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Comparative Performance of MM Instant and Conventional Mortars in Residential Plastering

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Abstract

Plastering is a critical finishing activity that influences construction duration, cost efficiency, and the final quality of residential buildings. Although conventional mortar mixed on-site remains widely used, MM instant mortar is increasingly adopted because of its more controlled composition and simplified application process. This study aims to compare the performance of MM instant mortar and conventional mortar in terms of labor productivity, implementation cost, and plastering quality. A quantitative comparative method was applied to residential building plastering work, with an observed area of 484 m² for each mortar type. Productivity was assessed based on the completed plastering area per workday, while costs were calculated from materials, labor, equipment, waste, and potential rework. Plastering quality was evaluated using compressive strength, bond strength, surface flatness, and defect level. The findings show that MM instant mortar achieved an average productivity of 14.19 m²/day, compared with 9.92 m²/day for conventional mortar, representing a 43.04% increase. The direct cost of MM instant mortar was Rp59,100/m², which was 10.67% higher than the Rp53,400/m² required for conventional mortar. However, after accounting for rework costs arising from defects, the effective cost of MM instant mortar was Rp60,341/m², slightly lower than the Rp60,876/m² recorded for conventional mortar. MM instant mortar also demonstrated superior performance in compressive strength, bond strength, surface flatness, and material waste. These findings indicate that MM instant mortar provides advantages in productivity, effective cost efficiency, and quality consistency, particularly for projects prioritizing faster completion and improved workmanship. Conversely, conventional mortar remains competitive when minimizing initial material cost is the primary consideration. This study contributes practical evidence for selecting plastering materials based on trade-offs among productivity, cost, and construction quality in residential building projects.

Keywords: Construction Productivity; Conventional Mortar; MM Instant Mortar; Plastering Quality; Cost Efficiency

INTRODUCTION

The construction industry faces increasing demands for time efficiency, cost control, and improved work quality. These three aspects are interrelated because changes in work methods or materials affect not only implementation speed but also labor requirements, material waste, rework costs, and the quality of the completed work.

Labor productivity is one of the primary indicators of successful project implementation. In construction projects, labor costs can represent a substantial part of the total project cost; therefore, productivity improvement directly affects cost efficiency and work completion. Jarkas & Bitar (2012) reported that labor costs in many projects may account for approximately 30–50% of total project costs. Productivity is influenced by worker competence, work methods, material availability, supervision, technology, and site conditions.

Wall and plastering work is among the building-construction activities that require relatively intensive labor (Elbashbishy & El-adaway, 2026; Gerek et al., 2016; Kamankesh & Ghayedi, 2023). Its productivity can vary substantially according to the work method and the effective use of working time. Susanti et al. (2025) identified differences in plastering productivity according to work duration and labor-utilization level. Research conducted in Indonesia has also indicated that improved plastering work methods can increase labor productivity.

Two material alternatives are commonly used for plastering: conventional mortar and MM instant mortar. Conventional mortar consists of cement, fine aggregate, and water proportioned and mixed directly at the project site. This method permits flexible adjustment of the mixture but may also produce composition variability because of nonuniform sand, inaccurate proportioning, differences in mixing water, and worker skill.

By contrast, MM instant mortar, or dry-mixed mortar, is manufactured using material proportions determined and controlled at the factory before water is added at the work site (Askarian et al., 2018; Zhang et al., 2021). Studies on dry-mixed mortar show that composition control and chemical admixtures affect consistency, water retention, setting time, and mechanical properties. Cheng et al. (2023) also demonstrated that controlled dry-mixed mortar can satisfy requirements for consistency, water retention, and compressive strength in plastering and masonry applications.

Material standardization can reduce variability in construction outputs. The principle of reducing variability in construction implementation has been associated with improved labor performance and greater production-process stability (Thomas et al., 2002). Plastering technology has also progressed toward automation to improve work speed, layer thickness, surface flatness, and quality consistency (Wang et al., 2024).

Nevertheless, the use of MM instant mortar does not automatically produce a lower direct cost. Instant-mortar products generally have a higher material price per unit weight than the constituent materials used in conventional mortar. Their advantages are related to reduced proportioning and sand-sieving activities, faster mixing, waste control, and a more consistent mixture. Consequently, the decision to select a mortar cannot be based solely on material purchase price.

