MASONRY MATERIALS

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Presented by:

MASONRY INSTITUTE OF HAWAII

TILECO INC.

MASONRY INSTITUTE OF AMERICA
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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Why Masonry?

At the end of the session Attendees will learn that Concrete Masonry is:

- Green
- Affordable
- Flexible & Attractive
- Safe
- Robust and Resilient

Why Masonry?

- Learning Objectives
  - Specifying Masonry Materials and at the Same Time be Consistent with Material Standards
  - Specifying Masonry for LEED Credits Using Recycled and Local Material
  - Consideration of Life-Cycle Cost of Masonry
  - Determining Masonry Fire Ratings

CONCRETE MASONRY UNITS

ASTM C90

ASTM C90

What is Covered

- Properties
  - Compressive Strength
  - Face Shell and Web Thickness
  - Manufacturing Tolerances
  - Absorption Requirements
  - Weight Density
  - Permitted Cracking
  - Permitted Chippage
  - Visual Acceptance Criteria

What is not Covered

- Fire Rating
- Sound Rating
- Thermal Properties
- Water Repellency
- Mold Rejection
- Infestation Resistance
- Color Variation**
- Texture**

ASTM C90

ASTM C90, TABLE 2, Strength, Absorption and Density Classification Requirements					
Density Classification	Oven-Dry Density of Concrete, lb/ft³	Minimum Water Absorption, lb/ft³		Minimum Net Area Compressive Strength, lb/ft²	
	Average of 3 Units	Average of 3 Units	Individual Units	Average of 3 Units	Individual Units
Lightweight	Less than 105	18	20	2000	1800
Medium Weight	105 to less than 125	15	17	2000	1800
Normal Weight	125 or more	13	15	2000	1800

ASTM C90

7. Finish and Appearance

7.1 No more than 5 % of the units in the shipment shall exhibit one or more of the characteristics described in 7.1.1 through 7.1.4 and 7.2.

7.1.1 Units with dimensions not meeting the requirements of 6.1.

7.1.2 Units with finished face(s) containing chips larger than 1 in. (25.4 mm) in any direction.

7.1.3 Units with finished face(s) containing cracks wider than 0.02 in. (0.5 mm) and longer than 25 % of the nominal height of the unit.

7.1.4 Units that are broken.

7.2 Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall not show chips or cracks, not otherwise permitted in 7.1.2 and 7.1.3, or other imperfections when viewed from a distance of not less than 20 ft (6.1 m) under diffused lighting.

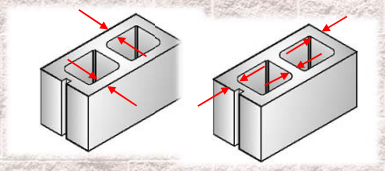
7.3 The color and texture of units shall be specified by the purchaser. The finished surfaces that will be exposed in place shall conform to an approved sample, consisting of not less than four units, representing the range of texture and color permitted.

ASTM C90

- Old minimum strength requirement – 1,900 psi
- New minimum strength requirement – 2,000 psi
- No "Equivalent Web Thickness" requirement
- Now "Normalized Web Area" and minimum "Web Thickness"
- No Type I (since 1999)
- No Grade N (since 2008)
- Producers should NOT certify that materials are Type I/II or Grade N/S (RFI before submittal, could require a redesign of control joint spacing)

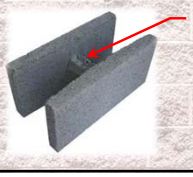
ASTM C90

- Minimum Face Shell Thickness (8 inch unit) 1-1/4"
- Minimum Web Thickness (all units) 3/4"
- Normalized Web Area (all units) 6.5 in^2/ ft^2



ASTM C90

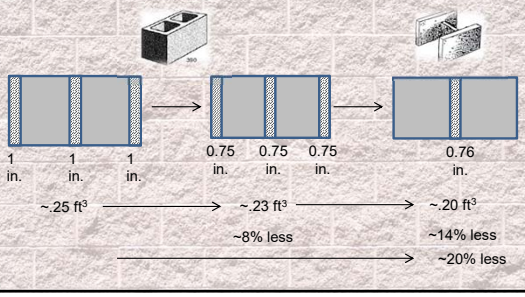
- Open-end units are virtually impossible to manufacture with 3/4" webs and 6.5 square inches of total web area per square foot (5.75 in^2/unit)
- Caution when reviewing specifications; some specifiers may ask for the "minimum" web area



