COUNCIL FOR MASONRY RESEARCH

RESEARCH NEEDS REPORT

Research Needs of Masonry Materials and Systems

1996

Brick Institute of America
Mason Contractors Association of America
National Concrete Masonry Association
National Lime Association
Portland Cement Association
The Masonry Society

Research Needs of Masonry Materials and Systems

Prepared by

The Council for Masonry Research

The Council for Masonry Research was formed to fulfill the need for an organization to lead and assist in the development of material oriented research designed to increase and preserve markets for masonry materials. The Council, representing diverse interests from within the materials segment of the masonry industry, is composed of the following organizations:

Brick Institute of America
Mason Contractors Association of America
National Lime Association
National Concrete Masonry Association
Portland Cement Association
The Masonry Society

Through its contributing members, the Council has sponsored and actively participated in both industry and federally funded research programs while also providing continuing technical and/or financial support to such far reaching industry programs as:

Construction Materials Council
Disaster Investigation Studies
Masonry Standards Joint Committee
National Concrete and Masonry Engineering Conference
North American Masonry Conferences
Technical Coordinating Committee for Masonry Research
The Masonry Designers Guide
University Professors Workshop

Until formation of the Council for Masonry Research, development of masonry materials, design procedures, construction practices, and regulatory aspects of masonry technology had been generally an undirected, uncoordinated process.

Masonry materials (units, mortar, grout) have evolved over a long period of time with little overall planning to address such factors as use and suitability. The current state of design and regulatory technology is a combination of empirical methods and analytical processes based upon traditional working stress design, with limit states and strength design concepts now being introduced.

Construction practices have also developed over the years. While field operations range from one or two people with a mixer, some units and basic tools, to large projects using sophisticated equipment, masonry construction in the U. S. still basically consists of masons spreading mortar and placing units, one at a time by hand, as has been done for centuries.

Technological advances depend upon research and the implementation of knowledge obtained. A wealth of research information exists on a variety of topics related to the diverse aspects of masonry design and construction. However, this research has usually been initiated by individuals or organizations with varying motivation.

Priorities for research reflected the interests of the individual organizations and generally were not based upon an overall assessment of needs. Hence, past research tends to have produced an uneven distribution of information with some topics receiving more attention than others.

This situation has resulted in masonry design methods, building constructions, and test standards based partially upon research information and partially upon experience and intuition.

While past research in structural masonry has resulted in improved, predictable masonry performance under extreme, earthquake-type loading, much more is required to fully realize the potential of masonry structures for all applications and future needs.

Development of stronger, more durable masonry materials and systems will result in improved performance of traditional and future applications and will also expand masonrys use into nontraditional advanced applications.

Masonry construction costs are sensitive to materials-handling costs; therefore, the development of equipment to help install masonry materials or to achieve overall improvements in material handling is essential.

Cold weather construction practice is another area with room for potentially significant improvement. Extending the construction season from 8 months to 12 months would have direct benefits from an efficiency standpoint, and would also result in a more stable work force year round.

Standardizing practices for masonry materials, design, and construction will make masonry more competitive; while addressing regulatory issues such as building codes will also produce potentially significant benefits.

High performance masonry will require improvements in construction practices. These changes will require changes in mason training and education which are considered fundamental to high performance masonry.

INTRODUCTION

The need for workshops to establish research agendas for masonry is evident. Required advances in masonry technology must be assessed in a more consistent and orderly manner, with a mechanism for coordinated implementation of research provided to satisfy those needs. Continued documentation of structural properties will result in better and more predictable performance. Such workshops also serve to define research needs, both short and long term, and establish priorities. The goal of the workshops should be to concentrate on new ideas, new materials, and new construction methods to move masonry construction into the 21st century and to make it more competitive with other building materials.

The original concept for a workshop to establish a research agenda for masonry was conceived in 1979 by Doctor John Scalzi, National Science Foundation, and James L. Noland, Atkinson-Noland & Associates. This first workshop, under the auspices of the National Science Foundation, was held in Marina Del Ray, California on March 11-12, 1980.