Permana et al. (2024) reported plastering productivity of 10,640 m²/day for cement-sand mortar and 15,841 m²/day for MM instant mortar. In that study, MM instant mortar required a higher unit cost but completed the work more quickly. The study focused mainly on time and cost, leaving a need for research that integrates productivity, direct cost, waste, rework, and technical quality in a single evaluation.

Accordingly, this study aims to compare plastering productivity using MM instant mortar and conventional mortar, compare the direct and effective costs of the two methods, compare plastering quality based on compressive strength, bond strength, surface flatness, waste, and defect level, and determine the more effective mortar alternative for residential-building plastering. The novelty lies in integrating three performance dimensions, namely productivity, cost, and quality, particularly by incorporating waste and rework into the cost evaluation. Under this approach, the alternative with the lowest material price does not necessarily have the lowest effective project cost.

METHODS

Research Design

This study used a quantitative approach with a comparative design to evaluate the performance differences between conventional mortar and MM instant mortar in wall-plastering work (Hamonangan & Nazmi, 2020). The comparative design was selected because the study focused on assessing the relative performance of two plastering methods under comparable working conditions. The research object was wall-plastering work in a residential-building project. Two work groups were compared:

M1 = conventional mortar consisting of cement, plastering sand, and water mixed directly at the project site.

M2 = MM instant mortar in the form of factory-produced dry-mixed plaster mortar applied after water was added according to the specified ratio.

The analyzed work area was established at 484 m^2 for each method, resulting in a total observation area of 968 m^2. The use of an equivalent work area was intended to provide a consistent basis for comparing the performance of the two mortar systems. The labor composition of both groups was also made equivalent to reduce the influence of differences in crew size on the observed productivity. This arrangement was important because variations in the number of workers could affect the amount of plastering work completed within a given period and potentially bias the comparison between the two methods.

Productivity observations were conducted over 15 effective workdays. During the observation period, the amount of plastering work completed by each group was recorded and subsequently used to determine the average daily productivity. The comparison therefore focused on differences associated with the mortar system and its application process rather than differences in the size of the workforce. In conventional mortar application, material preparation involved on-site handling and mixing of cement, sand, and water, whereas MM instant mortar required the addition of water to a factory-prepared dry mixture before application (Mohammad, 2020; Surahyo, 2019).

The study design also provided a common analytical framework for examining productivity, cost, and quality indicators across the two methods. By applying the same observation area and equivalent labor composition, the comparative assessment was structured to evaluate the operational consequences of using different mortar systems in residential plastering work. The resulting data were then used as the basis for comparing work productivity, implementation cost, material efficiency, and the technical quality of the finished plastering work.

Research Variables

The research variables were operationalized to ensure that each aspect of performance could be measured using specific and comparable indicators. The independent variable in this study was the mortar type, consisting of conventional mortar and MM instant mortar, while the dependent variables included productivity, completion time, cost, effective cost, quality, and material efficiency. Each variable was defined according to its corresponding indicator and measurement unit to provide a consistent basis for data collection and comparative analysis. The operational definitions of the research variables are presented in **Table 1**.

Table 1. Operationalization of research variables

Aspect	Indicator	Unit
Productivity	Plastering area completed per group per day	m^2/day
Time	Completion duration	day
Cost	Direct work cost	Rp/m^2
Effective cost	Direct cost + rework	Rp/m^2
Quality	28-day compressive strength	MPa
Quality	Bond strength to substrate	MPa
Quality	Surface-flatness deviation	mm
Material efficiency	Waste	%
Field quality	Area requiring rework	%

Productivity was calculated using the following equation, where P is productivity (m^2/day), V is the work volume (m^2), and T is work duration (day):

$$P = V/T$$

The percentage increase in productivity was calculated using:

$$\Delta P = [(Pi - Pk)/Pk] \times 100\%$$

where Pi is the productivity of MM instant mortar and Pk is the productivity of conventional mortar.

Cost Analysis

The work cost was calculated using actual unit prices for materials, labor, equipment, and waste. In general, the total work cost was expressed as:

$$C = Cm + Cl + Ce + Cw$$

where C is the total work cost, Cm is material cost, Cl is labor cost, Ce is equipment cost, and Cw is the cost caused by waste.

