STRUCTURE MATTERS

The monthly publication of Structural Engineers of Massachusetts

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INSIDE THIS ISSUE:

May 19th Presentation & Discussion:

AISC Standard Code of Practice & software that takes a steel structure from design through drafting & shop drawings

REGISTER NOW at http://www.ssfne.org/pdf/WPI.2011.WS.pdf to attend the presentation below, scheduled from 12:45-1:45. It's part of the **30th Annual Steel Design Conference** on **May 19th** at the **WPI Campus Center** from **9 a.m.-3 p.m.**

Frame Analysis, Member Design, Connection Design & Detailing

This presentation will take you through a project from model creation to shop drawing production while emphasizing the importance of an accurate BIM model. A new engineering product which works seamlessly with the SDS/2 Detailing software will be showcased. The following is a discussion outline:

- Creating an accurate 3D BIM model
- Load Application
- Frame Analysis
- Member Selection (Beams, Columns, Bracing,
- Connection Design (Options, Restrictions, Loads, ASD or LRFD)
- Importance of connection material as part of model
- Compatibility
- Creating Shop Drawing

So, if you would like to see how engineers, detailers and fabricators can all work together on the same model, you won't want to miss this presentation.

About the Presenters...

Steven M. Ashton, P.E. is the SDS/2 Engineering Sales Representative for Design Data. He has 20-years of experience as a structural engineer including 9 as a senior engineer with the American Institute of Steel Construction. He is President of the Structural Engineers Association of Kansas and Missouri (SEAKM). He has a B.S. degree in Civil Engineering from South Dakota State University and an M.S. degree in Civil Engineering from the University of Kansas.

Michelle McCarthy is an SDS/2 sales executive for Design Data. In her six years at Design Data, she has been a speaker at a number of conferences; written articles for several steel industry trade publications as well as demonstrates and sells SDS/2 software. McCarthy has a Bachelor's degree in Journalism from the University of Nebraska-Lincoln and a M.A. degree in Management from Doane College.

ABOUT SEAMass: *A non-profit organization, SEAMass pursues the common interests of practicing structural engineers and others sharing an interest in their activities. Members are individual licensed professional engineers, licensed professional structural engineers, engineers in training, students pursuing a degree towards structural engineering and individuals sharing an interest in the activities of SEAMass.*

Upcoming Events - Mark Your Calendar

MAY 2011

4th SEAMass Annual Meeting & Dinner. Eric Hines, P.E. presentation on the Charlestown, MA Wind Technology Testing Center (WTTC) at Northeastern University Alumni Center.

18th BASE Dinner Meeting at MIT Faculty Club. Brian Quinlan, P.E. will speak on "Lessons Learned in Structural Software: Implementing a Software Error Reduction Plan".

19th SFNE/SEAMass split program in Worcester, MA featuring a discussion of the AISC Standard Code of Practice and software that will take a steel structure from design through drafting / drawings. For program details and registration information, go to: http://www.ssfne.org/pdf/WPI.2011.WS.pdf

JUNE 2011

15th Presentation by **Mark Webster** and **Matthew C. Carlton, AIA, LEED AP** at SGH Cafeteria. The Ames Building is considered to be the first skyscraper in Boston. It was the tallest building in Boston from its completion in 1893 until 1915. Over a ten-year period, SGH served as the structural engineer for the renovation, and provided envelope and façade investigation and restoration design services to the once-abandoned building as it was transformed into a boutique hotel. We will discuss the history of the Ames Building and its architectural significance, describe some of the structural challenges we encountered, and review some of masonry repairs that we developed during the project . *This is a voluntary donation event.* **HOW TO REGISTER: E-mail Mary McAdam at mmcadam@edginc.com**

FALL 2011

International Existing Building Code (IEBC) is a fact of life in the 8th Edition of the Massachusetts Code. Venue and program particulars for this case study with panel discussion by members of the Structural Advisory Committee (SAC) are being prepared. This will be a combined event with BSCE. All New England SEAS are invited.