Currently about 11½ in^2 of (web) connection

ASTM C90

- Old versus New
- All open-end and double open-end manufactured in CA and NV exceed the minimum Normalized Web Area, and will exceed minimum web area



MASONRY VENEER

Masonry Veneer

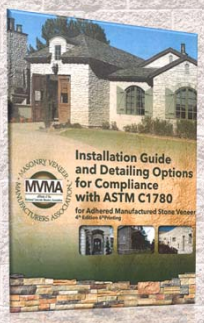
Masonry Veneer Units

- Clay Masonry Units
  - Full Brick
  - Thin Brick
- CMU Veneer
- Stone Veneer
  - Natural Stone
  - Manufactured Stone

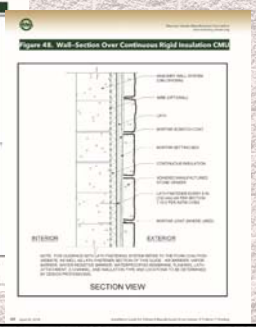




Masonry Veneer Units



Masonry Veneer Units



Masonry Veneer Units

- Key Installation Points
  - Substrate Preparation
  - Water Management
  - Proper Selection and Installation of Metal Lath
  - Proper Fastening of Metal Lath
  - Clearances
  - Mortar Selection, Mixing and Application
  - Setting Units
  - Environmental, Chemical, Cleaning & Other Abuse

Masonry Veneer Units

ASTM C216-12a Standard Specification for Facing Brick

10.1.1 Other than chips, the face or faces shall be free of cracks or other imperfections detracting from the appearance of the designated sample when viewed from a distance of 15 ft (4.6 m) for Type FBX and a distance of 20 ft (6.1 m) for Types FBS and FBA.

ASTM C216-14

10.1.1 Other than chips, the face or faces shall be free of cracks or other imperfections detracting from the appearance of the designated sample when viewed under diffused lighting from a distance of 15 ft (4.6 m) for Type FBX and a distance of 20 ft (6.1 m) for Types FBS and FBA.

MORTAR

Masonry Materials - Mortar

Excerpt from a Project Specification

2.02 G Mortar

1. Mortar shall be Type S in accordance with ASTM C270. Proportions (all parts by volume shall be one part, Type II Portland Cement; 1/2 part hydrated lime and 4 to 4-1/2 parts mortar sand. The mortar shall have a flow, after suction, of 70 percent or more when tested for water retention in accordance with ASTM C91 except mortar shall be mixed to an initial flow of 125 to 135 percent.
2. Minimum strength (psi at 28 days): 1800 p.s.i.

Masonry Materials - Mortar

ASTM C270-14 – Mortar for Unit Masonry

1.2 The proportion or property specifications shall govern as specified.

1.3 When neither proportion or property specifications are specified, the proportion specifications shall govern, unless data are presented to and accepted by the specifier to show that mortar meets the requirements of the property specifications.

1.4 This standard is **not** a specification to determine mortar strengths through field testing (see Section 3).

ASTM C1586-05 – Quality Assurance of Mortars

4.1 Use Specification C270 to specify masonry mortar by either the Proportion or Property Specifications of that standard, but not both.

Masonry Materials - Mortar

ASTM C270 TABLE 1 MORTAR PROPORTIONS

MORTAR	TYPE	PROPORTIONS BY VOLUME (cementitious materials)							AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION
		Portland cement or blended Cement	Masonry cement			Mortar cement			HYDRATED LIME OR LIME PUTTY
			M	S	N	M	S	N	
Cement-Lime	M	1	-	-	-	-	-	-	¼
	S	1	-	-	-	-	-	-	Over ¼ to ½
	N	1	-	-	-	-	-	-	Over ½ to 1 ¼
	O	1	-	-	-	-	-	-	Over 1 ¼ or 2 ½
Mortar cement	M	1	-	-	-	-	-	1	-
	M	-	-	-	-	1	-	-	-
	S	½	-	-	-	-	-	1	-
	S	-	-	-	-	-	1	-	-
	N	-	-	-	-	-	-	1	-
	O	-	-	-	-	-	-	1	-
Masonry cement	M	1	-	-	-	-	-	-	-
	M	-	1	-	-	-	-	-	-
	S	½	-	-	-	-	-	-	-
	S	-	-	1	-	-	-	-	-
	N	-	-	-	-	-	-	-	-
	O	-	-	-	-	-	-	-	-

