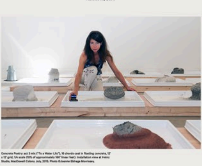
THE ART OF THE SLUMP

by Michelle Fornabai

The fleeting fate and enduring potential of the slump test



Concrete Poetry: act 3 mix ("To a Water Lily"), 16 chords cast in floating concrete, 12' x 12' grid, 1/4 scale (10% of approximately 160' linear feet). Installation view at Heinz Studio, MacDowell Colony July, 2016. Photo ©Joanna Eldrege Morrissey.

Concrete use in the modern world is exceeded only by the use of naturally occurring water.[1] About 7.5 billion cubic meters are made each year—more than one cubic meter for every person on earth[2] —and for every 100m3 of concrete poured, a .0057m3 slump test is made.[3]

Ubiquitous if diminutive, the slump test is performed on building sites worldwide. Banal but unique among concrete testing methods, it is a widely adopted field test that transcends language and economic barriers, requiring a simple kit comprised of a cylinder, a rod, a scoop and a plate of specified dimensions. And yet, despite its prevalence and propagation, is the slump test an endangered species of material testing?

As a measure of conformity whose results carry weight, the slump test has been criticized for its inclinations and leanings. By following lines of least resistance, it remains easily influenced—inflected by aggregate size, admixtures, the addition of fibers and aerating agents,[4] succumbing to time in transport and pliant under the hand of the technician who enacts it. Yielding results that remain malleable—neither exact nor reproducible nor even definitively related to rheology[5] —what it tells us remains ambiguous. And yet failing the slump test, or even failing to slump test, forms the legal basis for the rejection of batches of concrete or even of concrete already placed in the work.

A standard practice, the slump test bears the standards of architectural practice—in the textual specifications of construction documents used by the architect to delineate concrete. Whether prescriptive or performative, specifications hold the line where concrete's materiality is concerned—ensuring its suitability to be formed and forced, its workability and subsequent strength, according to the drafted lines of formwork and to the lines of structural calculations. The ink of architectural conventions is no more fluid than this concrete on paper. Radical heterogeneity and material specificity are thinned into a single, monolithic line—the datum of the original line of the slump mold compared against the slumped concrete.

slump cone placed| hard, non-absorbent surface | fresh concrete | in three stages | each time, each layer | tamped 25 times | with standard rod | struck off flush | with mold | lifted carefully | vertically, upwards | concrete subsides | slump measured | to 5mm | against cone | with rod.

An apparently simple act, the slump test is a highly controlled performance elaborated in detail in textual specifications by the ASTM International.[6] These specifications determine both the material and dimensional constraints for the equipment: cone (stainless steel or plastic, 4" x 8" x 12"), rod (galvanized steel, 5/8" x 24"), plate (hard, non-absorbent, 24" x 24"). Moreover, they describe the procedural for the performance of the test: filling (3 layers, approximately 70mm), tamping (25 times each layer), de-molding (overfilled, struck off, lifted vertically with feet akimbo) and measuring (with a precision of 5mm, measured to top of standard cone with standard rod). Yet for all the lines written to specify and all the lab tests performed to quantify, every slump in concrete misses the ideal form in a unique way and each performance of the slump test eludes meaningful definition by words like a dance or a poem.

Performing the slump test is an art—a certified craft whose practitioners at the highest level know which feints and slights of hand produce veracity or false results.[7] Provisional and precarious, each slump test is time-sensitive to the chemical process that cures concrete, which is itself sensitive to transient environmental conditions. With an immediacy that is fleeting, fugitive and fragile, the slump captures but an instant—and itself exists only for a brief moment in time. Durable but disposable, it is recorded then discarded; the slump's short lifespan belies its enduring power in legal, economic and built environments. With years of continued performance since its invention by Chapman in 1913, its use is considered time-tested, its impermanence considered to produce lasting results. As an empirical test, a temporary act or an artifact, the slump relies by definition on the sensory experience of the observer.

If the slump test resembles contemporary performance art more than scientific evidence, can it constitute a form of architectural research? Materials testing, increasingly held within the domain of the laboratory rather than the field, has begun to pervade the studio as the precursor to innovation in architecture. New materials, subsequently deployed in the field according to their expanded characteristics, form a basis of contemporary experimentation in architecture. Such research treats materials as having an a priori rationality—an inherence or essence of performative capability—that then "succeeds" as a new solution to an existing problem. But does this material research really change the discipline's underlying assumptions?