ANNUAL DUES 2011-2012

June begins the new fiscal year for SEAMass, and it's time for members to renew their commitment and membership. Renewal notices will be issued shortly for 2011-2012 annual dues. ***Thank you in advance for your prompt attention to renewing YOUR commitment and support to this member-driven organization.***

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We're on the Web! SEAMass.org

The Structural Engineers Association of Massachusetts (SEAMass) is a non-profit organization established to pursue the common interests of practicing structural engineers and others sharing an interest in the activities of structural engineers.

Members are individuals who are licensed professional engineers, licensed professional structural engineers, engineers in training, students pursuing a degree towards structural engineering and individuals sharing an interest in the activities of SEAMass.

The Association is a Member Organization of the National Council Structural Engineers Associations (NCSEA).

Editor's Message

Thanks for taking a few moments of your busy schedule to *keep yourself informed* by reading this newsletter—one of your **member benefits**!

As always, your SEAMass board and publications committee is working to bring you *articles of interest* and *information that affects the future of our profession.* Don't forget to share your feedback regarding the Guide to Engineering Services (pages 5-6)! Have a great month, and we'll look forward to seeing you at an upcoming event! (calendar on page 12)

Welcome New Members

Paul Livernois, P.E.
Symmes, Maini & McKee Associates

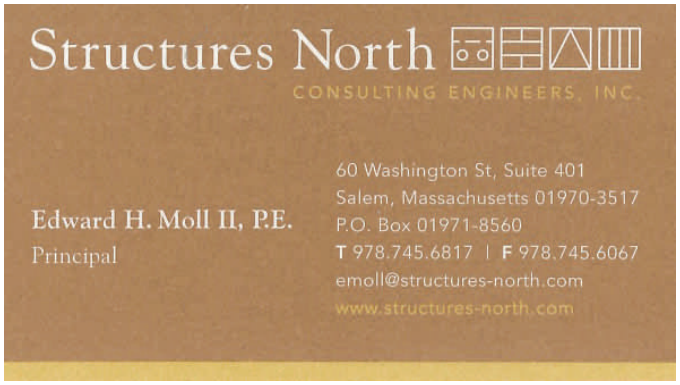
Colin Simson, P.E.
Symmes, Maini & McKee Associates

Member Spotlight / Q & A with:
Edward H. Moll, II P.E., SECB
Structures North Consulting Engineers

Editor's Note: *Ed Moll is the outgoing president of SEAMass, having served for two consecutive fiscal years. We thank him for his long-standing service to our organization!*

What do you see as the overall goal of SEAMass as an organization?

I believe our bylaws do a good job of outlining our goals:, and our efforts in the past few years during my presidency have endeavored in all of these areas: a. Promotion and advancement of the art, science, practice and image of structural engineering; b. Serving the business and technical interests of structural engineers, c. Promoting communication and recognition among structural engineers and related professionals, d. Promoting and maintaining professional standards of and qualifications to practice in Massachusetts, and e. Communicating the ethics, standards, goals and accomplishments of the Association to structural engineers, related professionals, government and the public." **(Continued on page 8)**



Emergency Amendment to IBEC—2009

EMERGENCY AMENDMENT TO THE MA-AMENDED IEBC-2009

BBRS action of 4/12/11 IS AMENDED FURTHER

The BBRS, at its 4/12/2011 monthly meeting voted the following EMERGENCY AMENDMENT (note that Chapters 1 and 3 captured in the Emergency amendment below refer to Chapters 1 and 3 of the IEBC-2009, thus Section 101.5.1 below is a MA-amendment to Chapter 1 of the IEBC-2009 and replaces an earlier MA-amendment to this same Section):

EMERGENCY AMENDMENT

101.5.1 Prescriptive compliance method*. Chapter 3 of this code is allowed to be used for repairs, alterations, additions and changes of occupancy of existing buildings provided that such existing buildings were designed and constructed to the previous 6th Edition of the Massachusetts State Building Code or more recent Editions of the Massachusetts State Building Code or can demonstrate 'equivalency' to same.*

NEWS ALERT:

The Emergency Amendment to 101.5.1 Prescriptive Compliance Method, Chapter 3 voted by the BBRS on 4/12/11 to define the use of the Prescriptive Compliance Method to buildings designed and constructed to the 6th Edition or more recent version of the Code has been rescinded. Regarding the use of this section for roofing projects, BBRS permits the use of the Prescriptive Compliance Method. IEBC limits the use of this method to buildings which comply with the current fire code, but the Massachusetts amendments modified this requirement.

