Cost of Poor Quality Form

User Manual

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Introduction

What is Cost of Poor Quality?

Cost of Poor Quality (COPQ) is the total cost to the company as a result of internal and external failures or deficiencies of ready mixed concrete. COPQ is calculated in dollars for each cubic yard of sales.

Why should we calculate COPQ?

Any company interested in improving their revenues and profits should consider quantifying the COPQ as outlined here. COPQ is used as a tool for focusing attention on the company's quality management system (QMS). By investing and implementing better quality practices, a company can reduce its COPQ and increase profitability. Establishing the company's reputation as a higher quality supplier in the local market will help increase revenue. COPQ is a tool to identify areas of continuous improvement and to track year over year trends.

How do I implement the calculation of COPQ in my company?

The NRMCA recommends that COPQ should be established and documented by the accounting department. This establishes a credible process evaluated by a company entity not directly connected to the responsible departments. COPQ should be a line item in a company's chart of accounts as it represents a cost along with other items that impacts profitability. Including accounting line items in the company's chart of accounts makes this a routine process. The details of costs should; however, be established in concert with all company entities that contribute to it.

Is COPQ reflective of the quality department?

A high COPQ value is not directly reflective of the performance of the quality department. This is similar to a loss on the company balance sheet not being reflective of the accounting department. The quality department may not have responsibility or authority to purchase, manufacture, or to establish pricing and generate sales; and thereby cannot be responsible for problems or costs associated with those functions. The quality department should be given the responsibility to identify factors and to design a quality improvement program to reduce COPQ. Implementation of the quality improvement program requires management commitment and the joint efforts of all company personnel in operations, purchasing, and sales.

How to calculate COPQ?

COPQ is typically defined in a much broader manner, i.e., the cost associated with failures for any activity undertaken by the company. For example, lack of driver pre-trip inspections may result in equipment breakdown or road calls; poor directions to a jobsite and improper signage may result in increased fuel costs and longer haul time and associated delivery cost. These are examples of failure/non-conformance associated with operations. Similarly, incorrect invoicing represents a deficiency of accounting and incorrect price quotes is a failure of the sales department.

The NRMCA RES committee decided not to define COPQ in such broad terms. Instead, COPQ is defined as the total cost of failures related to poor concrete material quality only. This may be broadly stated as occurrences when concrete fails to meet the quality or performance requirement in the purchaser's order or project specification. It could also include occurrences when company-defined quality objectives are not met, or benchmarks are exceeded. While this document provides general guidance on this, the company should specifically define what constitutes a failure.

COPQ is comprised of internal and external failure costs.

Internal failure costs are incurred when defects are realized before the product is delivered to the customer. These include costs due to incorrect materials accepted/stored, dealing with concrete materials received that do not meet specifications when tested, production errors in batching, costs due to time spent in adjusting mixtures due to systemic errors, lost loads due to wrong or unapproved mixtures dispatched, dispatcher's failure to cancel order, delayed arrival at jobsite, etc.

External failure costs are incurred to address defects discovered by customers. These include rejected concrete loads, back charges, corrective action attributed to incorrect concrete placed, removal and replacement, etc.

For the COPQ calculation, the NRMCA has identified costs associated with fifteen internal and external failures.

Using the COPQ Form

This tool can be used to calculate COPQ for an individual plant, a division, an entire company, or any other grouping of plants. Some general information is needed for the form to work. Total annual yardage, total number of loads, and the average sale price per cubic yard are required inputs.

The form breaks the fifteen failure costs into 4 areas of operations:

- Failures due to ingredient materials at the plant
- Failures due to design, batching, or plant issues
- Failures due to issues discovered on the jobsite or with placed concrete
- Lagging internal costs

You do not need data for all 15 items for the form to be useful. You can focus efforts on 1 or 2 of the areas listed above or tackle the entire form.

It is understood that every company will track the data needed to calculate COPQ differently. It may come from dispatchers diverting an improperly batched load, batch personnel adjusting a load in the yard, or salesman who fields the call about a finishing issue on the job. Excellent communication and coordination are required in order to gather the necessary information. In many cases, the exercise of initially pulling the information together is a valuable learning experience.

In the following sections, each of the 15 failure costs will be broken down and will identify the necessary information needed to calculate that cost.

In the spreadsheet, there is a "What's This" button next to each cost. By clicking that button, it will pull up a help tab to give more information on the calculation.