Not less than 2¼ and not more than 3 times the sum of the separate volumes of cementitious materials

Masonry Detailing and Construction

- The Root of the Problem – ASTM C270

ASTM C270, TABLE 2, PROPERTY SPECIFICATION REQUIREMENTS[A]

Mortar	Type	Avg. Compressive Strength at 28 Days, min psi	Water Retention, Min. %	Air Content, Max %	Aggregate Ratio
Cement-Lime	M	2500 (17.2)	75	12	Not less than 2¼ and not more than 3½ times the sum of the separate volumes of cementitious materials
	S	1800 (12.4)		12	
	N	750 (5.2)	75	14	
	O	350 (2.4)	75	14	
Mortar Cement	M	2500 (17.2)	75	12	
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14	
	O	350 (2.4)	75	14	
Masonry Cement	M	2500 (17.2)	75	18	
	S	1800 (12.4)	75	18	
	N	750 (5.2)	75	20	
	O	350 (2.4)	75	20	

[A] Laboratory prepared mortar only

Masonry Materials - Mortar

ASTM C270 TABLE 2 MORTAR PROPERTIES[A]

Mortar	Type	Average Compressive Strength at 28 days, min. psi (MPa)	Water Retention min. %	Air Content, max. %	Aggregate Ratio (Measured in Damp, Loose Condition)
Cement-Lime	M	2500 (17.2)	75	12	Not less than 2¼ and not more than 3½ times the sum of separate volumes of the cementitious materials
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14	
	O	350 (2.4)	75	14	
Mortar Cement	M	2500 (17.2)	75	12	
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14	
	O	350 (2.4)	75	14	
Masonry Cement	M	2500 (17.2)	75	18	
	S	1800 (12.4)	75	18	
	N	750 (5.2)	75	20	
	O	350 (2.4)	75	20	

[A] Laboratory prepared mortar only

Masonry Materials - Mortar

ASTM C270-14

3.3 The compressive strength values resulting from field tested mortars do not represent the compressive strength of mortar as tested in the laboratory nor that of the mortar in the wall.

ASTM C270-14

8.3 Specification C270 and C780, the compressive strength values resulting from field sampled mortars are not required nor expected to meet the compressive strength requirements of the property specification of Specification C270, nor do they represent the compressive strength of the mortar in the wall.

Masonry Materials - Mortar

ASTM C780-14a Evaluation of Mortars for Unit Masonry

1.4 The test results obtained under this test method are not required to meet the minimum compressive values in accordance with the property specifications in Specification C270.

ASTM C780-14a

5.2.6 Mortar compressive strength test values are not representative of the actual compressive strength of mortar in the assembly and are not appropriate for use in predicting the compressive strength that would be attained by the mortar in the masonry assembly. The measured compressive strength of a molded mortar specimen is almost always lower than the strength of the same mortar in the wall, primarily as a result of differences in mortar water content and specimen shape.

Masonry Materials - Mortar

ASTM C780-14a

A6.1 Strength values for mortars obtained through these testing procedures are not required, nor expected, to meet strength requirements of laboratory Specification C270 mortars or necessarily represent the strength of the mortar in the wall.

ASTM C1586-05 Quality Assurance of Mortars

4.2 This (Proportion) procedure of specifying mortar requires no sampling and testing of mortar, and hence, no measurement of mortar properties in the laboratory or the field is required. All that is necessary is field confirmation of the proper proportions of the mixes used in construction.