Certainly, contemporary advances in concrete strength, evinced by modern high performance concrete emerging from the lab, confront the slump test with both its limits and its limitation. At the upper bound with stiff mixes of very little slump and at the lower bound with mixes of very large slumps, concrete designed with a low water to cement ratio—with superplasticizers and PHC admixtures that reduce required water or extend its setting time—quickly occupies the limits of the slump test. Yet the very old confronted as much as the new, with the rocks of the aggregate itself—their density, size, shape, surface area, friction—dominating the slump in their angle of repose[8] and dictating the size of rheometers using coaxial cylinders too large for easy transport from lab to field.[9]

Would it be limited for contemporary practice to potentially limit the field by implying that the limitations of the slump test delimit its usefulness? Will such limits endanger the slump test in the future? If we put the slump to the test, can it stand the test of time? Neither past nor future, the slump test will be ever of the moment—inherently and insistently so. Concrete itself is a medium in time, whose changes of state involve multiple senses of time ranging from the imminently present "now" to geological time. In effect, the slump test's sensitivity to time may underlie its adaptability in time; recording it over time (slump-time curves) may extend its measure to include plastic viscosity, which could bridge the historical gap between the field and the lab in testing concrete's workability.[10]

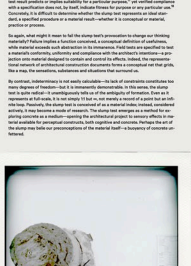
Over time, deciphering the slump test's results has pushed the limits of disciplinary lines to encompass fluid mechanics, soil mechanics and rock mechanics.[11] Heterogeneous, multiform and changeable, concrete's limitless variations perpetually locate the slump test at the unsettled boundary between conformity and non-conformity. In time, will the slump test seem prescient? Paradoxically, the slump test accommodates to standardize, but remains unconventionally typical. By molding itself, it adapts to regularize, yet is understood to be singularly non-conforming. In conforming, it assimilates to normalize, which is singularly unusual. Becoming rigid, it acclimatizes itself to naturalize the uncharacteristically anomalous.

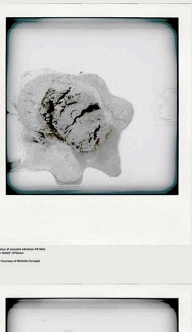
Rather than asking whether the slump test is failing the discipline, we might ask how the discipline is failing the slump test? Or, how might the slump test continue to test us as a discipline? Perhaps we are failing to change our architectural thinking materially. It is said that if you are a hammer you perceive everything to be a nail, but what would it mean to perceive concretely? In testing, as experiments verify, refute or establish the validity of a hypothesis, results bind us to a way of seeing a priori—a bias to discern what is telling without listening to what is being told. If the empirical relies upon our senses, how do we move from sense to significance?

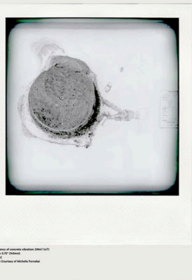
What is the slump test telling us *in concreto*? Does the slump test shape our idea of concrete with inadequate representations incapable of solution?[12] Or does it concretely yet imperfectly form rules of practice and inform in actual instances, even if limited and defective, rather than abstractions?[13] By definition, test methods are construed as definitive procedures that produce a result[14] —a determination of one or more characteristics according to a specified procedure[15] —and yet the precise method of testing or measuring a physical property is commonly understood to affect the property itself.[16] Paradoxically, a test result predicts or implies suitability for a particular purpose,[17] yet verified compliance with a specification does not, by itself, indicate fitness for purpose or any particular use.[18] Concretely, it is difficult to determine whether the slump test represents an ideal standard, a specified procedure or a material result—whether it is conceptual or material, practice or process.

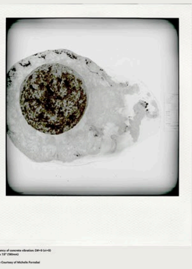
So again, what might it mean to fail the slump test's provocation to change our thinking materially? Failure implies a function conceived, a conceptual definition of usefulness, while material exceeds such abstraction in its immanence. Field tests are specified to test a material's conformity, uniformity and compliance with the architect's intentions—a projection onto material designed to contain and control its effects. Indeed, the representational network of architectural construction documents forms a conceptual net that grids, like a map, the sensations, substances and situations that surround us.

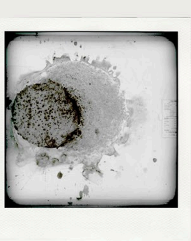
By contrast, indeterminacy is not easily calculable—its lack of constraints constitutes too many degrees of freedom—but it is immanently demonstrable. In this sense, the slump test is quite radical—it unambiguously tells us of the ambiguity of formation. Even as it represents at full-scale, it is not simply 1:1 but ∞, not merely a record of a point but an infinite loop. Passively, the slump test is conceived of as a material index; instead, considered actively, it may become a mode of research. The slump test emerges as a method for exploring concrete as a medium—opening the architectural project to sensory effects in material available for perceptual constructs, both cognitive and concrete. Perhaps the art of the slump may belie our preconceptions of the material itself—a buoyancy of concrete unfettered.