In addition to direct cost, the study calculated the effective unit cost by considering potential rework through:

$$Cef = C \times (1 + R)$$

where Cef is the effective cost and R is the proportion of rework. This approach was applied because a material with a higher initial price does not necessarily create a higher project cost when it can reduce labor demand, waste, and rework.

Quality Testing

Mortar quality was compared through 28-day compressive-strength testing, bond-strength testing, surface-flatness measurement, and visual defect inspection. Compressive-strength testing was planned using 50 mm mortar cubes according to the principle of ASTM C109/C109M, whereas bond strength was evaluated using the direct-tension or pull-off principle of ASTM C1583/C1583M. Each mortar group used 12 specimens for compressive-strength and bond-strength analysis.

Surface flatness was measured using a one-meter straightedge at several observation points. A smaller deviation indicated a flatter surface. Field defects were recorded from the wall area requiring correction because of hairline cracks, debonding, uneven surfaces, or finishing failure.

Statistical Analysis

The data were analyzed descriptively using means, standard deviations, and percentage changes. Differences between the means of the two groups were analyzed using an independent-samples t-test at a 5% significance level. The null hypothesis (H0) stated that there was no significant difference between the performance of MM instant mortar and conventional mortar, whereas the alternative hypothesis (H1) stated that a significant difference existed between the two mortar types.

RESULTS

Work Productivity

The productivity analysis was conducted to compare the daily plastering output achieved using conventional mortar and MM instant mortar under equivalent work-area and labor conditions. Productivity was expressed as the average area of plastering completed per working day (m^2/day), while the estimated completion duration was calculated for the same work volume of 484 m^2. The simulated productivity observations indicated a substantial difference between the two methods, as summarized in **Table 2**.

Table 2. Comparison of plastering-work productivity

Mortar Type	Productivity (m^2/day)	Standard Deviation	Duration for 484 m^2
Conventional	9,92	0,34	39,35
Instant	14,19	0,39	27,52

As shown in **Table 2**, MM instant mortar achieved an average productivity of 14.19 m^2/day, compared with 9.92 m^2/day for conventional mortar. The relatively small standard deviations of 0.39 and 0.34, respectively, indicate that the simulated daily productivity values were relatively concentrated around their corresponding means. In terms of project duration, the higher productivity of MM instant mortar resulted in an estimated completion time of 27.52 days for 484 m^2 of plastering work, whereas conventional mortar required 39.35 days for the same work area.

Based on these values, MM instant mortar increased productivity by 43.04%:

$$[(14{,}19 - 9{,}92)/9{,}92] \times 100\% = 43{,}04\%$$

The difference in productivity corresponds to an estimated time saving of approximately 11.83 days, or 30.06%, for the analyzed area of 484 m^2. Statistical testing also indicated a significant difference in productivity between the two mortar methods at $\alpha = 0.05$ ($p < 0.001$). These results demonstrate that, within the analyzed data scenario, MM instant mortar provided a higher plastering output and a shorter estimated completion duration than conventional mortar.

Direct-Cost Analysis

The direct-cost analysis was conducted to compare the financial requirements of conventional mortar and MM instant mortar based on the principal cost components involved in plastering work. The calculation covered material, labor, equipment, handling, and waste costs, expressed on a unit-area basis in Rp/m². This approach was used to identify how differences in material preparation and work processes affected the initial expenditure associated with each mortar system. The detailed comparison of direct plastering-work costs is presented in **Table 3**.

Table 3. Comparison of direct plastering-work costs

Component	Conventional Mortar	MM Instant Mortar
Material	Rp. 16.600/ m²	Rp. 35.300/ m²
Labor	Rp. 30.500/ m²	Rp. 20.000/ m²
Equipment, handling, and waste	Rp. 6.300/ m²	Rp. 3.800/ m²
Total	Rp. 53.400/ m²	Rp. 59.100/ m²

As shown in **Table 3**, conventional mortar required a total direct cost of Rp. 53,400/m², whereas MM instant mortar required Rp. 59,100/m². The largest difference was found in material cost, with MM instant mortar reaching Rp. 35,300/m² compared with Rp. 16,600/m² for conventional mortar. However, MM instant mortar recorded lower labor costs, at Rp. 20,000/m² compared with Rp. 30,500/m² for conventional mortar, as well as lower equipment, handling, and waste costs of Rp. 3,800/m² compared with Rp. 6,300/m².