Masonry Materials - Mortar

ASTM C1586-05

5.5.3 Measurement of construction site masonry mortar compressive strength using Test Method C780, Annex A7, is not the appropriate test method to determine the compliance of the mortar with the compressive strength requirements of Specification C270; however it may have some value in the determination of mortar uniformity.

ASTM C1586-05

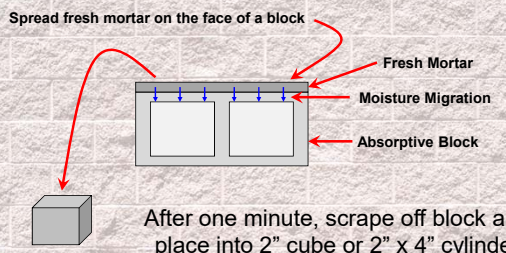
5.5.3.1 Measuring mortar compressive strength of field sampled mortar has no relevance unless preconstruction testing is performed in the laboratory using similar mixing equipment, mortar materials, and the same specimen geometry.

Masonry Materials - Mortar

Certificate of Compliance

Masonry Materials - Mortar

UBC Standard Test Method 21-16



After one minute, scrape off block and place into 2" cube or 2" x 4" cylinder

Masonry Materials - Mortar

Cubes vs. Cylinders

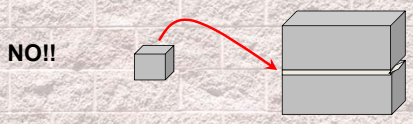
Will they produce the same tested strength?

The cylinder strength will be about 85% of the cube strength. Correction factors must be applied when using cylinders

Masonry Materials - Mortar

In the wall mortar strength...

Does the strength of a mortar cube represent the strength of the mortar in the wall?



The mortar in the wall will be much stronger than the tested strength of the cube because of …

- Smaller aspect ratio of mortar joint
- Lower water to cement ratio for mortar joint

GROUT

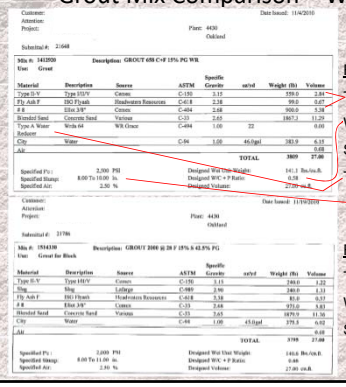
ASTM C476

- Grout mix design must either be proportioned as required by Table 1, or proportioned to meet a required strength
- High initial W/C ratio is very important when proportioning grout
- Excess mix water is absorbed by masonry units prior to re-consolidation
- Admixtures may not be used unless "approved by the purchaser" (C476), or "acceptable" (TMS 602), or "approved by the enforcement agency" (CBC)

ASTM C476 – Review of Mix

- Grout mix design should indicate that the grout will meet the requirements of C476
- W/C ratio should be between .65 and .80
- Slump should be indicated as "8 to 11 inches"
- Total cementitious content should be 564 to 620 pounds
- Mix designs do NOT need to be over strength like concrete mixes
- Following these guidelines the grout strength should well exceed 2,000 psi (most of the time higher than 3,000 psi)

Grout Mix Comparison – What's Wrong?



First Submittal

Total Cementitious = 658 lbs.

W/C = 0.58

Slump = 8 to 10 inches

Type A Water Reducer

Resubmitted

Total Cementitious = 565 lbs.

W/C = 0.66

Slump = 8 to 11 inches

High SCM (Green) Grout

- A three phase program to determine the limits of Portland cement replacement in masonry grout
- Determine if code required minimum grout strengths can be maintained with high levels of Supplemental Cementitious Materials (SCM)
- Determine at what day strength tests should be performed for high SCM grout
- Provide laboratory test data and grout mix guidelines to design professionals

WHO?????

- Funded by:
  - CMACN
  - Masonry Institute of America
  - Utah Masonry Council
  - Arizona Masonry Guild
  - Illinois Masonry Institute Promotion Trust
  - Northwest Concrete Masonry Association
- Testing lab:
  - Twining, Inc., Long Beach, California

Why Spend All This Money????