A subsequent workshop, specifically to address research needs, was held in Washington, D. C., on August 28-30, 1988. That meeting was supported by the Council for Masonry Research under the auspices of the National Science Foundation. During the three day session, four main topics were defined and a total of 33 critical research needs from a possible list of 44 were identified and proposed for funding. Findings of the workshop were published in a Report of the Workshop on Research Needs for Masonry, prepared by Dr. Scalzi and Dr. Russell H. Brown of Clemson University.

In November, 1993, a planning workshop for the National Program on High Performance Construction Materials and Systems, sponsored by the Civil Engineering Research Foundation (CERF), Federal Highway Administration (FHWA), and the National Institute of Standards and Technology (NIST), was held in Gaithersburg, Maryland. The purpose of this program was to prepare a multi-industry program to accelerate the commercialization of High Performance Construction Materials and Systems. As a result of this workshop, masonry industry participants determined that this was an opportune time to take advantage of the information gathered to update the 1988 research needs report agenda.

A third Masonry Research Needs Workshop was subsequently held on April 28-30, 1994, at which time participants considered the research concerns identified during the November, 1993 meeting. The participants grouped the programs into the following 10 categories:

I. Design Procedures
II. Construction Technology and Workmanship
III Material Performance
IV. Advanced Masonry Applications
V. Technology Transfer
VI. Environmental Performance Characteristics
VII. Instrumentation, Monitoring and Testing
VIII. Production, Manufacturing, Scheduling
IX. Environmental Impact
X. Sustainability Topics

Within each of these categories a significant list of topics were identified (see Appendix) and evaluated for consideration as potential research projects. From this overall list, 13 critical needs areas were identified.

It is the intent of the Council for Masonry Research that these lists be reviewed and updated at five year intervals. Other organizations are encouraged to submit recommendations for research programs which are intended to benefit the masonry industry as a whole. This includes manufacturers and users of glass block, terra cotta, and stone, as well as associated materials.

The following report identifies primary areas of study (category) and the specific projects selected. It also recommends a basic approach to be taken in implementing the programs and the benefits to be derived.

The items are listed by numerical order of category and should not be construed to be in order of priority.

Research Needs Recommendations

Category: Design Procedures

Project: Develop simplified design procedures for masonry structures.

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Identifying design criteria and procedures which are most often subject to misinterpretation.
2. Developing clear and concise code language which can be more readily understood by design professionals with little or no experience in masonry design and construction.
3. Developing computer software which will alleviate many of the tedious and time consuming tasks occasioned by the variety of materials incorporated into masonry construction.
4. Improve design procedures for base isolated structures and masonry Infill frames to encourage their use.

Benefits: Simplification of design procedures will reduce the depth of knowledge needed by the design professional and enable young and unexperienced designers to become more comfortable with masonry design procedures. This will also help to assure a more effective use of masonry.

Category: Material Performance

Project: Develop masonry unit materials and assemblages which exhibit predictable behavior in providing resistance to the effects of fire, heat and sound transmission, and water penetration.

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. The modeling and measurement of structures in order to predict the response of masonry to environmental conditions.
2. Carry out testing to document and evaluate the performance of masonry during and after fire exposure. This will include units of various material composition, size and configuration, and laying patterns for both restrained and unrestrained conditions. Control joint materials will also be examined.
3. Measurement of the response of masonry to heat and sound transmission through laboratory tests and in-situ investigations.

   Results from laboratory tests will be correlated with field investigations to establish methods of predicting performance using calculation procedures.
4. Development of a reliable test method for measurement of resistance of masonry of various material properties to water penetration. Assemblies will consist of both integrally and surface applied waterproofing treatments.
5. The investigation of a means to improve unit behavior in structures by the use of new materials and unit configuration.
6. The evaluation of methods to improve performance in these areas through modifications to current materials properties, design methods or construction procedures.

Benefits: The ability to reliably predict masonry performance will allow Architects and Engineers to properly select materials with a greater degree of confidence. The development of new and more efficient materials and systems will result in lower operating costs and increased comfort for building occupants.

Category: Material Performance

Project: Investigate the feasibility of constructing with preassembled masonry assemblies.