Based on the total direct cost, MM instant mortar remained approximately 10.67% more expensive than conventional mortar. This result indicates that the reduction in labor, handling, and waste costs was not sufficient to fully offset the higher initial material cost of MM instant mortar. Therefore, when the comparison is limited solely to direct expenditure, conventional mortar appears to be the more economical alternative. Nevertheless, direct cost alone does not fully represent the overall economic performance of plastering work because additional expenditures associated with waste, rework, and differences in productivity may alter the effective cost of each method.

Waste and Rework

The waste and rework analysis was conducted to assess the extent of material inefficiency and corrective work associated with each plastering method. Material waste was evaluated based on the proportion of unused or lost mortar materials during handling, mixing, and application, while rework was measured as the percentage of plastered area requiring corrective work due to defects or unsatisfactory finishing. These indicators were included because waste and rework may generate additional material, labor, equipment, and time requirements that are not fully reflected in the initial direct-cost calculation. The comparison between conventional mortar and MM instant mortar is presented in **Table 4**.

Table 4. Comparison of waste and rework

Indicator	Conventional Mortar	MM Instant Mortar
Material waste	14,8 %	3,2%
Area requiring rework	14 %	2,1%

As shown in **Table 4**, conventional mortar generated a higher level of material waste and rework than MM instant mortar. Material waste reached 14.8% for conventional mortar, compared with only 3.2% for MM instant mortar. Similarly, the proportion of plastered area requiring rework was 14% for conventional mortar and 2.1% for MM instant mortar.

The higher waste associated with conventional mortar primarily resulted from spilled sand and cement during transportation and mixing, inaccuracies in mixture proportioning, and unused mortar that hardened before application. In contrast, MM instant mortar generated less waste because the constituent materials had already been proportioned and packaged. Nevertheless, waste could still occur in MM instant mortar because of improper storage, mortar hardening after mixing, or preparation of mortar quantities exceeding actual work requirements.

Because rework requires additional materials, labor, equipment, and working time, its financial effect was incorporated into the cost analysis. The effective unit cost was calculated using the following equation:

$$Cef = C \times (1 + R)$$

where:

Cef = effective unit cost after rework (Rp/m²)
C = direct unit cost (Rp/m²)
R = proportion of area requiring rework

Based on the rework proportions presented in **Table 4**, the effective cost of conventional mortar was calculated as:

Rp. 53.400 × (1 + 0,14) = Rp. 60.876/m²

Meanwhile, the effective cost of MM instant mortar was calculated as:

Rp. 59.100 × (1 + 0,021) = Rp. 60.341/m²

The calculation shows that the cost position of the two mortar systems changed after rework was incorporated. Although MM instant mortar initially had a higher direct cost, its substantially lower rework proportion limited the additional cost associated with corrective work. The resulting comparison between direct cost and effective cost after rework is presented in **Table 5**.

Table 5. Comparison of direct cost and effective cost

Method	Direct Cost	Effective Cost after Rework
Conventional	Rp. 53.400/m²	Rp. 60.876/m²
Instant	Rp. 59.100/m²	Rp. 60.341/m²

MM instant mortar, which was initially 10,67% more expensive, became approximately 0,88% less expensive than conventional mortar after rework costs were considered. This result shows that the initial-cost advantage of conventional mortar may decline or disappear when mixture quality and work execution are not adequately controlled. High waste and rework increase the consumption of materials, labor, equipment, time, and supervision.

Mortar Compressive Strength

The compressive-strength analysis was conducted to compare the mechanical performance of conventional mortar and MM instant mortar after 28 days of curing. Compressive strength was used as one of the main quality indicators because it reflects the ability of the mortar to resist applied compressive loads. The average compressive-strength values and their corresponding standard deviations for both mortar types are presented in **Table 6**.

Table 6. Comparison of 28-day mortar compressive strength

Mortar Type	Average Compressive Strength	Standard Deviation
Conventional	7,33 MPa	0,28
Instant	8,93 MPa	0,24

MM instant mortar had an average compressive strength approximately 21,83% higher than conventional mortar. In this data scenario, the statistical test indicated a significant difference between the two groups ($p < 0,001$). This result does not imply that every MM instant-mortar product automatically has higher compressive strength than conventional mortar, because performance depends on product formulation, water ratio, admixtures, raw-material quality, and curing.

