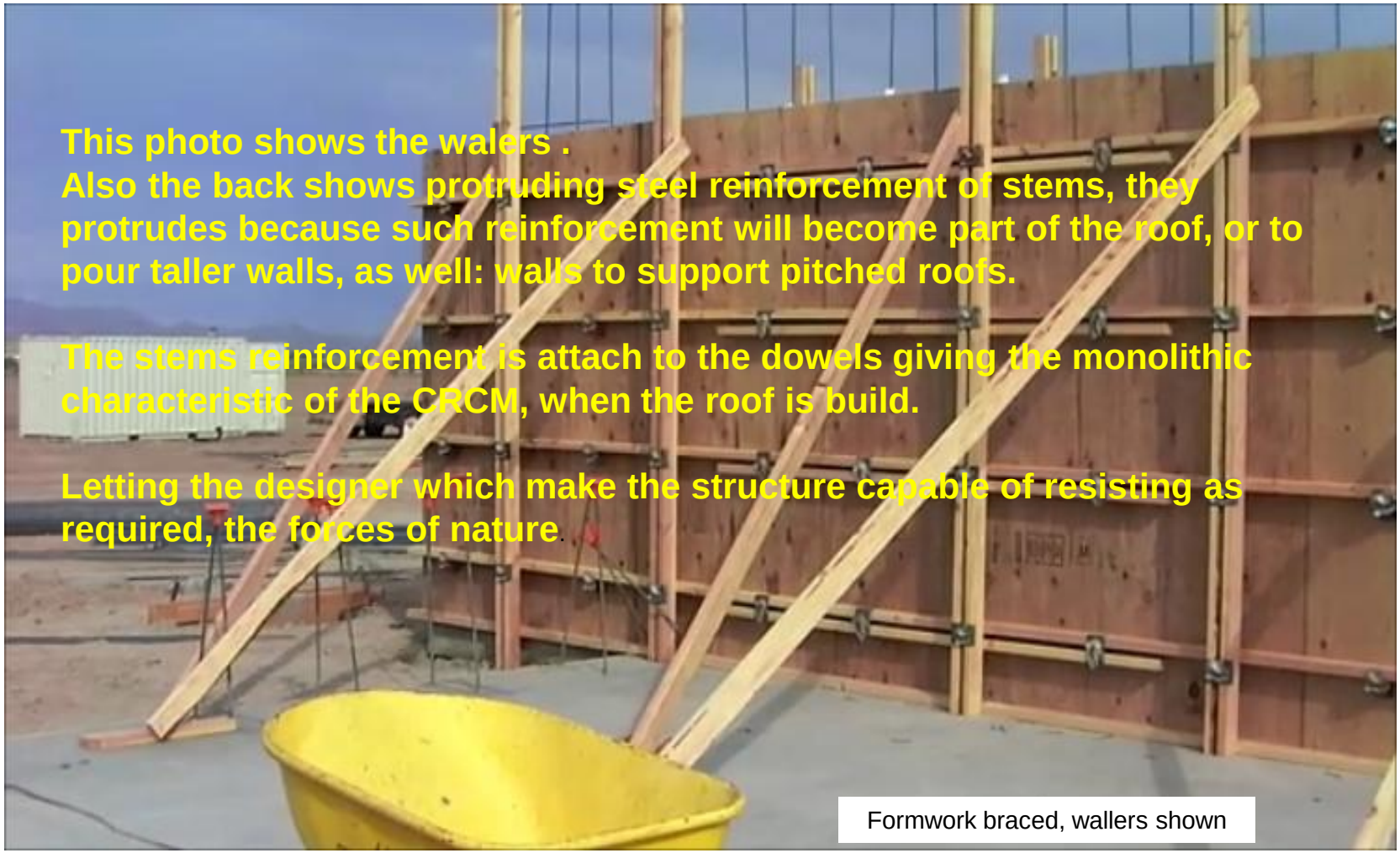
Jahn “C“ brackets are used in scabbed joints for long formwork for walls.