Under the current amendment, in using the Prescriptive Compliance Method for a reroof project, as long as the weight of the existing roof assembly is not more than 5% greater than the existing roof assembly, and no other alterations are planned to change the framing or lateral load resistance of the building, there are no structural requirements. There are no requirements to brace the parapets, unless the parapets are in poor condition. The specific wording of the Emergency Amendment will reach the Massachusetts Register shortly. This is a stop gap measure while the BBRS studies a comprehensive provision.

Your INPUT is REQUESTED in finalizing this brochure:

GUIDE TO ENGINEERING SERVICES

for One and Two-Family Residential Structures

Compiled by the DELL Committee of Boston Association of Structural Engineers (BASE)

EDITOR'S NOTE: This is Part II of last month's article, requesting YOUR INPUT and FEEDBACK regarding text to be included in a 'Guide to Engineering Services' informational brochure being developed for distribution. **You may reference Part I on pages 3-5 of the March issue at this URL:** http://seamass.org/News2011-03.pdf. **Please SUBMIT YOUR FEEDBACK (questions, suggested edits, or concerns) directly to committee co-chairperson VAL PREST, P.E. at grotoneng@gmail.com.**

GUIDE TO ENGINEERING SERVICES—DRAFT Brochure Content PART 2 OF 2

QUESTIONS AND ANSWERS (Cont'd from Part 1 of 2):

If my contractor tells me that they always "over-build" their structures, would I still want to engage an engineer?

Yes. It is important to realize that the functions and background of a contractor and an engineer are different. The contractor builds the structure based on a design that was either provided to them or determined directly from the building code. An engineer comes with a different set of skills. They design a structure based on a multitude of loading conditions and materials with differing structural properties.

A contractor often works from experience based on something they believe to have worked in the past. A contractor may know that to resist a higher load, they need a larger beam, but may not be able to properly size the beam and connections. Larger members and stronger materials do not necessarily mean the structure is more stable as structural stability is a concept misunderstood by many contractors.

An engineer is trained to understand the behavior of a wide range of different materials and to predict how that behavior will change under loading and environmental conditions. He/she is trained to consider complete load paths, and the integrity and stability of the overall structure.

Should I have the Structural Engineer review the construction?

By all means! This is your best assurance that the construction was completed in accordance with the construction documents (drawings, notes and specifications). The Engineer serves as a second set of eyes to catch any changes or items that are not completed adequately or "fall through the cracks." It is also an opportunity to confirm whether suitable products and proper installation procedures were used. A contractor may also be more conscientious knowing that his/her work will be reviewed by a design professional.

Ask the Engineer to review the work and prepare an "affidavit" letter (letter of completion) for you and the Building Department, stating that the work was completed in accordance with the construction documents and sound engineering principles to the best of his/her knowledge. The local Building Inspector will often perform a "walk-through" inspection. They are looking at the structure in general and do not verify that all of the structure conforms to the structural documents. The cost of engineering is only a fraction of the cost of construction and it ensures that you have a "complete" project as it relates to structure.

We purchased some floor plans from a book to build our new home. Do I still need an engineer?

It is strongly advisable that you have a structural engineer review the drawings for structural adequacy and suitability relative to the site that you will be placing it on. It may seem like a bitter pill to swallow, since the structural engineering services will require additional fees beyond the cost of the architectural drawings. However, drawings purchased from a book or online seldom include adequate structural information for your local building codes. The provider of the drawings usually and rightly recommends that you engage the services of a structural engineer to complete the design. (*Continued on page 6)*

GUIDE TO ENGINEERING SERVICES *(cont'd from page 6)*

We purchased some floor plans from a book to build our new home. Do I still need an engineer?

By law, because an engineer is obligated to produce engineering designs under his/her own review; they cannot take a set of drawings and just stamp them. A new set of structural drawings would need to be produced or a separate, stamped letter of review that attests to the structural adequacy of what has been designed. When a complete structural design is given to a contractor, you will receive a more accurate price to complete the work.