- California AB-32
- SCM requirements in CalTrans Standard Specifications
- Grout mixes already in use
- Demand for the reduction of Portland cement in construction
- Position masonry construction in a "green" environment
- Determine limitations of high SCM grout mixes

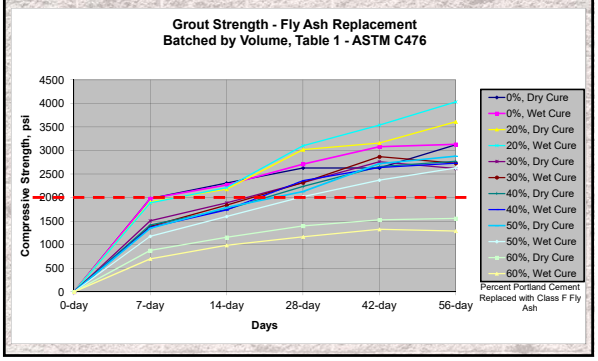
Test Program (General)

- Total of 378 specimens tested, 126 samples
- Phase I – dry and wet cured (ASTM C157 and C511)
- Phase II and III – wet cure only (ASTM C511)
- Samples cast in 8X8X16 standard CMU's
- Wet saw was used to cut samples two days before testing (4X4X8)
- Specimens were capped with high-strength sulfur capping compound

Test Program (Phase I)

- Mixes were proportioned by volume (ASTM C476)
- Batched with 0%, 20%, 30%, 40%, 50% and 60% Class F coal fly ash (by volume)
- Tested at 7, 14, 28, 42 and 56 days
- W/(C+FA) approximately 0.8, slump at 9 inches
- Batch weights:
  - 0% replacement, 100.3 lbs PC
  - 60% replacement, 43.9 lbs PC and 50.4 lbs FA
- Half of all specimens cured wet, half cured dry

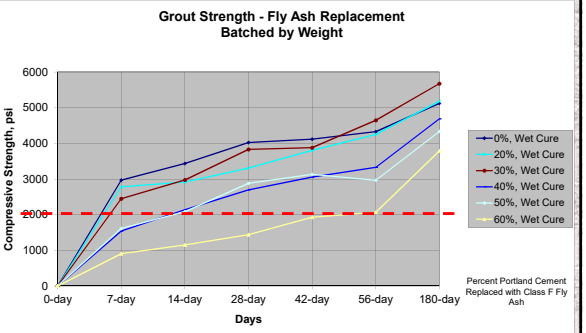
Test Program (Phase I)



Test Program (Phase II)

- Mixes were proportioned by weight (CBC 2103A.12.2)
- Batched with 0%, 20%, 30%, 40%, 50% and 60% Class F coal fly ash (by weight)
- Tested at 7, 14, 28, 42, 56 and 180 days
- W/(C+FA) between approximately 0.73 and 0.65, slump at 9 inches
- Batch weights:
  - 0% replacement, 611.0 lbs PC per cubic yard
  - 60% replacement, 244.0 lbs PC and 367.0 lbs FA per yd^3
- All specimens cured wet

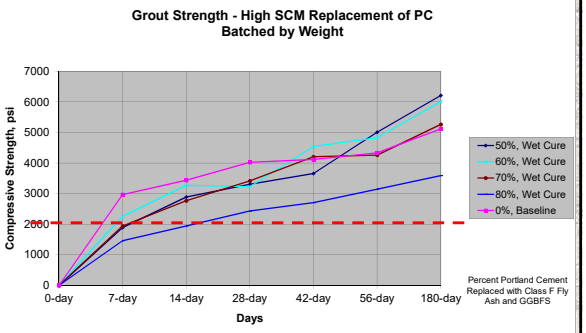
Test Program (Phase II)



Test Program (Phase III)

- Mixes were proportioned by weight (CBC 2103A.12.2)
- Batched with 50%, 60%, 70% and 80% Class F coal fly ash (FA) and ground granulated blast-furnace slag (GGBFS) (by weight)
- FA was limited to 25% in all mixes
- Tested at 7, 14, 28, 42, 56 and 180 days
- W/(C+FA+GGBFS) approximately 0.7, slump at 9 inches
- Batch weights:
  - 50% replacement, 244.0 lbs PC, 153.0 lbs FA and 214.0 lbs GGBFS per cubic yard
  - 80% replacement, 183.0 lbs PC, 153.0 lbs FA and 275.0 lbs GGBFS per cubic yard
- All specimens cured wet

Test Program (Phase III)



What Do We Know?