Jahn Corner lock used at outside corners to secure 2x4 wales

OPENINGS ON WALLS FOR DOOR AND WINDOWS

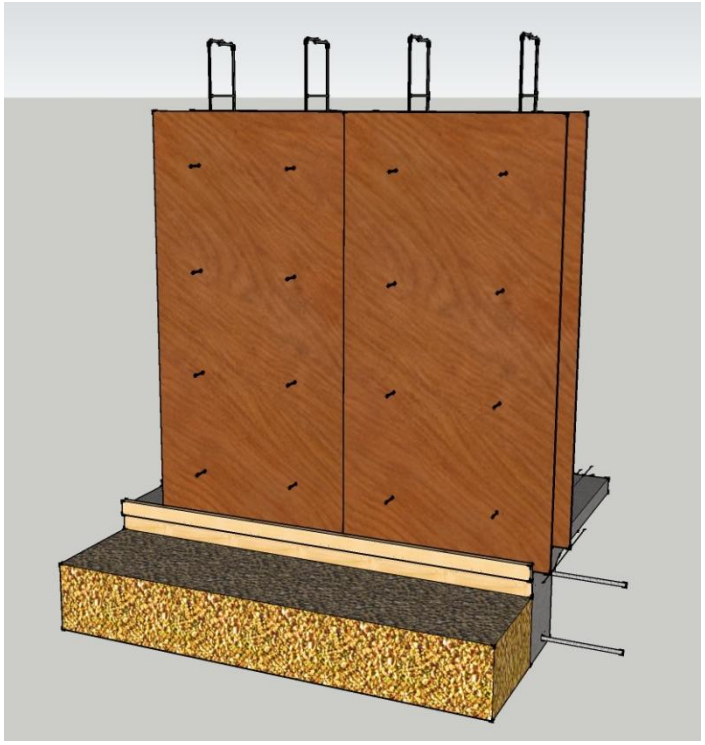


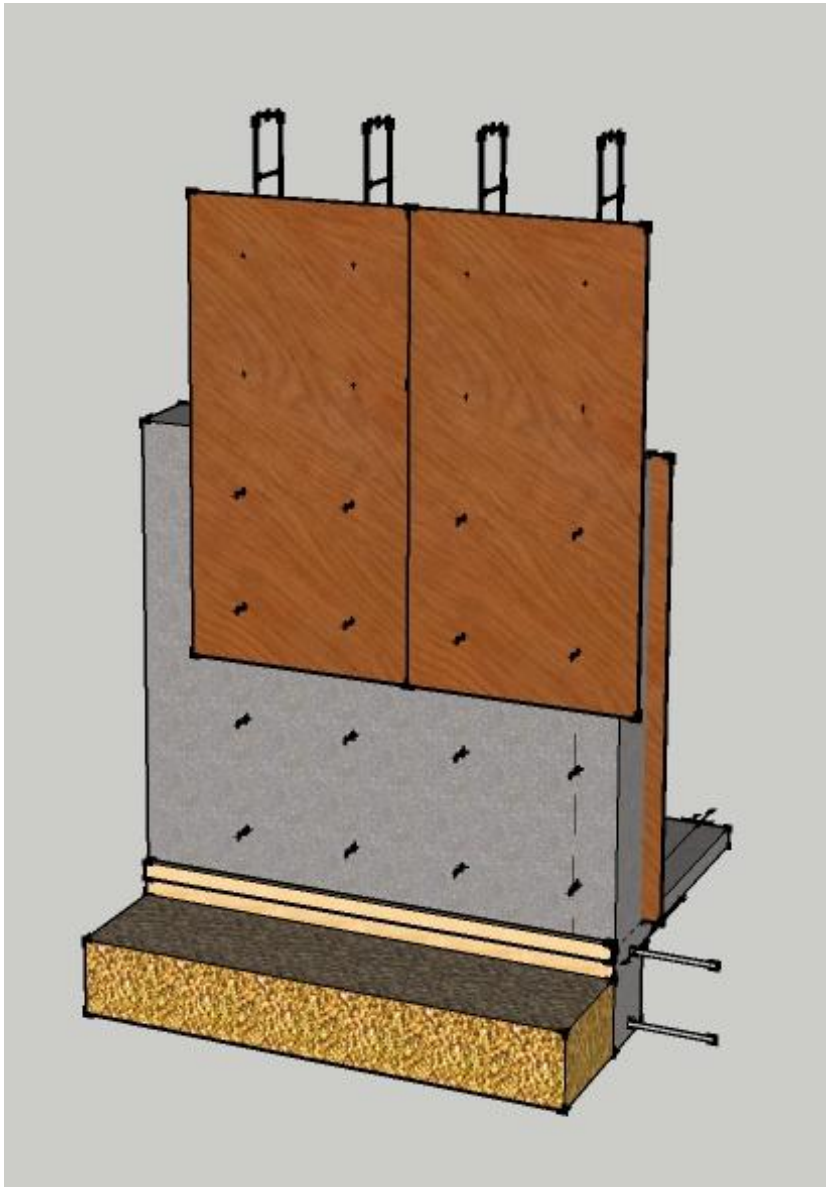
To have openings to place door or windows, make two opposite jambs as shown in A, a top like B, assemble those as C, place in the required space on the wall, by drawings and use 2x4 flats on the bottom nailed to the floor slab as shown in D.