How is a structural engineer paid?

Engineers are generally paid on an hourly or lump sum basis. Typically they will ask for a retainer at the project outset and payments at specific intervals and/or upon completion. Some engineers will require final payment prior to issuing an "affidavit" letter. Because methods could vary between engineers, it is best to ask them about their fee structure. Typically one can expect to pay an engineer for all consultations (including the initial visit) and the subsequent analysis and/or design and any peripheral costs for travel time, printing design-related documents, etc.

If you are unsure about the need for a Structural Engineer you can contact your local building inspector or a Structural Engineer.

Reminder: Please e-mail YOUR FEEDBACK to VAL PREST, PE at grotoneng@gmail.com

PROGRAM OVERVIEW:
Semi-Rigid Diaphragms & Other Practical Structural Engineering Design Examples
Presented by Timothy Mays, Ph.D., P.E.

On April 5, 2011, sixty-four (64) structural engineers received, once again, a very thorough presentation that the Citadel's Tim Mays, PhD, PE is well known for.

Professor Mays made his third local appearance in as many years for the SEAMass audience. The 4-PDH credit program is recognized in all jurisdictions that require course prequalification's before presentation.

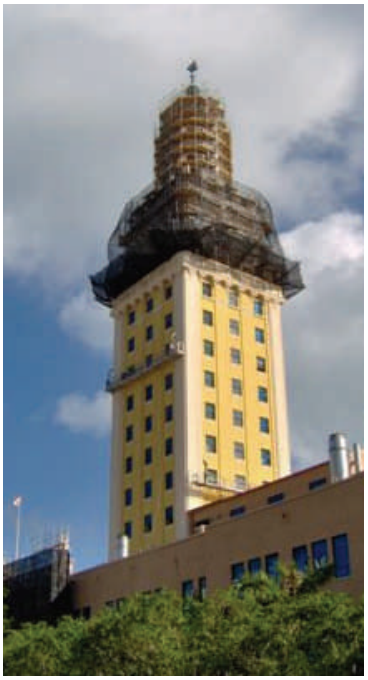
Tim lectured in depth regarding the distinctions between horizontal diaphragm floor/roof plate's stiffness and reinforcement. Integrated with the presentation were seismic joints and their function. A presented feature, unrelated to the diaphragm theme of the seminar, was how engineers should deal with wheel loads on concrete filled metal deck floors. As usual, Tim's handouts were practical and will become a desk top reference for the attendees.

Mystery Photo REVEALED

The mystery photo from our March issue is the ornate copper weather vane that sets atop the **Freedom Tower in Miami, FL.** The Freedom Tower itself is a combination of structural steel and masonry sitting atop a reinforced concrete structure built circa 1925.

The Freedom Tower is undergoing extensive masonry, concrete, and steel repairs by the Southeast Division of Contracting Specialists Incorporated (CSI) with corporate headquarters in Attleboro, MA. Engineering evaluation of the existing structure is being conducted by Icarus Construction Services, LLC with headquarters in Worcester, MA.

Unfortunately, there was no contest winner for this Mystery Photo.



ABOUT FREEDOM TOWER:

- Built in 1925; serves as a memorial to Cuban immigration to the U.S.
- Originally the tower, inspired by the Girabla Tower in Seville, Spain, housed the Miami News & Metropolis. Once the newspaper company vacated the building in 1957, the federal government used the building to process, document and provided medical services to incoming Cubans fleeing Fidel Castro. The building's cupola tower contained a beacon light that shined over Miami Bay.
- The tower passed through several owners until in 1997 Jorge Mas Conosa purchased the building and restored and converted the tower into a monument for the refugees who fled to the US.
- 2004 – The Freedom Tower was purchased by Pedro Martin (Terra Group) with the intentions of creating condominiums, when the developer's plans were stopped by preservationists; he donated the tower to Miami Dade College. The College now uses the tower as a cultural and educational center.
- 2008 - the Freedom Tower was added to the list of U.S. National Historic Landmarks.

