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Ten Concrete Buildings: Donald Judd's Incomplete Integrations of Art & Engineering

ROB WHITEHEAD, AIA, LEED AP*
Assistant Professor of Architecture
Iowa State University, Ames, Iowa, United States
rwhitehd@iastate.edu

Abstract

This paper will examine the relationship between artistic intentions and structural constraints of materiality and form related to the work of Donald Judd's *ten concrete buildings* at the Chinati Foundation in Marfa, Texas. Although the project was designed to be an ambitious structural thin shell concrete buildings, only minimal documentation of the project was produced, and only portions of the buildings were eventually completed. The paper will discuss the buildings in relation to Judd's other work, including his large-scale sculptures and other architectural designs.

Keywords: Donald Judd, Barrel Vault, Art & Engineering, Concrete Buildings, Chinati Foundation.

1. Artistic Aspirations and Structural Limitations

In an isolated corner of Chinati Foundation grounds in the remote town of Marfa, Texas, portions of two concrete building shells, designed by the minimalist artist Donald Judd, have sat unfinished for nearly twenty years. These remnants are portions of Judd's larger design proposal for *ten concrete buildings*. These thin shell barrel vaults, varying in span from 9-18 meters, were designed to house original works of Judd's large-scale art. Although he had extensive experience in remodeling buildings and creating large scale outdoor concrete sculptures, these new buildings were Judd's first, and final, experiment in creating free-standing exhibition buildings.

These buildings were intended to have the same spare, exacting, material expression and rigid proportioning found in most of Judd's three-dimensional work, but as thin-shell structures, they had more complicated design requirements than Judd may have realized. This paper will describe how Judd's artistic design process, particularly the lack of design documentation and reliance on prototyping may have also contributed to these problems. Ultimately, conflicts between aesthetics, structural form, and construction complexities created several problems that resulted in poorly crafted buildings with visible signs of structural problems. (Figure 1).

2. Early Experiments in Technical Integration with Art

"Somewhere…a strict measure must exist for the art of this time and place." —Donald Judd [7].

In 1979, the Dia Art Foundation agreed to support the efforts of minimalist artistic Donald Judd in the creation of an unconventional complex of art and architecture on the abandoned 340-acre Fort Russell military garrison in Marfa, Texas. Judd sought to create a model artistic existence where the creation and permanent display of site-specific artwork was crafted for particular settings in an attempt to create "pure contemplation" through movement (Kellein [10]). According to former Chinati Foundation director, Marianne Stockebrand, this broad authority of design authorship provided Judd an opportunity to try and "unite art, architecture, and nature in an embodiment of his own philosophical outlook" (Stockebrand, [15]). Until his death fifteen years later, Judd's work consisted of two separate, but critically related endeavors: the remodeling of existing buildings into exhibition spaces and the creation (and curation) of large-scale sculptures placed at various sites within these buildings and around the compound. The *ten concrete buildings* were a clear reflection of positive and negative aspects of these experiences.

2.1 Fifteen Works of Concrete and Failures in Fabrication

Within months of obtaining the property, Judd developed plans for a collection of sixty large-scale prefabricated concrete blocks with hollow interiors (2.5m x 5m x 2.5m) arranged in 15 separate, variously configured groupings, all aligned along a 900m long axis within the landscape. These *fifteen untitled works in concrete* were first sketched in 1977, but they were completed during incremental episodes of design refinement and construction between 1980-84. From the beginning, the quality of concrete work coupled with Judd's design and approval process mired the installation with delays (Figure 2).

Unlike many other artists from his era, Judd didn't build his own work—he desired preciseness that required outside expertise. Judd forged long-term relationships with a few fabricators to the degree that he wouldn't need to produce detailed drawings or specifications in order to communicate his artistic intentions—only rough sketches with clearly noted dimensions (Noever [14]). Fabricators, like the Berstein Brothers and Lippincott, would interpret the drawings, and send samples of the proposed materials, connections, and often full-scale prototypes back to Judd for his review. Judd would make design adjustments as needed and the work would be refabricated if necessary (Lippincott [11]). While this process worked for portable works of art or furniture, it was problematic for the fixed, large-scale objects, like the *fifteen untitled works in concrete* (and the *ten concrete buildings*).