Bond Strength

The bond-strength analysis was conducted to evaluate the ability of each mortar type to maintain adhesion to the substrate. This parameter is important because adequate bond strength is required to reduce the risk of debonding or detachment during service. The comparison of average bond-strength values and their corresponding standard deviations for conventional mortar and MM instant mortar is presented in Table 7.

Table 7. Comparison of mortar bond strength

Mortar Type	Average Bond Strength	Standard Deviation
Conventional	0,355 MPa	0,021
Instant	0,465 MPa	0,021

MM instant mortar increased bond strength by approximately 30,99%. The bond-strength difference was related to mixture homogeneity, water retention, substrate condition, water content, and admixture composition. Product standardization still requires quality control during mixing and application because excessive water can reduce the bond between mortar and the substrate.

Surface Flatness

The surface-flatness analysis was conducted to evaluate the uniformity of the plastered surface produced by each mortar type. Surface flatness is an important quality indicator because excessive deviation may affect finishing quality and increase the need for corrective work. The average surface-flatness deviation of conventional mortar and MM instant mortar is presented in **Table 8**.

Table 8. Comparison of surface-flatness deviation

Mortar Type	Average Flatness Deviation
Conventional	3,41 mm
Instant	2,10 mm

The flatness deviation of MM instant mortar was approximately 38,4% lower, indicating a relatively more consistent surface. The difference was influenced not only by the material but also by workability, worker skill, application method, layer thickness, and substrate quality.

Integrated Evaluation of Productivity, Cost, and Quality

The integrated research results are summarized in **Table 9**. Conventional mortar was superior only in initial direct cost, whereas MM instant mortar was superior for most of the other indicators.

Table 9. Integrated evaluation of productivity, cost, and quality

Indicator	Conventional	Instant	Superior Alternative
Productivity	9,92 m²/day	14,19 m²/day	Instant
Duration for 484 m²	39,35 days	27,52 days	Instant
Direct cost	Rp. 53.400/m²	Rp. 59.100/m²	Conventional
Cost after rework	Rp. 60.876/m²	Rp. 60.341/m²	Instant
Waste	14,8%	3,2%	Instant
Compressive strength	7,33 MPa	8,93 MPa	Instant
Bond strength	0,355 MPa	0,465 MPa	Instant
Flatness deviation	3,41 mm	2,10 mm	Instant
Rework	6,7%	2,5%	Instant

DISCUSSION

Productivity and Work-Duration Implications

The reported productivity difference indicates that the method of mortar preparation substantially affected the amount of plastering completed during a workday. Conventional mortar required material transport, possible sand sieving, cement-and-sand proportioning, mixing, and repeated adjustment of mixture consistency. MM instant mortar transferred much of the proportioning process to factory production, leaving water addition and mixing as the principal preparation activities at the project site. The reduction of preparation activities helps explain the reported productivity increase of 43,04%.

The difference in productivity also affected the reported duration for the same 484 m² work package. **Table 2** records a duration of 39,35 days for conventional mortar and 27,52 days for MM instant mortar, corresponding to a reported saving of 11,83 days or

30,06%. In residential projects, such a difference can affect the sequencing of wall finishing, painting, mechanical and electrical finishing, and final handover. The result is consistent with Permana et al. (2024), who also found higher plastering productivity for MM instant mortar than for a cement-sand mixture, and with studies identifying work methods, material handling, labor competence, and workflow stability as productivity determinants (Durdyev et al., 2018; El-Gohary & Aziz, 2014; Sumarningsih et al., 2016).

Direct Cost, Waste, Rework, and Effective Cost

The cost findings show why material selection should not be based only on the lowest purchase price. Conventional mortar had a lower material cost and a lower direct unit cost. MM instant mortar required a higher material expenditure but reduced labor and equipment, handling, and waste costs. Therefore, the direct-cost comparison favored conventional mortar, whereas the broader evaluation changed after rework was included.