Member Spotlight (Cont'd from page 3)

What ideas do you have about the role of SEAMass in getting younger engineers involved in the structural engineering community?

We have had many discussions about this as a board, and at the national level at the NCSEA conventions. It seems that SEAMass is a bit top heavy with older engineers and principals of firms, mostly due to our offshoot from BASE. In order to get our younger members involved in the community we need to reach out to them through the new modes of communication, including social media such as Facebook and Twitter, as well as to provide new opportunities to them for professional growth and networking. I was very happy to see at the national level that many officers of SEA's were young people, and like you, some were involved in the newsletter and in programs. I outlined a an outreach at last year's annual meeting that included Socials, SE Exam prep, and a Young Engineers Award program. I am hoping that this coming year will be the one where we are successful in encouraging grater young engineer participation.

What programs has SEAMass offered in the past that you felt were most successful? Why? What programs would you like to see in the future?

I think our programs committee has done a wonderful job this year with many interesting and successful programs. I worry that the volume of programs will cause burn-out due to the intensive efforts it takes to put these together. I would like to go back to either bi-monthly, or even quarterly high quality programs that are approved by NCSEA Diamond Review so that engineers can get there PDH hour requirements for out of state registrations, and so that our programs committee does not burn out in putting them on. Last year, I think that the Leroy Emkin of Georgia Tech Direct Design seminar and the Bill Thornton Practical Design of Bracing Connections seminar were both excellent, and our speaker at the annual meeting, James Pawlikowski of SOM on the construction of the Burj Khalifa, the tallest building in the world, was truly not to be missed. I was very disappointed in the attendance for this presentation, as it warranted many hundreds of engineers. This year there have been many quality programs, and I particularly enjoyed the Matthew Bronski, "In the Footsteps of Vitruvius," presentation on his research on Roman antiquity construction this year. In the future, I think that programs on the new building codes based on IBC and IEBC 2009 will be a big success.

What Leadership roles have you had in SEAMass? What does that consist of? How did you end up in that position?

I was the first secretary of SEAMass upon its initial formation from BASE, then I was vice president, and for two years have been president, for a total of 4 years of service. I got involved in order to give back to the profession that I believe is hugely beneficial to our society and that has provided me my livelihood for 28 years. SEAMass is a start-up organization, and has not yet reached critical mass, though what we have accomplished in 4 years has been tremendous. We need far greater participation from our membership and from our board in order to reach our goal of being a vibrant and sustainable organization. I was instrumental in getting SEAMass set up as a 501c3 non-profit, helping to re-write the organization by-laws with the assistance of the Law Office of Morrison Mahoney. We successfully incorporated in June 2009 during my tenure as Vice President. I ran the programs my first year as president, and attended the National Convention as Massachusetts representative. This year my focus has turned to membership, the SEER committee, and getting the Diamond Review program established. As I move to the Board position as past president, I hope to continue to work with the membership and SEER committees, the Diamond Review program, and to support the incoming president, Richard Croswell.

Shrinkage Forces on Concrete & Stone

By Garen Gregorian, P.E. | Gregorian Engineers

The purpose of this article will be to demonstrate a simplified method of determining shrinkage forces in concrete and stone resulting from weathering.

Durability, corrosion resistance and resistance to chemical attack is directly related to concrete's permeability. If water cannot enter concrete, it cannot cause damage.

Penetration of water into concrete is achieved by capillary action through actual physical passageway. Reducing these passageways will increase resistance of concrete to water penetration. **(Ref.1)**

Certain concretes are watertight and water resistant as well as strong and enduring in proportion to their absolute densities. Conversely, weak concretes are permeable and of low endurance in proportion to their porosities.

Definitions

Porous: Possessing or full of pores, permeable to liquids.

Porosity: The ratio of the volume of interstices of a material to the volume of its mass.

Volume of Permeable Voids: Volume of space where water or air can permeate.

Excess Water as a Cause of Porosity

Aside from segregated pockets of stone which may also be caused by excess water, water voids are quantitatively more important than are air pockets as passageways for penetrating or percolating water.

The larger the water to cement ratio the greater the volume of capillary pores.