Judd hired a precast concrete company (CRS) out of nearby Odessa, Texas to fabricate the floor, roof, and wall panels for many of the first concrete boxes in this installation (Esmay [3]). Judd didn't produce detailed drawings or specifications outlining his expectations for quality and so the first several boxes produced had uneven slab lengths, corners that weren't square, and uneven finishes. Judd was disappointed in the results (Stockebrand [17]). For the next two years, he became increasingly more involved in the specifics of the fabrication process at CRS including the selection of moldings and formwork surfaces, the concrete admixtures, and even the process of pouring and finishing of the work (Esmay [3]). Even with these renewed efforts, the precast concrete work was not meeting his exacting standards and Judd shifted his approach. Many of these thirty precast boxes had flaws that needed extensive restoration only 20 years later (Stockebrand [16]).

Figure 1: Views of the two unfinished buildings in their current state. Photos by author.

Figure 2: Fifteen untitled works in concrete in context. Photos by author.

Judd decided to finish the remaining boxes by having them cast in place and hired an architect/concrete expert, Bob Kirk, Jr., from Architectural Concrete Associates Inc. in Dallas, to oversee the work. The site work had it's own limitations (lack of available skilled labor, consistency of concrete mixes, etc.) but Judd preferred this new approach as it better matched his design methodology (Stockebrand [18]). Kirk was an expert fabricator that understood his intentions and Judd had an ability to immediate inspect and revise of the work. Kirk would continue to work with Judd, serving as his design consultant for the *ten concrete buildings* a few years later.

2.2 Enhancing Function, Volume, and Materiality by Design

Before Judd decided to work as an artist, many of his thoughts about architectural design were shaped, in part, by his pratical experience in the U.S. Army as a draftsman, laborer, and construction foreman erecting several "frames and pre-fabricated buildings" (Kellein [10]). Judd explained that, "my aphorism is not that form follows function but that it never violates it. Or common sense, for that matter" (Judd [7]). Interestingly, Judd was briefly stationed at Fort Russell in 1947 before serving in the Korean War, and in a telegram to his family, he commented about the beauty of the town and its mountainous surroundings (Haskell [5]). Years later, when he eventually began working on the remodeling projects at this same fort, he accepted and appreciated the inherent order of the military buildings and their manner of architectural expression. Judd once wrote that "nothing is architecture unless the interior volume is evident" so correspondingly, he frequently exposed the structurally simple volumetric environments of the military buildings (Judd [6]).

These remodeled buildings were not meant to be "art" in-and-of-themselves, instead, they were intended to serve as a symbiotic compositional partner to the work they contained (Judd [8]). Judd

was highly critical of the design of many contemporary exhibitions spaces, describing them as "too clean and too slick," so he intentionally eschewed the minimalist materiality and exacting standards of craft that he applied to his art work in the remodeled projects (Stockbrand [18]). Judd favored natural materials (like wood and adobe) and methods of construction that showed the roughness and flaws of the material as part of their beauty (Figure 3).

2.3 The Oddity and Influence of the Arched Vault

Even though nearly every building needed extensive remodel and repair to properly house the foundation's collection, only a few buildings were noticeably altered from the exterior—most noteable were the two large artillery shed buildings. In 1983, when five years of repairs to the flat concrete roofs hadn't stopped the consistent leaking on the *100 untitled works in mill aluminum* housed inside, Judd placed a large corrugated metal vaulted "Quonset-hut" roof on top of the buildings, nearly doubling the building's height (Figure 4). Although it was effective in stopping the leak, the new vaulted roof form was primarily an aesthetic choice, not structural or volumetric. Judd, who had argued that, "forms for their own sake, irrespective of function are ridiculous" (Judd [6]) had dramatically altered the building with a highly connotative and representational form (a means of expression intentionally absent from Judd's artwork). But Judd felt the new roofs improved the existing buildings dramatically, regardless of the logic contridictions.