Formwork braced, wallers shown

Toller Walls or for pitched roof





An feature of the CRCM is its capabilities of make easy to build walls of any height, using the same formwork and reuse the snapties of the lower section.
Here we have at left a sketch of the formwork and snapties of a section of wall of 4 feet height.
At right and sketch of the 8 feet wall poured, thanks to the design of the formwork, is possible to move higher the forming raise the height of the wall 4 feet more or make the wall to a variable height to be supporting a pitched roof, some guides nailed to the formwork are used by the time of pouring.

This feature is one more to build high quality at affordable cost..

Walls for pitched roof

Walls for leveled roof

The process of preparation for pouring concrete at the CRCM walls is summarized as follows:
The placement all the formwork which requires the traced of the floor plan at full scale on the top of the floor slab, note that the dowels are at the center of the ribs (stems), following the traced lines anchor a 2x4 at ¾" of the interior face of the wall. Nail the CRCM nailers to the formwork, then attach the steel reinforcement to the dowels, hand 4x4 dobies to one stirrup at about half the height of the wall. Then glue the Styrofoam blocks to the floor slab, use an approved epoxy glue to Styrofoam by following the place marked by the tracer. The reinforcement of the flange normally:
wire mesh 6x6-w2.9xw2.9, unless structural or at the specified by engineer, will be wired to the rebars reinforcement. To keep the wire mesh in the center of the flange deep, if the diaphragm 2" thick: use 2x2x2 in. dobies, with a score one inch deep to have one inch to the EPS and one inch to the formwork, which is placed next. Wallers and brackets and bracing will be to be ready to pour. The flange becomes the diaphragm to resist earthquakes and or strong winds.

2 inch Dobie

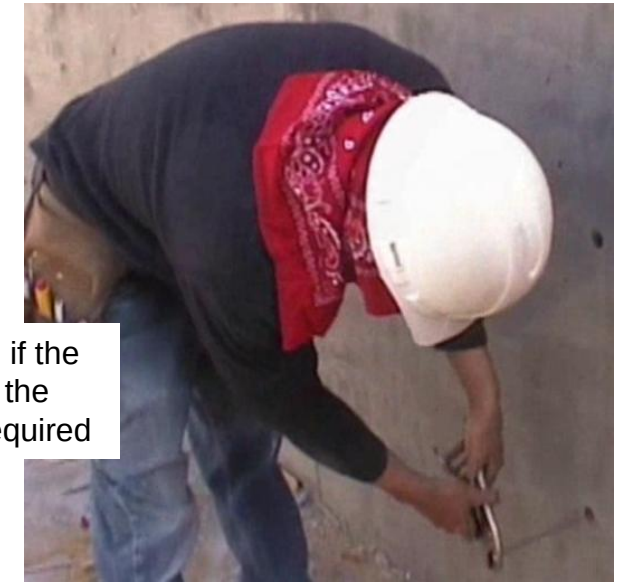
4 inch Dobie

Pumping concrete pea gravel

Vibrator use at concrete walls

Next day of pour, formwork can be moved.

Braking the ties no used if the wall is 8 ft eight, leaving the ones if taller walls are required