Table 1 below illustrates the relationship between water cement ratio, porosity, and permeability in concrete. **(Ref. 5)** "The first step in achieving a low permeability is to specify a water cement ratio of 0.4 or less and then to consider using a supplementary cementing material or blended hydraulic cement".

TABLE 1

Mix	W/C	Cure time	Permeability Hydraulic	Permeability Air	Porosity %	Volume Permeable Voids %
1	0.26	1 day 7 days	Too small to measure	37 29	8.3 7.5	6.3 6.2
2	0.4	1 day 7 days	0.03 0.027	130 120	11.3 11.3	11.4 12.2
3	0.5	1 day 7 days	0.56 0.2	120 170	12.4 12.5	13 12.7
4	0.75	1 day 7 days	4.1 0.86	270 150	13 13	14.2 13.3

Continued on page 8

Shrinkage Forces on Concrete & Stone (continued from page 9)

By Garen Gregorian, P.E. | Gregorian Engineers

Shrinkage Forces of Rocks - Bulking and Free Swell Test

Flow through porous rock, such as cemented sand or unfractured sandstone is regular and reliable. Permeability of the rock mass is a reasonably well defined quantity which can be used in analyses. Porous rocks often have a large pore volume of about 10 to 30 percent or more. **(Ref. 6)**

With reference to Army Core of Engineers Manual on Rock Foundations, Special Topics – in the "Free Swell Test," a specimen of rock is ground and put into a tube where water is added and increase in volume is recorded. This bulking is the increase in total volume of moist fine aggregate over the same weight dry, where surface tension in the moisture holds the particles apart causing an increase in volume. If alternate wetting and drying occurs, severe strain develops in some rocks causing increase in volume and eventual breakdown of the material. Porous concrete will crack similarly.

Figure-1 (below) shows the relation between moisture added to dry aggregates versus percent increase in volume. Addition of 5% moisture by weight results in roughly 25% increase in volume.

Figure 1—Building Brick Water Absorption (Ref. 2)

Maximum water absorption requirements for building brick:

Designation	Min. Water Absorption by 5hr boiling (%)		Max. Saturation Coeff.		Min Compressive Strength	
	Average of 5 brick	Individual	Avgerage of 5 brick	Individual	Avgerage of 5 brick	Individual
Severe Weathering	17	20	0.78	0.80	3000	2500
Moderate Weathering	22	25	0.88	0.9	2500	2200
No Weathering	No Limit	No Limit	No limit	No Limit	1500	1250

Structural clay load bearing tile wall
maximum water absorption by 1 hr boiling % average 16 to 28% Take 20%

Shrinkage Forces on Fresh Concrete

As an example, we will look at the following concrete proportioned by absolute volume where total aggregate may range from 60 to 75%, cement from 7 to 15%, and water approximately 20%

Ref.: "Cast in Place Walls", Concrete craftsman series 2, CCS-2 ACI, 2000
Cement: 10%
Air: 5%
Fine Aggregate: 25%
Coarse Aggregate: 45%
Water: 15%

Assuming 3000 psi concrete, the tensile strength will equal $6\sqrt{f'c} = 6 \times 54.6 = 328.6$ psi. Though not allowed for major supporting structures a factor of safety of 3 can be taken to obtain allowable stress in tension.

Taking a factor of safety of 1/3, the allowable tensile stress(P) becomes approximately 100 psi = 14,400 lb/ft^2

Continued on page 9

Shrinkage Forces on Concrete & Stone (continued from page 10)

By Garen Gregorian, P.E. | Gregorian Engineers

If we take allowable stress of freshly placed concrete to equal zero, then from the initial placement to final cured the average tensile stress is roughly 50 psi.

As the volume of the paste decreases by 20% (which is roughly twice the porosity) then this force on the area will be equal to 50x0.2 = 10 psi or 1,440 lb/ft^2

To determine the shrinkage force per foot width of concrete take a 1'-0"x 6" slab section and determine the length at which it will crack.

A x P = L x A x D or L = P/D
1'-0" x 0.5'x 14,400 = Lx1'-0" x 0.5' x 1,440 lbs/ft^2/ft
L = 14,400/1,440 = 10 feet.