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. The examination of techniques for constructing members at off-site centralized mass production facilities.
2. The development of procedures which can be used for joining prefabricated assemblies and the use of techniques and devices to be employed on-site during and/or after erection to impart increased flexural strength in assemblies.
3. The investigation of new assembly techniques such as flexible matrix, mortarless interlocking units, or dry-stacked grout injection.
4. Determination of the relative advantages of prefabricated masonry construction versus site-built and development of construction systems and procedures that combine the benefits of both.

Benefits: The use of preassembled masonry assemblages will provide higher levels of quality, reliability and cost effectiveness than possible in the field for certain types of masonry components.

The ability to preconstruct masonry elements and/or strengthen masonry assemblages after erection will help to reduce construction time, reduce labor costs, and provide year-round employment.

Category: Material Performance

Project: Develop units/materials that optimize placement of reinforcement and grout.

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. An investigation of the performance of masonry units with reduced thickness faceshells and webs in reinforced construction.
2. An examination of the use of materials and production techniques used in masonry unit manufacture that will serve to increase unit/mortar bond strength.
3. The development of a grout with little or no shrinkage or water loss which will provide adequate bond to units and reinforcement.
4. The investigation of a grout with sufficient tensile capacity to replace or reduce reinforcement requirements.

Benefits: Although materials such as masonry are excellent in compression, optimal utilization requires measures to provide masonry walls with essentially equal capacity under all stresses.

The use of units with reduced faceshell thicknesses will provide for greater □d□ distances and ease of grout placement. Increased □d□ distances and improved grout will result in lesser steel requirements and reduced construction costs.

Category: Material Performance

Project: Develop masonry units, mortars and grout with improved volume change characteristics.

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Investigation of the effects of moisture content and

temperature on the performance of masonry.

2. Identification of the variables related to raw materials and production methods which affect volume change.

3. An analysis of the influence of these variables on units, mortar, grout, and assemblages.

4. Measurement and modeling of masonry assemblages to predict the response of masonry structures to volume changes under the influence of moisture and temperature.

5. The design of mechanical controls to counteract the effects of volume changes.

6. An investigation of the use of alternative materials in the production of units, mortar, and grout which minimize volume changes without adversely affecting other physical properties.

Benefits: This research will result in increased control of material properties and improved quality assurance, as well as lower maintenance costs and increased product acceptability.

Category: Material Performance

Project: Development of High Performance Masonry Materials.

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Documentation and development of dynamic material properties (ductility, flexural strength, tensile and shear strength of masonry).

2. Development of reliable procedures for measuring masonry performance under dynamic loads.

3. The evaluation and improvement of the dynamic performance of masonry.

Benefits: This project will result in design procedures which utilize full material capacity, resulting in lower construction costs and improved performance.

Category: Technology Transfer

Project: Establish a Center for Distribution of Masonry Information

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. The identification of user needs for an interactive knowledge base of information including but not limited to material properties and performance, design procedures, construction details, construction procedures, and maintenance requirements.

2. Establishment and development of the structure and working system.

3. Operation of the system on a trial basis as a demonstration project to document successes and shortcomings.

4. To develop and establish a long term program to operate the knowledge-based system.

Benefits: This project will establish a permanent centralized depository for information on all phases of masonry which will be readily accessible to the public.

Category: Environmental Performance Characteristics

Project: Improve Passive Solar Efficiency

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Model and measure the response of masonry to changes in temperature and direct and indirect exposure to the sun.

2. Investigation of the effects of material mass and building orientation on interior climate control.

3. Development of materials which respond to temperature stimuli.

Benefits: This research will result in lower building operating costs and improved comfort for building occupants.

Category: Environmental Performance Characteristics

Project: Investigate Uses for Waste Materials in Masonry Products

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Investigation of waste materials that have a potential for use in the manufacture of masonry units and products. Identify acceptable and adverse chemical and physical characteristics.

2. Evaluation of the effect of materials on unit properties.

3. Development of mix designs which incorporate waste materials in the manufacturing process and which improve or maintain unit properties while decreasing or maintaining unit costs.

Benefits: The benefits are twofold: They will help to maintain or reduce manufacturing costs while responding to environmental concerns.