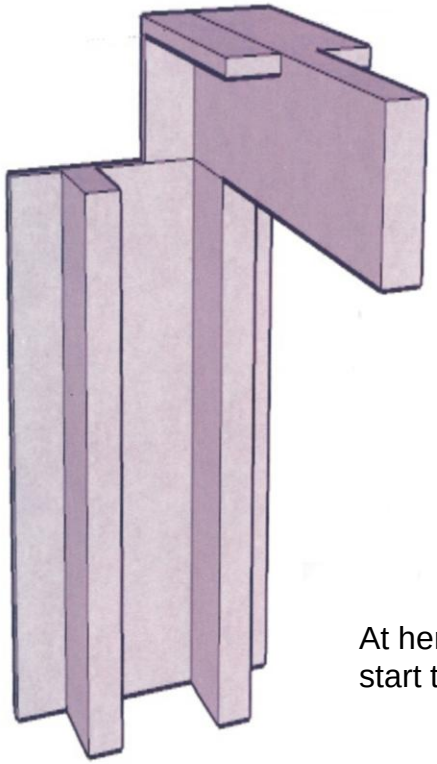


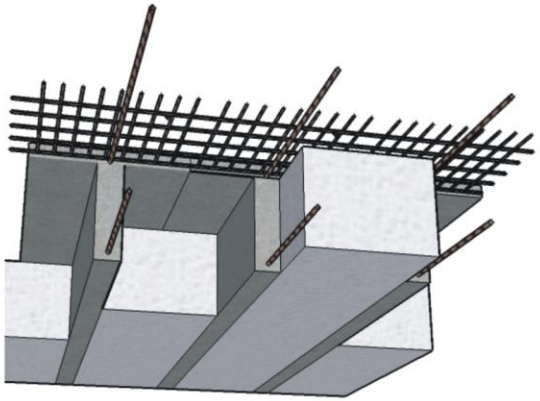
NONBEARING WALLS

Nonbearing walls can be wood or steel framing, we recommended steel framing to keep the building resisting fire by have not flammable materials in the structure, as well sustainable, which make the system Green.
CRCM provides nailers at 2'-0" center to center, which should be used to hold the vertical tracks holding the nonbearing walls. The sill track attached on the floor slab, the top track can be screwed to any one of the roof nailers set at 2'=0" or perpendicular to the roof nailers, following the instructions on the construction documents. The screws dimensions and placement distances per structural calculations.

CRCM ROOF

Below left: the diagram shows part of a ribbed wall supporting and connected to the roof T-beam. This connection creates bracing between walls improving the structural capacity to resist forces such as wind pressure and earthquakes. Below center and right are a diagram and photograph of CRCM roof and ceiling before being furred with drywall panels in the tradition of American interior finishes.





At here this point you have an idea of what is CRCM about, and in follow pages you will start the Everybody can build, process.

The cutting , bending and putting together the steel reinforcement can be done in site per a laborer using manual tools, or electrical tools more easy to work, or can be ordered to be manufactured to any store giving such service

At right a picture of the formwork to hold the roof elements to be pour. The vertical supports can be rented pipe shore with U-head holding lumber in dimensions by the spans required, with 8x2 lumber used to be under the stem.

Temporary structure to hold EPS and steel reinforcement

A recommended practice is the use of a chemical additive to the concrete at the mixing time to seal the natural cracks resultant at the shrinking for lost of water at the hardening process.

View of roof steel reinforcement and EPS insulation

Pouring concrete pea gravel by pumping

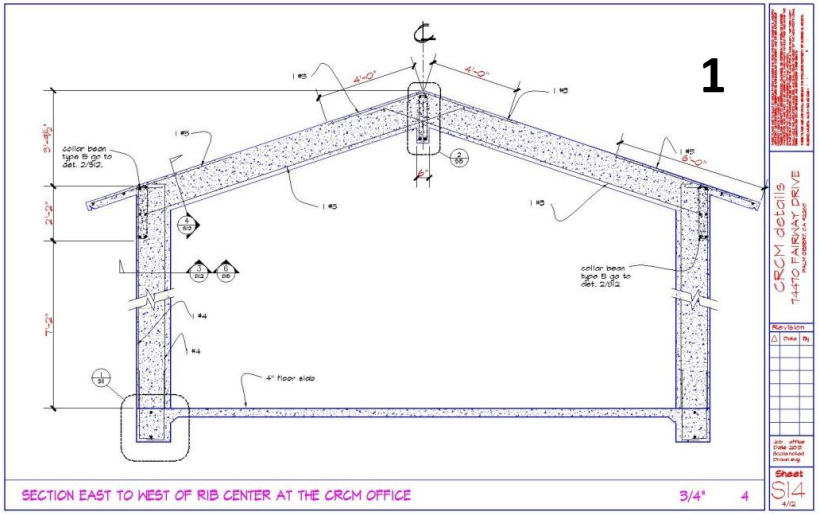
Knowing that the tradition of gable roofs is important CRCM manual will show how to built them. In spite then is not critical to have them even in snow country, because using concrete to build there is control of of the dimensions and resistant of the material, then flat roofs can be designed to support big loads of snow, but to satisfy the tradition you will find the answer in the Manual; or ask us for support.

Underside of the CRCM concrete roof, note the CRCM nailers shown at the center of the ribs, ready to receive the furring, which can be gypsum panels or any décor materials upon whishes of owner.

GABLE ROOFS STEEL REINFORCEMENT

Once the internal side of the walls is in place, before placing the other side, the reinforcement designed by structural engineer, following the Codes and Regulations prevailing, plus the special conditions of wind speed, and seismic motion, which produces greater effects will govern the design for construction stability.