Figures 3A, 3B, & 3C: Existing buildings remodeled by Judd, (Left to Right), The arena, the artillery sheds, and one of the barracks. Photos by author.

Figures 4A, 4B, & 4C: (Left to Right), Original artillery shed building Shell, Judd (on ladder) inspecting new metal panel work & revised building elevation view. Images by Chinati Foundation.

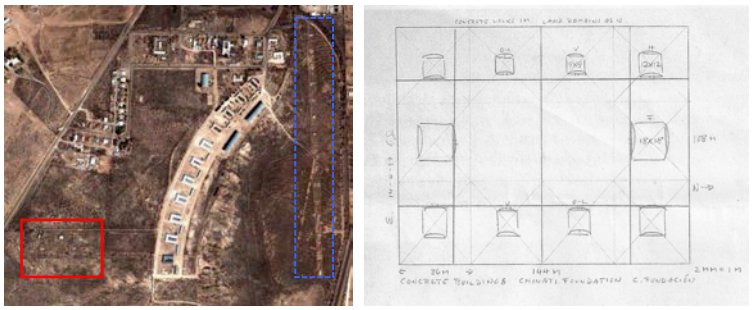
The arch form inspired Judd. Days after first sketching this solution for the artillary sheds, he drew a similar roof section and labeled the sketch as a study for the "concrete buildings" he had originally envisioned in 1980 (Fluckiger [4]). Even though the size of *ten concrete buildings* and their arrangement would be adjusted over the next several years, this roof form remained a constant. Other aspects of the new building designs were also informed by Judd's previous experiences designing exhibition spaces and large-scale concrete sculptures, but unlike this previous work he intended to have the new buildings become works of art which created a corresponding level of elevated technical challenges that tested Judd's creative resistance to compromise.

3. New Buildings and Older Influences

"…just reworking old buildings becomes tiresome." – Donald Judd, 1989 [8]

The *ten concrete buildings* were designed to permanently exhibit 18 original large-scale works created by Judd in 1980, including two new massive stainless steel pieces, and versions of his well-known "Stacks" and "Progressions." This completed work remained in storage because the Dia Art Foundation never financed the construction of the new concrete buildings and Judd didn't feel that any other buildings would be suitable for their display (Judd [8]). Eventually when the Chinati Foundation took over the collection from Dia in 1987, and opened the exhibitions to the public for the first time, the *ten concrete buildings* project went forward.

Preferring not to build on open land, Judd located the buildings on the site of a former prisoner barracks in the southwestern corner of the grounds, visually separated from the other buildings (Figure 5A). In accordance with the repetition and regularity of layouts found on the military base (and in his artwork), Judd drew a site plan with twelve 36m x 36m squares in a 4 x 3 rectangular grid arrangement. He logically positioned the ten buildings at the center of each square around the perimeter, leaving the two center bays as open land (Figure 5B).



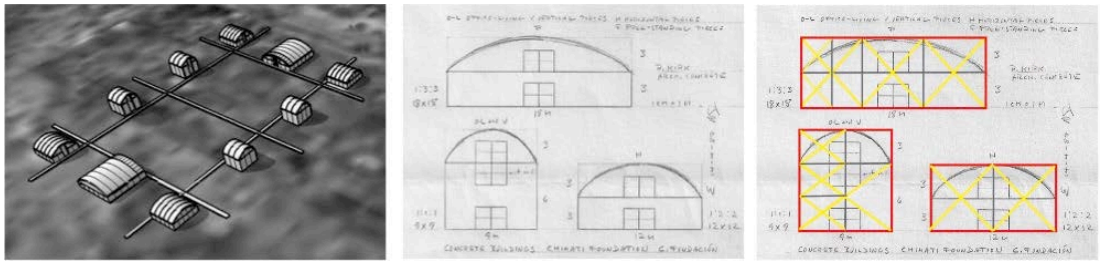
Figures 5A & 5B: (Left to Right), Aerial view of Chinati Foundation; site for untitled concrete boxes outlined in blue & site for *ten concrete buildings* outlined in red. Judd's site plan drawing showing overlaying site geometry, building placement and dimensions. Drawing from Chinati Foundation.