Category: Environmental Performance Characteristics

Project: Documentation of Acoustical Properties of Masonry

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Conduct a literature search of previously documented acoustical tests.
2. Analyze results and develop database of results based on unit weight and surface treatments.
3. Correlate STC values and NRC values of masonry to physical properties and surface treatment of units.
4. Development of calculated methods for determining STC values and NRC values based on historical data.
5. Development of in-situ acoustical tests of masonry assemblages to establish reliability of calculated methods.

Benefits: This will provide designers with reliable methods for specifying masonry assemblages for Sound Transmission and Noise Reduction in new construction.

This will also result in the increased use of masonry in types of construction where control of sound transmission and noise reduction is an important consideration.

Category: Environmental Performance Characteristics

Project: Establish Basis for Calculated Fire Resistance Ratings

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Determine whether existing calculation method guidelines provide a reliable basis for assigning fire resistance ratings.
2. Conduct a literature search of previously documented fire tests.
3. Construct a database of information based on material properties and fire test results.
4. Correlation of test results with material properties.
5. Development of calculated methods of predicting performance of masonry assemblages exposed to fire based upon masonry unit properties.
6. Introduction of the calculation methods into the building codes.

Benefits: This project will provide a reliable means of establishing the role of masonry as a passive resistance to fire which cannot be compromised as most active systems.

It will also increase the use of masonry in critical structures where fire resistance is of utmost concern.

Category: Environmental Performance Characteristics

Project: Fire Resistance Documentation (Passive/Active)

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Conduct a literature search of all insurance agency reports, official fire department records, newspaper accounts, and all other possible sources of information documenting performance of masonry structures exposed to fire damage.
2. Documentation of known failures of active systems (sprinklers, alarms, etc.).
3. Documentation of ability of masonry to control fire spread and minimize loss of life and property damage where active systems have failed.

Benefits: This project will result in the increased use of masonry occasioned by public awareness of fire safety afforded by masonry.

It will also provide reduced dollar loss due to fire damage.

Category: Instrumentation, Monitoring and Testing

Project: Develop Test methods for monitoring in-situ masonry

Approach: The suggested steps to be considered in achieving the goal of this project are:

1. Identification of current instrumentation and that which must be developed to identify and document masonry assemblage failure modes.
2. Development of a means for evaluating in-situ performance of masonry assemblages exposed to unusual or excessive structural loading and direct contact with wind driven rain.
3. Development of nondestructive test methods which provide reliable and quantitative measures of masonry performance.

Benefits: The goal of this research is to reduce maintenance costs and increase the useful life of structures.

APPENDIX

The following is the complete list of items considered at the April 23, 1994 workshop from which the priority items indicated in this report were selected.

I. Design Procedures

Structural Analytical Methods
Design Code Provisions and Specifications
Fire Analytical Methods
Thermal Design
Integrated Computer-aided Design, Conceptual Layout, Analysis, Takeoff, Estimating

Technology Transfer, Education

Acoustical Performance

Develop and Codify Design Procedures that are User Friendly, Clear, and Address Essential Points of the Structural System Under Consideration

Develop Standard Performance Related Details

Develop Expert System to Develop (Proposed) Solutions for Various Situations

Develop Integrated Code/Design Systems to Encourage Engineers and Architects to Focus on Critical Structural Parameters

Develop Performance Based Code/Specification Criteria for Masonry

Investigate Structural Forms for Optimum Performance

Develop Design Procedures for Base Isolated Structures

Develop Design Procedures for Masonry Infill Frames (To Take Advantage of the Benefits of the Infill)

Development of Structural Component Models Based on Observed (Documented) Performance

Develop Design Software Using Finite Element Models

Develop Wall Systems that Accommodate Substantial (6 inch) Story Drifts

Develop Performance Requirements for Reinforcement (Including Joint Reinforcement) for Different Limit States

Document Splice, Embedment, Anchorage Lengths Required in Reinforced Masonry of Various Thicknesses (i. e. Relationship Between Splice Length and Element Thickness)