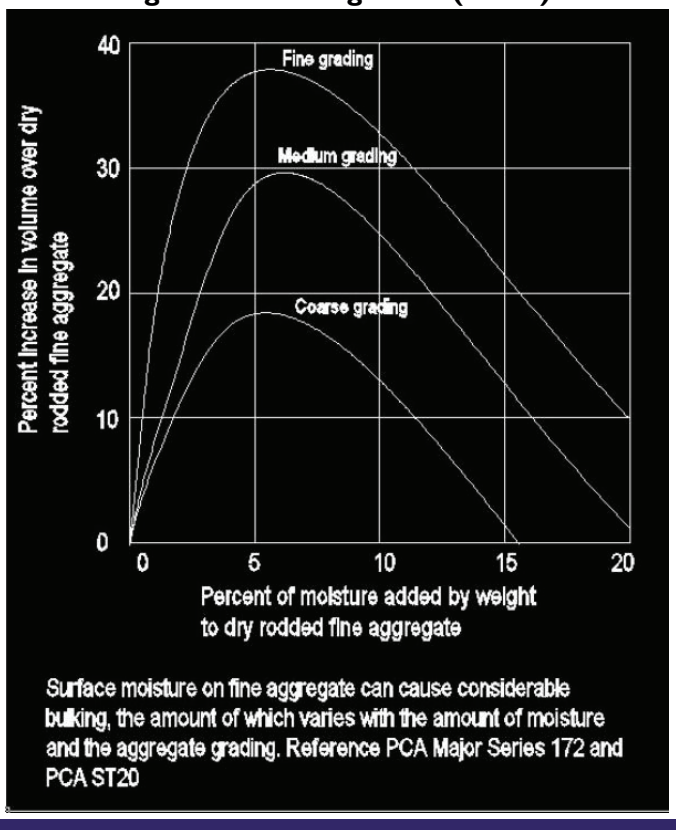
For rocks, a 25% increase in dry density can more than double the swell pressures developed in the material. **(Ref.6)**

As the density of the stone is directly related to its tensile stress. We can take an allowable tensile stress of 199 psi for limestone.

Taking 25% increase in the dry density of a facade sample during swelling, then drying shrinkage forces will approximately equal 25% of the tensile stress of 198 psi or 49.75 psi.

For facades of unreinforced solid brick masonry with an allowable tensile stress of 7.5 psi (Ref. 8), and porosity of 20% from Figure-2, will result in a drying shrinkage force of 1.5 psi.

Figure 2—Bulking PCA (Ref. 9)



For Gypsum, taking a tensile stress of 116 psi will lead to a swell pressure of 29 psi. The porosity of gypsum board must be considered in the calculation, as the increase in dry density of the material will be the deciding factor in the pressure.

Hence for a 1/2" thick gypsum board:
½ x (4'x12) x P = 116 and P = 5 psi will crack if its porosity equals 5%.

For dry concrete, the porosity is 12% hence the force which will crack a concrete exposed to dry and wet conditions will be about 12% of the allowable tensile stress.

See page 10 for: Figure-3 (Ref. 6)

Shrinkage Forces on Concrete & Stone (continued from page 11)

By Garen Gregorian, P.E. | Gregorian Engineers

Strength of Rocks				
Type of Rock	Tensile Strength (psi)	Tensile Stress (psi)	Compressive Strength (psi)	Youngs Modulus (psi)
Shale (Utah)	2494	831	31328	8441196
Shale (Pensylvania)	203	67	14648	4525117
Granite (Georgia)	406.1	135	27992	5656472
Granite (Maryland)	3002.2	1000	36404	3683959
Granite (Colorado)	1726	575	32778	10239660
Marble (New York)	1696	565	18419	7832038
Marble (Tenessee)	942	314	15374	7005323
Sandstone(Alaska)	754	251	5656	1522896
Sandstone(Utah)	1595	531	15519	3103808
Slate (Michigan)	3698	1232	26106	11008360
Gypsum (Canada)	348	116	46267	--
Limestone (Indiana)	594	198	7687	7687000
Limestone (Germany)	580	193	9282	9253408

Figure 3—Typical Strength of Rocks (Ref. 6)

References:

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