- 50% FA and 70% FA+GGBFS mixes are practical
- Strength test dates should be at 42 or 56 days with high SCM mixes (designers will change specifications)
- FA and GGBFS increase the apparent slump, sufficient water must remain in the mix even when slump increases
- CalPoly SLO study developed a high SCM self-consolidating grout using NO chemistry, just high SCM
- Over 700 prism tests were performed in BYU study proving that high SCM mixes meet strength requirements
- Data has been published showing significant PC savings compared to tilt-up, pre-cast or cast-in-place structures

UNIT STRENGTH TABLE

Masonry Unit Strength Recalibration

- Verification of masonry compressive strength
  - Prism test method
  - Unit strength method
  - Testing prisms from constructed masonry
  - (Masonry prism test record—No longer available)
    - Uniform Building Code exclusive
    - At least 30 historic prisms required
    - Test record results required to be at least 1.33 f'_m

Masonry Unit Strength Recalibration

Masonry Prism

Unit Strength

Masonry Unit Strength Recalibration

Prism Test Method	Unit Strength Method
• CMU strength, 1,900 psi minimum	• CMU strength, 1,900 psi minimum
• Assume high strength unit = 3,750 psi	• Assume high strength unit = 3,750 psi
• Type S Mortar	• Type S Mortar
• Grout = 3,750 psi	• Grout = 3,750 psi
Will test between 3,200 and 3,500 psi	Table verifies 2,500 psi (≈ 30% less)

1973 Uniform Building Code

1973 UBC Table 24-J ASSUMED COMPRESSIVE STRENGTH I[illegible] BRICK [illegible]ASONRY

COMPRESSIVE STRENGTH OF MASONRY UNITS, (psi)	ASSUMED COMPRESSIVE STRENGTH OF BRICK MASONRY, f'_m, psi		
	TYPE M MORTAR	TYPE S MORTAR	TYPE N MORTAR
Special Inspection Required→	Yes / No	Yes/No	Yes/No
14,000 plus	4600 / 2300	3900 / 1950	3200 / 1600
10,000	3400 / 1700	2900 / 1450	2400 / 1200
6,000	2200 / 1100	1900 / 950	1600 / 800
2,000	1000 / 500	900 / 450	800 / 400

- **Section 2404 (c).2.d.3 Assumed ultimate compressive strength**
  Hollow Concrete Units—Grade N……f'_m = 1350 psi

1988 Uniform Building Code (thru 1997)

1988 UBC Table 24-C SPECIFIED COMPRESSIVE STRENGTH OF MASONRY, f'm, (psi) BASED ON SPECIFYING THE COMPRESSIVE STRENGTH OF MASONRY UNITS

Specified Strength of Clay Masonry Units (psi)	Specified Compressive Strength of Masonry, f'_m	
	Type M or S Mortar (psi)	Type N Mortar (psi)
14,000 or more	5,300	4,400
12,000	4,700	3,800
10,000	4,000	3,300
8,000	3,350	2,700
6,000	2,700	1,100
4,000	2,000	1,600
Specified Strength of Concrete Masonry Units (psi)	**Specified Compressive Strength of Masonry, f'_m**	
	Type M or S Mortar (psi)	**Type N Mortar (psi)**
4,800 or more	3,000	2,800
3,750	2,500	2,350
2,800	2,000	1,850
1,900	1,500	1,350
1,250	1,000	950

2011 TMS 602, Specification for Masonry Structures

Table 2—Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction

Net area compressive strength of concrete masonry units, psi		Net area compressive strength of masonry, psi
Type M or S mortar	Type N mortar	
---	1,900	1,350
1,900	2,150	1,500
2,800	3,050	2,000
3,750	4,050	2,500
4,800	5,250	3,000