Develop Performance Requirements for Veneers, Anchors and Backing

Develop Masonry Cover Requirements to Ensure Structural Performance (i. e. yielding of Steel, Ductile Flexural Failure)

Develop Sizing Requirements for Masonry Fireplaces and Chimney (Combustion Related Requirements)

Document the Shear Strength of Masonry Beams and the Shear Strength of Walls Loaded Out-of-Plane

II. Construction Technology and Workmanship

Technology Transfer, Education and Training Certification

Quality Control, Testing, Inspection, Certification

Construction Specifications

Cold Weather, Hot Weather Techniques (Seasonal Mortar/Grout Mix)

Material Logistics

Robotics

Masonry Construction Safety

Accessories - Sealants, Gaskets, Reinforcement, Coatings

Productivity Enhancement

Develop New Ways of Building Components

Develop Construction Techniques That are Cost Effective and Not Too Sensitive to Construction Variability

Quality Assurance Critique for Accepting/Rejecting Masonry

Develop Educational Material for Masons

Document the Effects that Cold Weather Has on Performance Using Different Construction Techniques

Investigate Effect of Moisture Content of Units on Performance (Bond, Shrinkage, etc.)

Develop More Reliable and Efficient Techniques for Details (User Friendly)

Means to Identify and Rectify Acceptance of Materials and Workmanship

Development of Real Time Evaluation Methods of Construction Quality

Develop Performance Based Systems for Producing Job Specifications

Develop Improved Construction Techniques for Positioning Reinforcement in Masonry

Develop Recommended Curing Practices

Develop Expert System Which Controls the Specification and Construction Process

Overall Evaluation of Cleaning Procedures (Masonry Surfaces)

Develop Programs to Maximize Construction Safety

Develop Criteria for Maximizing the Life Cycle Value of the Construction Worker

Innovative Equipment to Automate Mortar Production

Develop Equipment to More Effectively Transport Units, Mortar, and Other Materials to the Mason at the Construction Site.

Improve Communications at the Construction Site with Less Expensive Equipment (Radios, etc.)

Develop a Device to Assist in Placing Units and Enhance Performance (Bond, etc.)

Develop Software to Handle Construction Contingencies which Influence the Construction Sequence

Develop Performance Criteria for Worker Skills related to Masonry Quality Requirements

Develop Construction Methods which Don’t Require Masons

Develop Construction Methods or Equipment that Reduce Sensitivity to Weather

Document Acceptability of Construction Methods (Placing Units in Wet Concrete Footing)

Develop Construction Methods that Require a Lower Level of Installation Skill Without Reducing Quality

III. Material Performance

Raw Materials: Units, Mortar, Grout, Reinforcement

Bonding (Cementitious Materials)

Composite Materials in Units (Sandwich, Glaze)

Material Properties: Anchors, Ties, Connectors

Accessories: Sealants, Gaskets, Reinforcement, Coatings

Properties of Units

Develop Masonry Components and Materials That Fulfill Their Performance Requirements (Structural, Acoustical, and Thermal) at Minimum Cost

Develop High Performance Masonry Material (Ductility, Flexural, Tension, Shear)

Develop Material with Higher Strain Capacity

Document Dynamic Properties of Masonry

Develop Reliable Procedures for Measuring Masonry Performance

Improve Unit Mortar Bond Strength

Develop Alternative Grout that has Adequate Bond to Reinforcement and Units

Develop Ways of Eliminating the Reliance on Manufacturers Specifications

Conduct Sensitivity Studies to Establish the Comparative Importance of Properties of Performance Objectives

Investigate Fundamental Relationship of Grout Ingredients, Masonry Unit Properties, and Placement Procedures

Develop Customized Units that Have Varied Properties Based on Requirements. (Example: Water Resistant Face Shell on One Side of Unit)