3.1 Regularity, Repetition, and Proportion

The buildings were all square in plan, sized in accordance with the artwork planned for display. The two largest buildings, 18m x 18m, were placed at each end of the long site axis and were designed to

exhibit the large stainless steel pieces. The four 12m x 12m buildings at the corners of the complex were meant to exhibit the "Progressions" work. The final four buildings, each 9m x 9m, were to be built on the remaining squares on both sides of the open courtyard; these taller buildings were intended to display the vertical "Stacks" work and accommodate living and studio spaces. All the buildings were linked with narrow walks aligned with the building entries that extended to the edge of the imaginary grid and abruptly stopped (Figure 6A).

The regularity and rigor for the site layout and building footprints isn't surprising for Judd, as it is seen in nearly all of his artwork, but he applied this design bias three-dimensionally as well. As a renowned Renaissance art scholar, Judd believed in the importance and impact of designing with clearly articulated mathematical proportions for the volume and form of the buildings, stating that, "you can't exaggerate the importance of proportion. It could almost be the definition of art and architecture" (Judd [6]). Correspondingly, he developed elevations for the three different building types based on a mathematical ratio of heights: the peak of the arched roof for the 18m buildings were originally 6m high (1:3:3), the 12m buildings were 6m high (1:2:2), and the 9m buildings were 9m high (1:1:1) (Figures 6B & 6C). The buildings were all drawn with arched roof forms, similar to the artillery sheds, but unlike the sheds, these roof forms were intended to be expressed structurally and volumetrically inside with an exposed thin shell concrete roof above.



Figures 6A, 6B, & 6C: (Left to Right), Axonometric view of building massing (by author), Elevation sketches (dated 14-4-87) by Judd, and elevational proportioning drawing (by author).

Problematically, this confluence of decisions about the building heights, forms, and materials were not based on structural considerations but aesthetics. Thin shell concrete structures can't be easily conformed to non-idealized forms and proportions. Although shell forms can be estimated intutively, certain modifications and refinements to these forms are traditionally made during the process of drawing an engineering which refines these structural proposals before construction (Medwadowki [13]). Unfortunately Judd's design and documentation for this proposal was predictably spare.

3.2 Documentation Without Development

Judd produced only two drawings for the project before construction began: a site plan and building elevations (Figures 5B & 6B), and similar to his sketches for artwork, he only dimensioned and annotated certain aspects of the work. Judd again relied on Kirk, to spearhead the construction effort, and even listed his name on the elevation drawing ("R. Kirk Architectural Concrete"). Eventually

Judd would draw a section drawing, more detailed elevations for each building, and an overall axonometric of all the buildings on the site. These additional drawings didn't contain any significant technical information about how the buildings would be built, but these new drawings showed two significant differences. First, the roof profile for the 18m buildings was altered from the original 6m height (1:3:3 proportion) to a taller 9m height (1:2:2 proportion). This new profile matched the roof profile for the artillery sheds and created a more structurally reasonable thrust line. Second, these detailed elevation drawings showed a series of panel joints and reveals across the all the building surfaces and, as a result, established a consistent thickness for all the walls and the roofs, regardless of their span, at a modest 12.5cm (Figure 7). The elevations showed the side supporting walls merging seemlessly together with the roof and separated from the end wall infill panels and windows with a series of reveals between panels. This thickness isn't necessarily ambitious for an accurately shaped and engineered thin shell roof profile, even for an 18m span (Billington [1]), but in relative terms it is only half as thick as all the walls and roof spans used in the concrete boxes and they had maximum spans of only 2.5m.

