

*Strategic convergence and foresight***Juan Seguro**

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ER-496 · Engineering Review · Version 0.1 · 12 October 2026**Abstract**

Construction additive manufacturing and photopolymer manufacturing are both established engineering domains, but the source access available to this review does not establish their convergence. The two held construction-AM reviews concern a field dominated by cementitious extrusion and do not establish photocurable chemistry at construction scale. This review therefore treats the missing join as the result. It identifies the evidence that would be needed before photopolymer manufacturing could be claimed as a construction-scale route: scale-appropriate feedstock handling, cure through the relevant dimensions, exposure and environmental control, structural and durability qualification, repairability, fire and code compliance, and a system-level comparison against established construction processes. A role-specific application map and scale-up assessment distinguish manufacturing aids, interfaces and delivered structural functions.

Keywords: photopolymer manufacturing · construction · additive manufacturing · evidence transfer · scale · cure · durability · codes

1. Scope and architectural position

This review does not claim that photopolymer manufacturing is already a construction-scale process. It asks what the construction-AM literature establishes, why that evidence is not photopolymer evidence, and what would have to be demonstrated to close the gap.

2. Controlled evidence base

The two held sources are broad reviews of additive manufacturing in construction: Paolini, Kollmannsberger and Rank [1], and Forcael et al. [2]. Neither complete review was examined. The institutional abstract of Forcael et al. explicitly includes vat photopolymerisation among the processes discussed; that mention is not a measured construction-scale photocure result. This manuscript therefore uses them only to establish the existence and scope of construction AM as a field, not to infer photocure performance.

3. The missing conjunction

A construction-AM process and a photopolymer process can each be real without evidence that they are technically convergent. The unresolved question in this assessment is whether a directly examined source demonstrates photocurable chemistry at construction scale or in a construction element under relevant structural and environmental conditions. Without that source, a convergence claim would repeat the failure mode identified in ER-411 and ER-466.

4. Scale and feedstock handling

Construction-scale production changes material volume, delivery distance, exposure area, heat and logistics. A future photopolymer route would have to show that its feedstock can be stored, moved, conditioned and delivered at the required scale while maintaining a controlled material state. No such performance is inferred from the held construction sources.

5. Cure and section depth

Photocuring at construction scale would require evidence that the energy-delivery system reaches the intended conversion state across the relevant geometry and exposure environment. Demonstration on a small photopolymer specimen would not establish full-scale cure. The qualification would need spatially resolved cure-state evidence tied to structural properties.

6. Structural performance and durability

A construction element is governed by load path, defects, joints, environmental exposure and service duration. A photopolymer construction claim would therefore need structural tests on representative elements and long-duration durability evidence appropriate to the intended environment. Existing construction-AM evidence cannot be transferred merely because both routes are additive.

7. Codes and acceptance

Construction deployment also requires a route from material/process evidence to the applicable code and approval framework. This article does not assign a specific code because the available evidence does not establish a photopolymer construction application or jurisdiction. The evidence chain must be application- and jurisdiction-specific.

8. Minimum evidence that would close the gap

A defensible convergence claim would require at least one direct source documenting photocurable chemistry used at construction scale or in a construction element. Stronger qualification would additionally require declared feedstock identity, scale, cure-state mapping, structural testing, environmental durability, joining or repair strategy, fire response where relevant, quality control and the applicable compliance route.

9. Minimum reporting set

Report application, scale, geometry, feedstock, photochemistry, exposure system, cure-state verification, process time, structural test method, environmental conditioning, durability interval, repair/joint strategy and regulatory or code context. Separate demonstration feasibility from qualified construction performance.

10. Classify the construction role before transferring evidence

The proposed application map distinguishes a photopolymer used as a manufacturing aid, a surface or interface material, and a constituent of a delivered structural element. These roles create different evidence questions. Demonstrating a printed mold, for example, would

establish a tooling route under the tested conditions, not the service performance of a building element made from the same polymer. A coating demonstration would not establish the load-bearing capacity of a complete assembly.

Each proposed application would therefore identify the delivered object, the photopolymer's function, its exposure conditions and the endpoint required by that function. Evidence from cementitious extrusion could help describe the broader manufacturing context, but it cannot supply the cure state, interface behaviour or performance of a different material route. The map should retain this distinction at the level of individual claims rather than only in a general limitations paragraph.

A candidate application without direct evidence can still be described as a research question. It should not be presented as an established convergence merely because additive manufacturing appears in both fields.

11. A scale-up question with a measurable bridge

The proposed scale-up assessment asks which physical or manufacturing differences arise between the demonstrated object and the intended application. Geometry, exposure access, interfaces, post-processing and use environment may require different observations depending on the role. The analysis would identify the specific difference and the measurement needed to test its consequence, rather than assuming that a larger geometrically similar specimen reproduces the same state.

For a hypothetical reusable mold, an informative study could distinguish initial dimensional agreement from retention over repeated use, while recording the contact and loading history relevant to that use. For a hypothetical bonded interface, the corresponding study would need to examine the interface under its own declared conditions. These examples define study questions; they do not establish a durable mold, an approved construction product or a structural design value.

A stronger evidence base would report unsuccessful scale transitions and the conditions that caused the prior evidence to fail. Such results would be especially useful for distinguishing a feasible manufacturing demonstration from a transferable construction application. The review's contribution is thus a role-specific bridge that can be tested, while numerical design criteria and regulatory suitability remain dependent on the exact application.