2013 TMS 602, Specification for Masonry Structures - *Proposed*

Table 2—Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction

Net area compressive strength of concrete masonry units, psi		Net area compressive strength of masonry, psi
Type M or S mortar	Type N mortar	
---	~~1,900~~	~~1,350~~
~~1,900~~	~~2,150~~	~~1,500~~
~~2,800~~ 2,000	~~3,050~~ 2,000	2,000
~~3,750~~ 2,500	~~4,050~~ 2,500	2,500
~~4,800~~ 3,835	~~5,250~~ ---	3,000
4,875	---	3,500
5,500	---	4,000

2013 TMS 602, Specification for Masonry Structures - *Accepted*

Table 2—Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction

Net area compressive strength of concrete masonry units, psi		Net area compressive strength of masonry, psi
Type M or S mortar	Type N mortar	
---	~~1,900~~ 1,900	~~1,350~~ 1,700
~~1,900~~ 1,900	~~2,150~~ 2,350	~~1,500~~ 1,900
~~2,800~~ ~~2,000~~ 2,000	~~3,050~~ ~~2,000~~ 2,650	2,000
~~3,750~~ ~~2,500~~ 3,250	~~4,050~~ ~~2,500~~ 4,350	2,500
~~4,800~~ ~~3,835~~ 4,500	~~5,250~~ ---	3,000
~~4,875~~	---	~~3,500~~
~~5,500~~	---	~~4,000~~

2013 TMS 602, Specification for Masonry Structures

Table 2—Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction

Net area compressive strength of concrete masonry units, psi		Net area compressive strength of masonry, psi
Type M or S mortar	Type N mortar	
---	1,900	1,700
1,900	2,350	1,900
2,000	2,650	2,000
3,250	4,350	2,500
4,500	---	3,000

2013 TMS 602, Specification for Masonry Structures

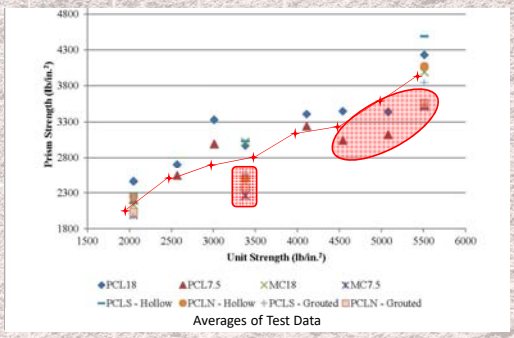
Table 2—Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction

Net area compressive strength of concrete masonry, psi	Net area compressive strength of concrete masonry units, psi	
	Type M or S mortar	Type N mortar
1,700	---	1,900
1,900	1,900	2,350
2,000	2,000	2,650
2,250	2,660	3,400
2,500	3,250	4,350
2,750	3,900	---
3,000	4,500	---

Background

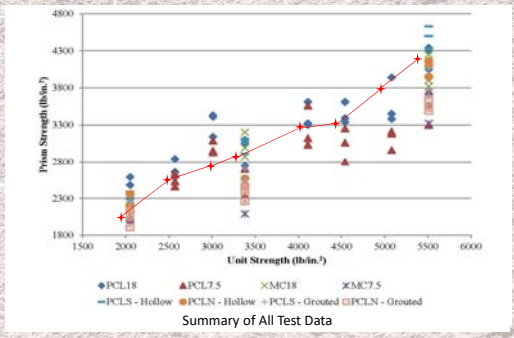
- How did we get there?
  - – Research – NCMA
  - – Proposal – TMS 602/MSJC Committee
  - – Rejection – TMS 602/MSJC Committee
  - – Task Group – Assigned by MSJC
    - Iteration
    - Compromise
  - – Successful Ballot – TMS 602/MSJC Committee