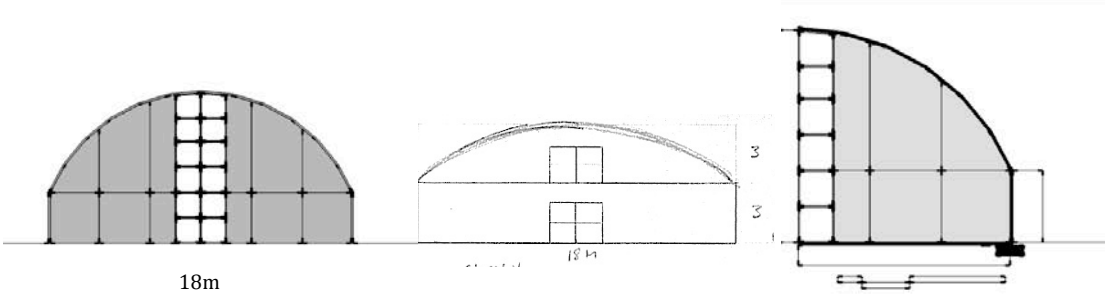


Figure 7: (Left to Right), Elevation of revised 18m building compared to original sketch & section drawing for 18m building. New drawings recreated by author from Judd drawings.

It is unclear if these changes and developments were made for aesthetic or structural reasons. Stockebrand recalls that Judd had "an engineer" review this work for structural viability, but there are no engineering calculations, shop drawings, or other items of evidence to support this (Stockebrand, [18]). Even if Kirk was the one who reviewed the work, this wasn't equivalent to an engineering review because he wasn't a structural engineer and had no previous experience with thin shell design.

4. Structural Forms and Construction Complications

"It's difficult to be informed by the extreme generalities of aesthetics when your problems are so specific." — Donald Judd, "Art and Architecture" [7].

Under certain circumstances, acceptable structural performance can be designed to accommodate artistic intentions, but in this case, Judd's artistic intentions for the buildings were also structural. By selecting concrete as the sole material then restricting the geometry and component thicknesses for aesthetic purposes, certain structural and material accommodations inevitably would need to be made—some that might require compromise. For example, like all barrel vaults, the structural

performance relies to a certain degree upon the selection of a viable cross-section profile, adequate reinforcing in the membrane surface, and some means of resisting the horizontal thrust generated from the arched roof form (MacDonald [12]).

4.1 Proportion versus Performance

Because all ten buildings all have square-shaped plans, they are short vaults that want to behave more like an arches than a beam (Billington [1]). To make the structures more efficient, the corresponding sectional profile of these vaults should ideally follow a funicular shaped curve, but Judd's selection of the roof profiles was based on aesthetic, contextual, and broadly based proportional rules. A graphic comparison shows that these profiles were divergent from the more idealized funicular shapes (under only uniform loading) to various degrees (Figure 8). For the 9m and 12m buildings, the funicular thrust line falls just outside the proposed roof thickness in the bottom third of the arch, but as the span gets larger, the discrepancy becomes more pronounced. Fort he 18m building, nearly the entire length of the proposed roof section falls outside the line of thrust, with a 30cm maximum difference. To compensate for these discrepancies in form, the vaults would adjust to try and span more like beams longitudinally (Billington [1]). As expected the roof has indeed deformed into saddle-shaped roof form.