Develop Units that Heal Cracks and Fractures
Develop Masonry Mechanics for Interconnecting Masonry Units (Eliminate Mortar)
Develop Methods for Monitoring Insitu Masonry Material Conditions
Develop Units that Optimize Placement of Reinforcement and Grout
Develop Mortar, Units and Grout that Minimize Volume Change (Note: Durability, etc. from Other Categories Apply Here)
Use of Nonmetallic Elements for Reinforcement and Connectors
Develop Fiber Reinforced Grout to Improve Ductility and Tensile Strength
Develop Light Weight Masonry Materials with Equivalent Strength
Prestressed Masonry
Develop Horizontal Prestressed/Posttensioned Methods
Identify Incompatible (Combinations of Materials) Situations (Coatings, Chlorides)
Develop Materials to Enhance Productivity
Develop Materials that are Applied to Masonry Walls to Improve performance
External Applications (Carbon Fiber, Ceramic Cloth) to Enhance Strength, Ductility, etc.
Establish NDE Techniques for Material Properties for Quality Control of Materials During Manufacture
Develop Additives to Units, Mortar and Grout to Enhance Performance
Document the Effect of Curing Conditions on Masonry Performance

IV. Advanced Masonry Applications

Prestressed Masonry
Automated Prefabricated Panels with CAD/CAM
Robotics
Marketing Existing Technology (New Applications)
Structural Component Applications
Horizontal - Paving, Flooring, Roofing
Codes and Standards
Develop Cost Effective Prefabrication Methods. Study Pros and Cons of Site Built vs Prefabricated Masonry (Large Scale)
Automation of Masonry Assemblies
Develop Techniques for Joining Prefab Assemblies
Use Flexible Matrix of Units that is Made Rigid at the Site
Develop Veneers (Pressure Equalized)
Develop Dry Stack, Grout Injected System of Bonding
Develop More Practical Methods of Constructing Reinforced Masonry Walls in Frame Buildings
Develop Cost Effective Reinforced Wall Systems
Develop Additional Non-Building Uses of Masonry that Take Advantage of the Economy of Scale and Prefabrication (Storage Tanks, Environmental Remediation Facility)
Use □Eco-Blocks□ or Turf Blocks for Paved Shoulders of Roads
Develop Pavers for Airport Runways.
Develop Technology for Achieving the Necessary Smoothness
Use Masonry Units as Catalyzing Beds for Industrial Processes
Develop Interior Finishes to Accommodate Electrical Installations

V. Technology Transfer

Center for Masonry Information
Bibliography of Technical References (Comprehensive Maintained)
Inclusion of Masonry in Schools of Architecture, Engineering, Construction Science
Manual of Masonry Practice
Mason Training
Forum for Communication and Feedback of New Procedures Developed Through Research

VI. Environmental Performance Characteristics

Passive Solar Energy
Thermal Performance
Fire Resistance (Documentation of Passive/Active Performance)
Acoustical Performance (Transmission, Noise Reduction)
Mold, Mildew - Health Issues
Building Codes
Freeze-Thaw Durability
Water and Air Penetration
Corrosion - Connectors, Reinforcement
Building and Component Movements
Manipulation of Thermal Mass
Durability (Freeze-Thaw, Salt, etc.)
Document Passive Solar Performance
New Unit Designs to Prevent Water Penetration
Document STC Ratings of Masonry Walls
Document Movement Coefficients and Design Methods for Controlling Wall Movement
Durability of Connectors (Corrosion, Alternate Materials)
Effects of Penetrations on Fire Resistance
Investigate the Deterioration Science of Masonry Unit Durability
Projectile Resistance of Masonry
Develop Improved Insulating Values for Masonry
Methods of Avoiding Efflorescence
Develop More Stain Resistant Masonry (Rain/Weathering)
Document Vapor Transmission Through Masonry
Quality Assistance for Durability (Verification of Construction in Accordance with Design)
Better Computer Modeling to Determine Vapor Transmission
Document Service Life Prediction of Masonry Structures (Units, Connectors, Attachments, etc.)
Means of Calculating Fire Resistance Based on Material Properties Rather than Fire Tests
Evaluation of Masonry Subjected to Fire
Perm Values for Brick, Block, Paint (Database) at Varied Moisture Contents
Test Methods for Rating Masonry Coatings (Surface Treatments), Integral Repellents
Develop Test Method for Moisture Penetration that is Meaningful, Easy to Conduct
Masonry Penetration Junction (How to Install Windows, etc.)
Document Performance of Rain Screen Principal (Establish Design Criteria)
Extend Function of Mortar to Act as Flashing
Use of Materials in Products and Masonry to Control Mildew and Mold
Prevent Movement of Moisture Through the Envelope
Maximize Use of Waste Materials in Masonry Products

