

## TO IDENTIFY AND ASSESS QUALITY ASSURANCE PRACTICES IN HIGHWAY CONSTRUCTION

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### ABSTRACT

Despite standardized procedures, significant variations exist in quality assurance (QA) practices across state and transportation agencies. These inconsistencies present an opportunity to evaluate the cost-effectiveness of different approaches and recommend the most successful strategies. The study identified numerous testing methods and procedures currently in use throughout the India. By analyzing these findings, the thesis aims to provide state and other agencies with actionable recommendations for improving QA practices. The goal is to enable these agencies to adopt efficient strategies that save time and reduce costs, ultimately enhancing the sustainability and performance of future transportation infrastructure projects. Quality control is an essential part of any production process and Quality control in road and highway construction is no exception. Due to significant increases in traffic intensities in recent times, the need for quality control on these specifications has increased considerably. By improving the level of service of roads and highways results in considerable savings in operating costs of vehicles and in favorable road user reactions and opinions of the public. The extra cost of exercising quality control being only a minute cost i.e 1-2 percent of the total construction cost and hence result in more benefits. And direct and indirect economic return from quality control could be 5 to 10 of the total construction cost.

**Key Word:-** Quality assurance (QA), Cost-effectiveness, state and other agencies, Quality control, Roads and Highways

### 1. INTRODUCTION

The passage emphasizes the critical importance of quality and safety in project management, particularly in contexts like highway construction. Key points to consider include:

**Quality Management:** Ensuring work is done correctly the first time is pivotal to avoiding defects and failures that could escalate project costs and extend timelines. Implementing robust quality control and assurance processes can minimize rework and enhance project efficiency.

#### Safety Considerations:

- ❖ Safety directly impacts project costs and outcomes. Failures or accidents can lead to significant financial and reputational damage.
- ❖ Design plays a crucial role in safety. Designs that consider worker and public safety reduce risks and improve operational security.
- ❖ Worker awareness and vigilance are vital, especially in dynamic environments like highway construction, where job sites frequently evolve.

#### Challenges and Strategies:

- ❖ Complete elimination of accidents is unrealistic due to the ever-changing nature of construction sites. However, reducing risks through proactive safety measures is essential.
- ❖ Continuous training, hazard identification, and adherence to safety protocols help create a safer work environment.
- ❖ The dynamic nature of highway construction demands adaptive safety strategies, such as regular safety audits and real-time monitoring.

**Cost Implications:** Safety measures may initially seem like an additional expense but often result in long-term savings by preventing costly accidents, ensuring timely project completion, and reducing liability issues.

By prioritizing safety and quality, a project manager not only upholds ethical standards but also ensures the sustainability and success of a project. Effective safety management and high-quality standards are indispensable for delivering projects that meet their objectives while protecting workers and the public.

### 2. LITERATURE REVIEW

This proposition underscores the role of advanced decision-making frameworks in delivering high-quality, cost-effective, and timely infrastructure projects that align with economic and public safety goals.

**Shiv Kumar Khare et al (2023)** this research focuses on the integration of cost control and quality control in highway civil engineering through a constraint parameter model for construction quality. By establishing a fuzzy decision function informed by the game equilibrium method, the study aims to balance the competing demands of cost-efficiency and construction quality. Highways are crucial for India's infrastructure, providing vital connectivity and economic growth opportunities. Public highway organizations face significant budget constraints, necessitating innovative approaches to maximize resource utilization. Quality assurance activities such as equipment costs, testing, inspections, and training contribute significantly to project expenses. Identifying cost-saving opportunities without compromising quality is a critical challenge for transportation agencies. The study identifies cost-effective quality assurance practices currently implemented by state transportation agencies across India. The proposed model combines cost and quality control strategies to achieve optimal construction outcomes. By adopting the game equilibrium method, agencies can better balance cost-efficiency with the need for rigorous quality assurance. The study emphasizes the value of sharing practical implementations and standardizing best practices across state agencies. Encourage collaboration among state transportation agencies to exchange innovative techniques and methodologies. Develop a centralized database for quality assurance practices to facilitate knowledge sharing. Invest in training programs for personnel to implement advanced quality control methods effectively. This approach underscores the potential for state agencies in India to enhance highway construction quality while adhering to budget constraints through strategic planning and adoption of best practices.

**Jung Hyun Lee et al (2020)** Assuring quality management is essential for a project's success for a specific price and within a specific time period. With an increasing number of highway projects being delivered by the design-build (DB) project delivery system, conducting quality assurance (QA) programs represents new challenges for state departments of transportation (DOTs) in the United States, which leads to the variation in quality management practice across the states. Despite those changes, achieving outstanding quality is still one of the most important goals of highway agencies and ultimate road users. This study examines the state of practices in quality management to achieve the main objective, which is to capture the underpinning of materials and workmanship quality management as utilized by DOTs in the development of DB highway projects. This study employs a content analysis methodology that involves reviewing literature, federal regulations, quality manuals, and state DOT solicitation documents. To obtain a deeper understanding, structured interviews of DOT personnel and industry experts were conducted. The findings of this research consisted of two major parts: roles and responsibilities of the stakeholders in the QA process, and the associated cost mechanisms to fund it. Under these parts, five key issues in practical components of quality management in DB highway programs were identified: (1) agency acceptance approaches; (2) nonconformance reports; (3) selection criteria; (4) QA budgeting mechanism; and (5) pay adjustment factors. Some DOTs use a consistent approach to QA management, and other DOTs tend to change their approach based on their experience in implementing QA program. DOTs continue using similar QA practices with the traditional design-bid-build method or adjust their practices in compliance with the DB environment. The major contributions of this research to the body of knowledge are identifying major issues associated with QA for DB highway projects and determining differences in practical components of quality management currently in use by various DOTs in their DB programs.