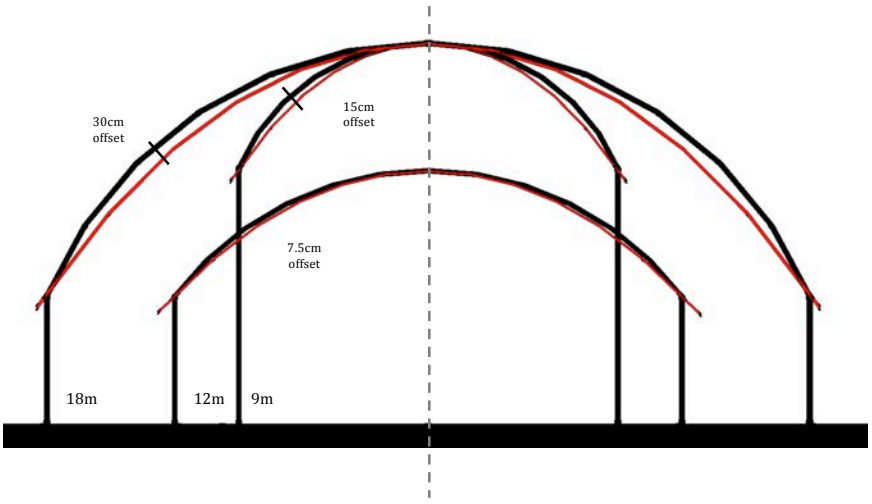


Figure 8: Cross section of all three buildings superimposed. Funicular thrust lines shown in red.

The geometry of the roof profile also affects the magnitude of horizontal thrust exerted at the perimeter of the vaults. Typically to resist this thrust, walls are thickened, buttressed, tied-back internally, stabilized with deeper end arches, corner columns, or support walls cantilevered out from the foundations. However, none of these approaches are part of the finished building's design. The only buttress bracing shown was during construction, when lumber was placed diagonally to brace the roof / wall connection. In the unfinished building, only modestly sized reinforcing is shown at the intersection of the wall and roof, but the wall itself isn't thicknened in any way (Figure 9B). The

supporting walls give a certain stability of stiffening, but they are thin, vertical precast walls that are separated from each-other, eliminating a continuity of horizontal resistence. Predictably, without any of these measures in place and a slightly errand roof profile geometry, the finished roof has deflected noticeably into a saddle shape and pushed the corners of the supporting walls out of vertical orientation (Figure 9C).



Figures 9A-9C: (Left to Right), The unfinished building with temporary bracing and roof panel formwork in place, the wall / roof intersection showing the modest reinforcing sizing, and a side elevation of the finished building showing sagging in the roof and deflection in end walls.

These problems with structural performance may have contributed to the project's unfinished status. Perhaps this evidence of deflection in the 12m building suggested to Judd and Kirk that the 18m building would undergo even more dramatic structural consequences (it would have higher levels of thrust and a greater discrepancy in idealized roof profile) or else the design would need to change, either by thickening the roof and walls or by adding an element to resist horizontal thrust (or both). It is unclear if Judd was aware that potential compromises that would need to be made if the projects went forward. While the structural issues were related to the formal choices, there were other aesthetic problems with the building that were attributable to the concrete material and construction methods of which Judd was certainly aware.

4.2 Construction Complications & Corrections

Like the concrete boxes built years before, Judd faced choices about whether the concrete would be pre-cast or cast on site. These different methods for constructing concrete shells would strongly influence the conceptual design of the shells and the selection of their form and connections (Medwadowski [13]), but in this case, the shell form was selected first and the construction methods were adapted accordingly. The aesthetic standards were elevated to be more in line with the concrete boxes than Judd's remodeled buildings. But the curved geometry of these buildings surfaces and the complicated system of reveals in every surface complicated an already difficult construction procedure. Judd chose to use a combination of pre-cast and cast-in place elements and again counted on Kirk's assistance. Almost immediately after the construction of the first building began, it was clear that achieving a high quality of the concrete would *again* be a challenge (Stockebrand, [18]).

The lack of form-tie holes, the regular gaps between the panels, the visible signs of patching at the intersection of surfaces, and the exposed hook straps on top of the shortest wall indicate that the walls were all tilted up into position. It is unclear whether or not these walls were pre-cast off-site (unlikely given Judd's previous experience with this process and the involvement of Kirk) or simply cast on site and tilted into place. Unfortunately, the aesthetic quality of these first pours was quite poor—visible honeycombing at corners and evidence of incomplete vibration at the edges where aggregate grouped. Unfortunately, the pours for the curved roof surface and edges were worse.