Critical synthesis: Construction convergence: deciding what can be transferred

Most construction-scale additive manufacturing evidence concerns cementitious extrusion or other processes rather than vat-cured polymer networks. It can inform questions about site logistics, production traceability or geometric inspection, but cannot establish the fire behaviour, UV weathering, creep or field reparability of a photopolymer structural element. The first requirement is a technology-by-property evidence map: print mechanism, load path, thermal and moisture exposure, component dimension, applicable construction duty and source depth.

A future feasibility programme should begin with the role assigned to the photocurable material: nonstructural interface, sacrificial pattern, functional coating or load-bearing component. Each role has different requirements for bond durability, ageing and regulatory acceptance. For a load-bearing proposal, testing needs to connect cure-depth heterogeneity, anisotropy, defects, sustained loading and environmental degradation; coupon strength alone is inadequate. Claims of environmental advantage similarly require a functional-equivalent life-cycle boundary and documented service life rather than mass of feedstock alone.

Construction-photopolymer evidence transfer: necessary tests

Construction additive manufacturing frequently uses cementitious, mineral or thermoplastic systems whose rheology, curing mechanisms, scale and environmental exposure differ from vat photopolymerisation. The fact that both systems build a shape layer by layer does not transfer compressive strength, durability or environmental performance results from one material family to the other.

For any proposed construction-scale photopolymer component, a defensible experimental programme first defines the intended structural or nonstructural function and expected service environment. It then specifies representative thickness and geometry, exposure and post-cure distribution, interface performance, creep, weathering, fire response where applicable, and degradation under relevant moisture and ultraviolet histories. No acceptance limit should be imported from a different process without demonstrating comparability.

Scaling creates separate constraints for optical penetration, exotherm, residual conversion gradients, oxygen inhibition and dimensional stability. Small-coupon cure success cannot certify a thick component. Use destructive sectioning or validated spatial measurements to quantify heterogeneity before interpreting nominal bulk properties.

Finally, distinguish a conceptual feasibility pathway from a demonstrated building product. Structural design verification, production quality records, applicable code requirements and long-term monitoring are independent layers. In the absence of direct photopolymer construction evidence, the conclusion must remain a research agenda rather than a validated construction application.

Why construction-scale evidence cannot be borrowed from other AM processes

The dominant mechanisms in cementitious extrusion, thermoplastic deposition and vat photopolymerisation are different. Rheological buildability, hydration, thermal welding and light-triggered network formation create noninterchangeable failure modes. Reported strengths or build rates from these processes are unsuitable as direct predictors of thick photocured structural elements. A review should first classify whether the proposed photopolymer article is structural, architectural, protective or a tooling component.

At increased section thickness, light attenuation and nonuniform conversion become central technical variables. Internal cure gradients can interact with shrinkage stress, heat generation, trapped volatiles and adhesion between regions exposed at different times. Mechanical coupon performance may not represent a bulky part with constrained cure. Experimental qualification should map depth-dependent conversion, dimensional evolution, internal defects, creep and relevant environmental exposure using validated spatial sampling.

Durability, fire performance and structural reliability require separate evidence frameworks and applicable codes. Until long-term service and representative-scale validation exist, the defensible claim is feasibility of a research route, not equivalence with existing building products. Explicitly recording the absence of direct photopolymer evidence prevents cross-sector analogy from becoming an unsupported design rule.

Supplementary critical review: evidentiary and qualification boundaries

Transferability test between construction AM and photopolymerisation

The relevant comparison is not whether both domains use three-dimensional geometry, but whether their material consolidation, scale-dependent transport, curing and final performance can be investigated under compatible conditions. Construction additive manufacturing literature is dominated by process and material systems that should not be relabeled as photopolymer evidence. For a proposed construction-scale photocurable route, first identify its exposure geometry, achievable through-cure, optical penetration and environmental boundary conditions. Next define the load-bearing state, the thermal and volumetric consequences of conversion, and how those conditions vary through the intended section thickness. A successful small specimen would not independently validate structural-scale uniformity or in-service durability. These are proposed assessment questions; the two cited construction reviews do not supply experimental answers to them.

Evidence gate for a defensible convergence claim

A direct convergence claim would require a source demonstrating a specified photocurable material and a relevant construction-scale geometry, accompanied by a reproducible process description and property evidence. The minimum decision record should separate process feasibility, geometrical tolerance, cured-state mapping, structural response, weathering and the applicable building-product requirements. Evidence at one gate cannot silently substitute for evidence at another. Material qualification may also depend on substrate interfaces, joining, outdoor exposure and inspection access, all of which are application-dependent. Without direct sources, the responsible conclusion remains a research question rather than either a positive forecast or a categorical declaration of impossibility. This review should be read as an evidence-boundary analysis and not as proof of industry adoption.

12. Limitations

The two retained sources are broad construction-AM reviews. The abstract of [2] includes vat photopolymerisation, but the complete reviews and their underlying photopolymer cases were not examined here. This article therefore makes no claim that photocurable construction has been demonstrated. Its contribution is the transfer boundary and the evidence architecture required to establish the convergence.

13. Conclusions

The source material examined here does not establish photopolymer manufacturing at construction scale; this is a limit of the assessment, not proof of absence across the literature. A convergence claim becomes defensible only when a source joins the two domains directly and when the resulting process is qualified for scale, cure, structure, durability and compliance.

References

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Competing interests

The author is Founder, CEO and CTO of 3Dresyns by Resyner Technologies S.L. The company develops and supplies photoresins and related process materials. No proprietary formulation, manufacturing sequence, process window or comparative product recommendation is disclosed.

Data availability

No new experimental dataset was generated.

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