Document Useful Life of Masonry
Means of Evaluating Toxic Potential of Masonry Products
Ensure Masonry is a Non-toxic Product
Develop Recycling of Used Masonry Products
Document Properties of Masonry Using Alternative Materials
Minimize Real Life Cycle Costs of Masonry, Including Environmental Costs
Develop Green Properties of Masonry
Develop Uniform Criteria for Looking at the Cradle to Grave Impact (Cost) of Different Building Materials
Develop Easier Methods of Reprogramming (Reuse) of Buildings
Develop Use of Masonry Products as Environmental Filters
Explore Use of Masonry Materials in Environmental Remediation

VII. Instrumentation Monitoring and Testing

Smart Structure - Instrumented, Measuring Response
Verification of Construction in Accordance with Design (As-Built)
Verification of Design Assumptions
Field Tests to Verify Compliance to Specifications
Improved (More Relevant) Tests of Masonry Materials and Components
Disaster Investigation
Identify Instrumentation Currently Available Which Needs to be Developed to Document Conditions (Stress, Strain, Temperature, Moisture)
Instrumentation to Measure Water Content of Grout with Time
Establish Through-the-Wall Moisture Contents and Relate to Calculated Thermal Properties
Develop Methodology for Determining Properties that Need to be Monitored
Develop Test Method and Criteria for Insitu Masonry (Water Penetration, Structural, Air Leakage)
Develop NDE Test Methods to Access Current Condition and Remaining Service Life
Develop Temperature Sensitive Materials for Vapor Barriers
Smart House - Automatic Change in Ventilation Depending on Environmental and Loading Conditions
Inflatable Bladders in Gap Between Masonry Infill and Bounding Frame (Active Control)
Develop Instrumentation to Automatically Verify the Quality of Materials

VIII. Production, Manufacturing, Scheduling

New Materials
More Energy Efficient Production
Automation - Mix Designs
Automated Verification of Size, Texture, Color
Coordination of Supply and Demand
Automated Ordering, Procedures, Delivery of Materials
Develop New Energy Sources for Fast Firing of Clay Masonry Units
Develop Zero Distortion Brick
Develop New Binding Method for Brick
Develop Masonry Unit Materials With Lower Thermal Conductivity
Less Energy Intensive Accelerated Curing Methods
Develop Raw Materials for Manufacturing Units that Require No Curing
Develop Self Bonding Units (Bonding Agent Applied at Manuacturing Plant)
Develop Methods of Coordinating Work Force Demand
Develop Masonry Materials with Zero Coefficient of Shrinkage Expansion
Use Bar Coding and Mail Slotting to Track Unit Inventory and Storage of Units
Use Just-in-Time Technology
Coordinate and Size Cubes of Units for Direct Delivery to the Mason
Use Conveyors at the Job Site for More Efficient Delivery of Units to the Mason
Investigate Optimum Size of Cubes of Units
Optimize Transportation/Handling to Minimize Chipping of Units
Develop on Site Recycling of Materials (Unit Culls)

IX. Environmental Impact

Cradle to Grave Impact (Raw Materials, Production, In-Use Energy)
Useful Life
Disposal Impact/Recycle
In-Use Impact
Use of Waste Materials (Slag, Coal, Ash, Waste Oil)
Volatile Organics (Inclusion or Exclusion)

X. Sustainability

Availability of Resources to Sustain Industry
Depletion Allowances
Tax Issues
Continued Use of Structure
Useful Life
Maintenance
Public Education
Assessment
Buildings that Let You Know When They Need Maintenance (Sealants, Coatings, Changes in Stress)
Develop Methods of Improving the Useful Life of a Building

The Council for Masonry Research encourages and welcomes suggestions and recommendations for Research Topics which have the potential for improving or broadening the use of masonry.

Direct your suggestions, recommendations and comments to:

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