The color of the concrete in the roof panels noticeably varies across the length of the building. One panel looks significantly patched on the top and another has visible grouping of small holes. At the exterior conjunction of the roof and wall, the concrete seems to have pooled at the low point of the vault during construction and exerted so much pressure on the formwork that the edges are actually billowed out instead of the crisp rigid edges along the perimeter. The roof intentionally overhangs the walls by a small distance, perhaps to accommodate a gutter or a drip edge, but this edge was very small and sharp and the concrete has spalled along the entire length (Figure 10A). To even out the textural differences in the surface and the color differential, Judd decided that the finished building would look better if it was completely sandblasted. This solution had the welcome benefit of making the building seem more connected to the land because this sandblasting exposes the aggregate within the concrete that is made of local stone (Figure 10B), but it doesn't hide the pour quality of concrete work.

Figure 10A-10C: (Left to Right), Concrete broken at the roof edge, poorly crafted reveals at outside corner showing evidence of sandblasting on the surface, & a view of the underside of the roof showing the difference in quality in the concrete between the walls and the roof.

The second building is mostly finished, the walls are finished all set in place, one-fifth of the roof is cast and the formwork for another roof section is still setting in place. The quality of the concrete pours in the second building's walls were much better. The edges are sharper and the surfaces are smoother, suggesting that they were cast in a metal pan moldings. The alignment of reveals and pour lines throughout the interior and exterior of the second buildings seems to have been well accomplished in some parts, nearly to the same level of craft as seen in the freestanding works. But the underside of the curved roof surface has inconsistent coloring and surface evidence of the plywood

formwork. These aesthetic issues may seem minor or overly picky, but those are the standards Judd had worked hard to establish for his entire career (Figure 10C).

4.3 Elevated Expectations and Exigent Circumstances

When coupled with the visible evidence of structural potential complications for the additional 8 buildings, may have affected Judd's decision to stop the work. Stockebrand believes that the work stoppage wasn't due to any complications with the structure or fabrication, but instead stemmed from a disagreement Judd had with Kirk about a topic unrelated to the project [18]. Unfortunately, Judd suddenly died a few years later, in 1994, leaving the project in its unfinished state (Comida [2]). It is likely that finishing the project would not have been something Judd would have wanted to happen posthumously. In his will he stated, "It is my hope that my works of art which I own at the time of my death…will be preserved where they are installed" (Temkin [19]). Clearly these buildings would fall under the category of works of art.

5. Creative Resistance to Technical Encumbrances

"..the thing as a whole, its quality as a whole, is what is interesting." – Donald Judd [9]

The completed portions of the buildings are positive examples of what the project could have become but also reminders of the tenuous balance between technical constraints and creative endeavors. If the project were to have continued, it may have involved additional, noticeble compromises of the original design—or perhaps not. It could have become a structurally viable proposal either with large scale adjustments to the form, material, and elevation *or* it simply could have benefited from smaller well-engineered adjustments refinement in portions of the building that are primarily hidden or aesthetically compatible. It is precisely this discourse that makes any creative endeavor so interesting and difficult because there are so many ways to solve the problem.

Whether or not Judd would have altered his design based on technical demands, and what adjustments would be acceptable, gets to the heart of his design ideology that he wrote about in his essays "Art = Architecture" and "Specific Objects" (Judd, [6], [9]). When sculptural works attempt to accommodate structural constraints there may be certain design decisions that may complicate matters, but these need to be measured against a project's larger creative and conceptual goals. In his large scale concrete work, including the remnants of the ten concrete buildings, Judd struggled with this integration of structural and material considerations, partially as a result of his working methodology of drawing and prototyping and the remoteness of the projects. However, just because these works had challenges in their execution, it shouldn't invalidate the efforts. As Judd repeatedly demonstrated throughout the Chinati Foundation campus, technical challenges and design ideals don't need to have opposing trajectories that involve detrimental compromises.

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