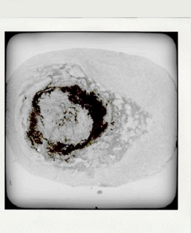


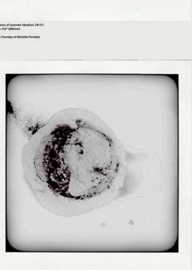


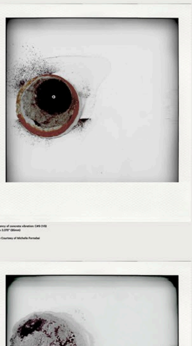


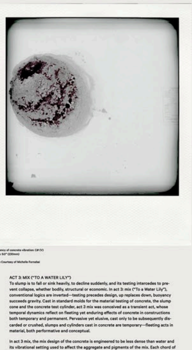


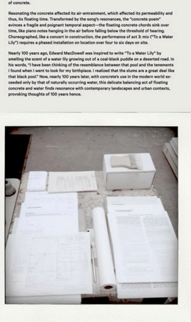












Frequency of concrete vibration: C# (V)
slump: 9.0" (230mm)
Image Courtesy of Michelle Fornabai

ACT 3: MIX ("TO A WATER LILY")

To slump is to fall or sink heavily, to decline suddenly, and its testing intercedes to prevent collapse, whether bodily, structural or economic. In act 3: mix ("To a Water Lily"), conventional logics are inverted—testing precedes design, up replaces down, buoyancy succeeds gravity. Cast in standard molds for the material testing of concrete, the slump cone and the concrete test cylinder, act 3 mix was conceived as a transient act, whose temporal dynamics reflect on fleeting yet enduring effects of concrete in constructions both temporary and permanent. Pervasive yet elusive, cast only to be subsequently discarded or crushed, slumps and cylinders cast in concrete are temporary—fleeting acts in material, both performative and conceptual.

In act 3 mix, the mix design of the concrete is engineered to be less dense than water and its vibrational setting used to affect the aggregate and pigments of the mix. Each chord of Edward MacDowell's song "To a Water Lily," composed at the colony as part of his Woodland Sketches, was cast at two different scales and vibrated with resonance speakers for 2 minutes as specified by the ACI (American Concrete Institute) for the vibrational setting of concrete.

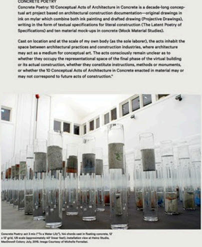
Resonating the concrete affected its air-entrainment, which affected its permeability and thus, its floating time. Transformed by the song's resonances, the "concrete poem" evinces a fragile and poignant temporal aspect—the floating concrete chords sink over time, like piano notes hanging in the air before falling below the threshold of hearing. Choreographed, like a concert in construction, the performance of act 3: mix ("To a Water Lily") requires a phased installation on location over four to six days on site.

Nearly 100 years ago, Edward MacDowell was inspired to write "To a Water Lily" by smelling the scent of a water lily growing out of a coal-black puddle on a deserted road. In his words, "I have been thinking of the resemblance between that pool and the tenements I found when I went to look for my birthplace. I realized that the slums are a great deal like that black pool." Now, nearly 100 years later, with concrete's use in the modern world exceeded only by that of naturally occurring water, this delicate balancing act of floating concrete and water finds resonance with contemporary landscapes and urban contexts, provoking thoughts of 100 years hence.

Concrete Poetry: act 3 mix ("To a Water Lily"), floating concrete mix design, ACI Specifications, June, 2016. Image Courtesy of Michelle Fornabai.

Concrete Poetry: act 3 mix ("To a Water Lily"), vibrational setting with resonance speakers, F# Major 9, two minutes per chord, pigment, perlite and concrete, 1' x 2' slump test cone, June, 2016. Image Courtesy of Michelle Fornabai.

Concrete Poetry: act 3 mix ("To a Water Lily"), vibrational setting with resonance speakers, F# Major 9, F# Major 9A (inverted), F# Major 9, two minutes per chord, pigment, perlite and concrete, 1' x 2' slump tests, June, 2016. Image Courtesy of Michelle Fornabai.



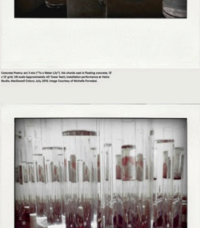
Concrete Poetry: act 3 mix ("To a Water Lily"), casting process, G# Minor, pigment, perlite and 1' x 2' slump test cone, June, 2016. Image Courtesy of Michelle Fornabai.

CONCRETE POETRY

Concrete Poetry: 10 Conceptual Acts of Architecture in Concrete is a decade-long conceptual art project based on architectural construction documentation—original drawings in ink on mylar which combine both ink painting and drafted drawing (Projective Drawings), writing in the form of textual specifications for literal construction (The Latent Poetry of Specifications) and ten material mock-ups in concrete (Mock Material Studies).

Cast on location and at the scale of my own body (as the sole laborer), the acts inhabit the space between architectural practices and construction industries, where architecture may act as a medium for conceptual art. The acts consciously remain unclear as to whether they occupy the representational space of the final phase of the virtual building or its actual construction, whether they constitute instructions, methods or monuments, or whether the 10 Conceptual Acts of Architecture in Concrete enacted in material may or may not correspond to future acts of construction.

Concrete Poetry: act 3 mix ("To a Water Lily"), 144 chords cast in floating concrete, 12' x 12' grid, 1/8 scale (approximately 40' linear feet), installation view at Heinz Studio, MacDowell Colony July, 2016. Image Courtesy of Michelle Fornabai.



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