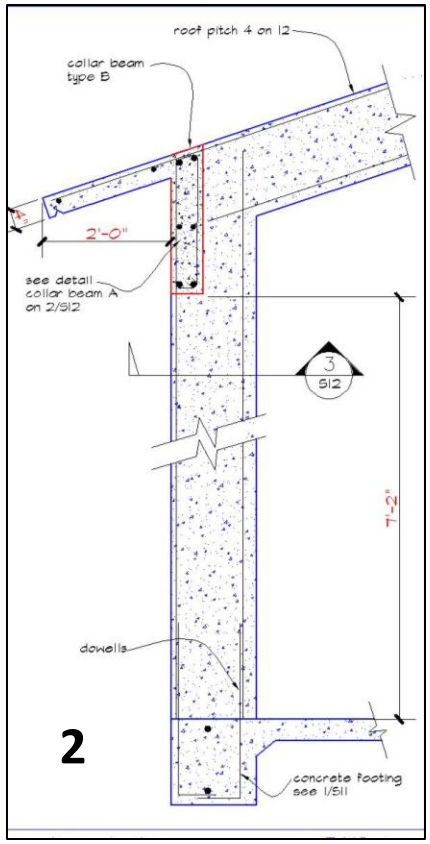
Regarding Fire protection, CRCM door and windows will have an automatic close protection of precast concrete as designed, show in this Manual.

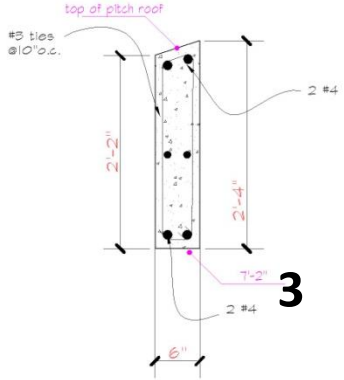


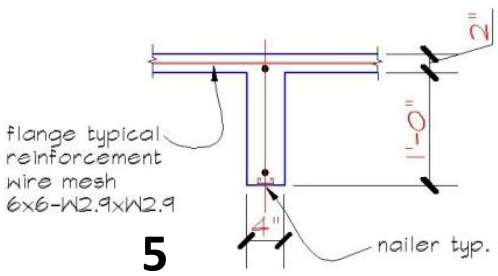
#1 a sample of an structural drawing a section at the center of a wall stem, #2 wall/roof. #3 reinforcement of collar beams. #4 The T-beam wall reinforcement, #5 T-beam roof.

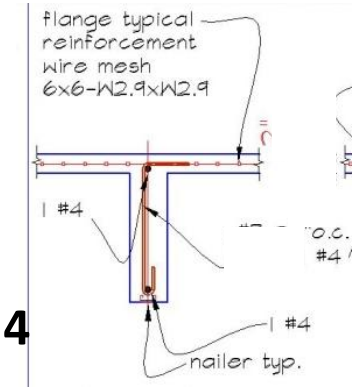
This structural's are for a building in the Coachella Valley, California.

Different location, different specifications, but similar process.









Please see "Taller walls or for pitched roofs" on previous pages for information.

DRYWALL

Placing drywall on a flat ceiling is fast and easy, concrete is calculated for admissible deflection, which is not perceptible by the human eye, means no shimming or shaving as required in traditional, resulting : good savings on cost and time of construction.

Same advantages to furring the walls, no shims, no shaving, the walls are perfectly plumb.

Noted the CRCM nailers on the wall and the insulation material.

Drywall on slanting ceilings are no problem

Note than the joints in between 2 gypboard panels are almost invisible.

After drywall taping, texture, and painted; the interior is quite similar to the customary traditional appearance of the built all around.
The difference will be dramatic if a wild fire or a tornado have action in the area.
The finish floor can be of any desirable material as well base board.

Plumbing, electrical and HVAC, are as customary, with the condition of having all the piping under the floor slab, and the HVCA modified changing the rule of One Ton for every 400 SF of building, considering the high R value of walls and roof of CRCM building.

Stucco finish with out the waterproof paper, chicken wire, scratch, brown, and finish coats, and the savings of CRCM doesn't need all those aggregates to have color stucco the building looks as the same quality of the traditional with less labor and cost; which means less time doing construction

This Manual has information for building a CRCM house, you need to be member of the CRCM Community which is free and have access to SUPPORT, send email to:

aburtoeugenioarch@hotmail.com

To have a set of architectural drawings you need to have the catalog of CRCM plans to choose the one for you.