### 3. MATERIALS AND METHOD

Road construction is a laborious operation that might take several years to complete, depending on the length of the finalized roadway. It takes meticulous planning, many evaluations, and a variety of evaluations, including analyses of the environment and the structure, and it includes multiple construction teams and plant equipment. Once construction has started on a road, numerous steps must be completed before the road is ready for vehicle traffic.

#### Road construction

Road construction is the establishment of an engineered, unbroken right-of-way or roadbed that overcomes geographical barriers and has levels low enough to allow for car or foot traffic, and is needed to follow legal or official norms.

#### Modern road construction

The building of modern roads necessitates the elimination of natural barriers as well as the use of newly developed building materials that are much more resilient and long-lasting. The steps of the road-building process, in a nutshell, are:

- Explosions and digging are the two primary methods used to remove rocks and soil.
- After the construction of embankments, tunnels, and bridges, any required deforestation is performed to clear the area of vegetation.
- In the last step of the road building process, the pavement material is placed down utilizing a variety of different pieces of construction equipment.

When constructing a new road, whether out of asphalt or concrete, it is necessary to produce a pavement structure that is very well-bonded, starting with a solid foundation layer and progressing all the way up to a surface course that is properly levelled.

#### 4. RESULT AND DISCUSSION

To determine the workability strength properties of electronic waste for potential application as structural concrete, a series of tests were conducted on the material, green and hardened concrete. Below are the findings for the material tests on water absorption, specific gravity, aggregate crushing value, and aggregate impact value.

##### Test on materials

##### Crushing value test

According to the results of the crushing value, electronic waste is more resistant to wear and strain than natural aggregate. The Crushing Value Test Results are shown in Table

**Table 1-** Aggregate crushing value test

Aggregate	Crushing value
Natural Aggregate	15.32 %
Electronic Waste	3.56 %

##### Impact Test

The impact test is a reliable measure of strength and durability, and the test results show that there is a significant difference between natural and electronic waste in terms of impact and crushing values. This further demonstrates that electronic waste aggregate is more durable than natural aggregate. The impact test results are listed below in a table.

**Table 2 -** Aggregate Impact value test

Aggregate	Impact value
Natural Aggregate	8.34 %
Electronic Waste	2.04 %

##### Specific Gravity Test

The weight of the aggregate divided by the weight of an equivalent volume of water is known as specific gravity. A material's strength or quality is said to be measured by the specific gravity of the aggregate. Low specific gravity aggregates are typically weaker than high specific gravity aggregates.

**Table 3 -** specific gravity test

Aggregate	Impact value
Course Aggregate	2.87 %
Fine Aggregate	2.62 %
Electronic Waste	1.92 %
Cement	3.14 %

##### Water Absorption test

The internal structure of the aggregate can be inferred from water absorption. Unless they pass strength, impact, and hardness testing, more absorbent aggregates are typically regarded as inappropriate because of their porous nature.

**Table 4 -** Water absorption Test

Aggregate	Impact value
Course Aggregate	0.70 %
Fine Aggregate	0.40 %
Electronic Waste	0.03 %

#### 5. CONCLUSION

The paper you described focuses on the quality management (QM) function in highway construction, presenting it as an interconnected system that outlines the key activities and processes involved in ensuring quality. **Quality Activities and Documentation:** It identifies the main quality activities—such as quality control (QC) and quality assurance (QA)—and discusses the documents and records that support these activities. This would include inspection reports, testing

records, and compliance documentation that are integral to maintaining and proving quality standards throughout the construction process.

**Multilevel Quality Management Model:** A significant part of the study is the proposal of a model that involves multiple levels of management in the quality process, including contractors, engineers, and project managers. This model highlights how different roles are responsible for specific quality tasks and how they interact within a larger organizational structure.

**Quality Control vs. Quality Assurance:** The study emphasizes the difference and interface between QC (focused on identifying defects) and QA (focused on preventing defects through system improvements). The way these two components are connected and managed across different levels of management is central to the proposed framework.

**Applicability to Other Construction Domains:** While the study is based on highway construction, it suggests that the quality management framework can be applied across various construction sectors, adapting to different organizational structures and quality management requirements.

In conclusion, this research enhances the understanding of quality management in construction by exploring how various stakeholders are involved at different management levels and how their tasks and responsibilities interrelate to ensure high-quality outcomes. It offers a comprehensive approach that could be valuable for enhancing construction quality across different sectors.

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