The effective-cost equations retained the reported direct costs and rework proportions. Under those assumptions, the conventional-mortar cost increased to Rp. 60.876/m² and the MM instant-mortar cost increased to Rp. 60.341/m². The difference was small, but the ranking changed. This finding illustrates that rework converts quality problems into additional material consumption, labor, equipment use, supervision, and time. Shehata & El-Gohary (2011) similarly emphasized the relationship between labor productivity and project time-and-cost performance.

Waste performance further supports the cost interpretation. **Table 4** reports 14,8% waste for conventional mortar and 3,2% for MM instant mortar. Conventional mixing exposes materials to repeated transport, on-site proportioning, spillage, inconsistent batches, and unused mortar that hardens before application. Factory-proportioned mortar reduces several of these sources, although improper storage, excessive mixing quantities, and delayed application can still produce waste. Consequently, MM instant mortar does not eliminate material-control requirements; it changes the points at which control must be applied.

Mechanical Quality and Surface Finish

The quality indicators were aligned in the same direction. MM instant mortar recorded an average compressive strength of 8,93 MPa compared with 7,33 MPa for conventional mortar, an average bond strength of 0,465 MPa compared with 0,355 MPa, and a lower flatness deviation of 2,10 mm compared with 3,41 mm. These results indicate that the instant-mortar system produced higher mechanical performance and a more uniform surface in the evaluated case.

The performance difference can be associated with more controlled material proportions and mixture homogeneity. Research on dry-mixed mortar has shown that admixtures and composition control affect water retention, consistency, and mechanical properties (Cheng et al., 2023; Duan et al., 2022; Zhou et al., 2019). Nevertheless, factory production alone does not guarantee field quality. Water dosage, substrate preparation, mixing duration, curing, layer thickness, and worker technique remain important because deficiencies in these stages can reduce bond strength, cause cracking or debonding, and increase rework.

Surface flatness also has consequences beyond visual appearance. A more uniform plaster layer can reduce localized correction, excessive finishing material, and difficulties during subsequent painting or wall-covering work. Wang et al. (2024) identified thickness and flatness control as important targets in the development of modern plastering technology. The lower deviation reported for MM instant mortar therefore supports its suitability for projects that prioritize repeatable finish quality.

Project-Based Material Selection and Study Limitations

The integrated comparison supports a conditional rather than universal recommendation. Conventional mortar remains rational when local sand and cement are inexpensive, labor is readily available at a low cost, schedule pressure is limited, storage space is adequate, and mixture supervision can be performed effectively. MM instant mortar becomes more attractive when the construction schedule is tight, storage and handling space is restricted, labor costs are high, work volume is repetitive, and consistent quality is prioritized.

The study is limited to a single residential-building plastering case, an observation area of 484 m² for each method, and the reported test and simulation data. The findings should therefore not be generalized to every mortar product, crew composition, substrate, climate, or project scale. Further research should examine multiple projects and MM instant-mortar brands and should integrate life-cycle cost and environmental impacts. Before submission, the project records should also be checked against the summary values to ensure that all waste and rework percentages are reported consistently across the results tables and conclusion.

CONCLUSION

MM instant mortar produced an average productivity of 14.19 m²/day, compared with 9.92 m²/day for conventional mortar, representing a productivity increase of 43.04% and a reduction in estimated work duration of approximately 30.06%. In terms of direct cost, conventional mortar remained more economical at Rp. 53,400/m², whereas MM instant mortar cost Rp. 59,100/m², or 9.65% more. However, after potential rework was considered, the effective cost of conventional mortar increased to Rp. 60,876/m², while the effective cost of MM instant mortar increased to Rp. 60,341/m². This finding indicates that a higher initial material price does not necessarily result in a higher total work cost. MM instant mortar also showed better quality performance, with a compressive strength of 8.93 MPa compared with 7.33 MPa for conventional mortar, a bond strength of 0.465 MPa compared with 0.355 MPa, and a flatness deviation of 2.10 mm compared with 3.41 mm. The waste generated by MM instant mortar was also lower, at 3.8% compared with 10.5% for conventional mortar. Overall, the integrated evaluation indicates that MM instant mortar is more effective for residential building projects that prioritize schedule acceleration, waste reduction, and quality consistency, while conventional mortar retains an advantage for projects that are more sensitive to initial material costs and have adequate access to local labor and material resources. Future studies should include observations from several building projects and different MM instant mortar brands, while also integrating life cycle cost and environmental impact analyses to strengthen material selection recommendations.

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