NCMA Research



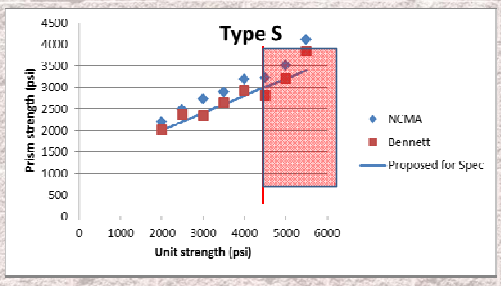
Averages of Test Data

NCMA Research

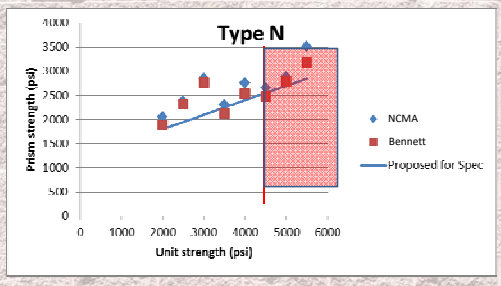


Summary of All Test Data

Background



Background



ASTM C90 Modification

- In concert with ASTM C90
  - There is a new change in ASTM C90-14 - Raise minimum average CMU strength requirement from 1,900 psi to 2,000 psi
  - Original Unit Strength change proposal assumed ASTM C90 change would be published
  - Unit Strength Table accommodates both 1,900 psi and 2,000 psi block strength during transition

Benefits

- **Design** – 2,000 psi, up from 1,500 psi
- **Material** – Recognized for improved manufacturing methods and increased quality control
- **Verification** – Moves results of two verification methods somewhat closer together while maintaining implied requirement for Prism Test Method on higher strength masonry

Strength Verification Method

- **Unit Strength** Verification is easily applied for design strengths of up to 2,500 psi, maybe 3,000
- **Prism Test** Verification may be applied for any strength masonry, but is the reasonable choice for higher design strength and the only choice for very high design strength

FIELD/LAB TESTING CERTIFICATION

Field/Lab Testing Certification

- Ever Had Trouble with Test Results?

ASTM C1019, Section 6.2 Alternative Methods
Alternative methods of forming the specimens shall be used only with the approval of the specifier. Such approval shall be based on comparative testing of grout specimens constructed from molds as described in 6.1 and the alternative method.

Field/Lab Testing Certification

TMS/ACI Joint Certification Program

- Lab Testing Technician
  - Knowledgeable with ASTM C90, C140, C270, C780, C1019, C1314, C1552
  - 1½ hour open book written test-70 questions
  - Closed Book Performance Examination
  - Must pass both sections 70% minimum overall
- Field Testing Technician
  - Knowledgeable with ASTM C67, C90, C140, C270, C780, C1019, C1314, C1552
  - 1 hour open book written test-60 questions
  - Closed Book Performance Examination
  - Must pass both sections 70% minimum overall

Field/Lab Testing Certification

- TMS/ACI Joint Certification Program
  - International Code Counctl (ICC) and California Division of the State Architect (DSA) considering certification as part of Structural Masonry Special Inspection (SMSI) Credentials
  - Certification will require Lab and Field Technicians to be know the correct ways to sample and test masonry specimens

CONCLUSION

Summary

- Concrete Masonry Units
  - ASTM C90 – Increased Strength
  - Watch for Specified Grade/Type – NO!!
  - Watch for Specified Minimum Web Connection
- Masonry Veneer
  - Synthetic Stone Becoming Popular
  - Resources are Available
  - Work with Designer for Best Application

Summary

- Mortar
  - Should be Specified by ONE of the Following
    - Proportion
    - Property
  - When by Proportion, Field Testing is not Appropriate Unless…….
    - Preconstruction Mortar is Tested and Only for Comparative Values, Not Absolute Values (Listed in ASTM C270, Table 2)

Summary

- Grout
  - Masonry's 'Ace-In-The-Hole'
  - Can Substitute Much More Fly Ash and Slag than Concrete **Green-Green-Green**
    - Saves Energy with Less Portland Cement Required
    - Recycles Waste from Other Industries
    - May Need Extra Cure Time
  - SCG Properties without all the Chemistry

Summary

- Other Stuff
  - Unit Strength Table Values Increasing
  - Code is Dynamic
    - Coring Changes
    - Mortar Grout Testing Changes
    - Continuous/Periodic Inspection Requirements
  - Public Comment = Powerful Input
    - California Building Code
    - TMS 402/602 Building Code for Maosnry Structures
    - IBC

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And Thanks to Those Who Made This Program Possible
Masonry Institute of Hawaii
Cement and Concrete Products Industry
Mason Contractors Association of Hawaii
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