Failures due to Ingredient Materials at the Plant

1. Incorrect Ingredient Materials Accepted/Stored
    - Costs incurred from returning an incorrect shipment or staff/equipment time to correct the error
    - For example, accepting 3/4-in. aggregate when 3/8-in. aggregate was ordered or pumping fly ash into a cement silo
    - Costs are calculated based on the annual number of occurrences and the average cost per occurrence
2. Cost of Handling Ingredient Materials that do not Meet Specifications

- Costs incurred from handling materials that do not meet specifications
- For example, dealing with an aggregate stockpile that didn't meet gradation
- Costs are calculated based on the annual number of occurrences and the average cost per occurrence

Failures due to Design, Batching or Plant Issues

3. Cost due to Concrete Loads Batched Incorrectly and Discovered PRIOR to Delivery
    - This could be incorrect mixtures (non-air mix was instead of air, wrong aggregate, etc.) or batch weights (incorrect cementitious content, etc.). These occurrences are when the batched concrete cannot be adjusted and delivered because it will not meet the order or specification.
    - Includes cost of discarding the load or the discounted price of the diverted load.
    - Costs calculated require the annual number of occurrences, the average sale price per cubic yard, the number of loads (or volume) diverted to other jobs, and the average discounted price per yard of diverted concrete.
4. Cost of Adjusting Concrete Mixtures at the Plant
    - This is different from cost #3. For these occurrences, the batch can still be adjusted and sent to the same job.
    - For example, adding water or admixture to correct the slump
    - Quantify the time to adjust the load
    - Costs are calculated based on the number of loads corrected each year, the average time (in minutes) to correct the load, and the average delivery cost – consider using $1.25/minute that is an industry benchmark in NRMCA surveys.
5. Over-Yielding and Cement Over Batching
    - This is a failure cost that tracks both over yielding and cement over batching for the top 5 selling mixes.
    - Calculation of over yielding costs is based on the average percent of over yielding of the 5 top selling mixes and the average sale price of concrete
    - Calculation of cement over batching costs are based on the average over-batch of pound per cubic yard of cement in excess of the target quantity for the top 5 mixes and the average price per pound of cement.
6. Backcharge/Credit due to Under Yielding
    - Costs calculated based on the annual amount of backcharges or credits due to under yielding.
7. Strength Over-Design
    - This is not a typical cost of failure as defined earlier – but concrete strength is excessively high (over-designed), this represents cost that affects profitability and impacts the company's ability to invest in better quality practices.
    - Identify mixtures where strength is over-designed by more than 800 psi for situations where the following apply in specifications:
        - a specified strength ≤5000 psi
        - No maximum w/cm requirement
        - No minimum CM content requirement
        - No early-age strength requirement
        - No fixed over-design requirement.
    - Over-design is the difference between the average strength attained by the mixture and the specified strength. An over-design strength of 800 psi corresponds to less than a 1-in-1000

chance of a low break assuming a typical standard deviation (S) of field strength test record of less than 433 psi (an industry benchmark established by NRMCA surveys). An analysis of a collection of project test results has shown that concrete mixtures targeted for a strength of this level ensures that there will be no occurrences of low strength test results and associated investigation.

- Companies desiring to improve quality need to attain a low standard deviation first, and only then should target a reduced over-design strength. A lower over-design strength that is not based on a low standard deviation will result in increase in low strength investigations and associated costs.
- Calculate the average over-design strength for the top 3 selling concrete mixtures
- Assume material cost of $\$1.25/yd^3$ for every 200 psi in excess of the 800 psi over design.

Failures due to Issues Discovered at the Jobsite or with Placed Concrete

8. Rejected Concrete Costs
    - This is the concrete rejected due to specification non-compliance or dispatch/batching errors
    - DO NOT include concrete returned resulting from over-ordering
    - For example, not meeting field acceptance tests, batching incorrect mixtures or batch weights, orders not cancelled, etc.
    - Costs are calculated using the volume of rejected concrete, the average material cost per cubic yard, and the average cost of handling the rejected load
        - The average material cost is defaulted to the NRMCA industry average of $60/cubic yard but can be set at different values.
        - The average cost of handling the rejected load is typically higher in urban areas as opposed to rural areas, and could consist of storing and crushing of leftovers, reclaimers, truck time, reduction in product value if reused, etc.
9. Backcharge/Credit due to Fresh Concrete Characteristics
    - Total amount paid to a third party due to a fresh concrete quality issue such as lack of finishability, difficulty pumping, setting time, air content, slump, etc.
10. Backcharge/Credit due to Hardened Concrete Characteristics
    - Total amount paid to third parties due to hardened concrete quality issues such as strength, cracking, scaling, color, epoxying a garage slab, remove and replace, etc.
11. Cost of Adjusting Concrete Mixtures On-Site
    - Based on time to adjust the load on-site
    - Costs calculated based on the number of loads corrected each year, the average time (in minutes) to correct the load, and the average delivery cost ($1.25/minute is the national average based on NRMCA surveys).

Lagging Internal Costs

12. Reduction/Increase in Product Liability Insurance Premium due to Quality from Previous Year
13. Liability and Penalties Paid Out due to Quality Issues or Specification Non-Compliance
    - Use the total value paid out for the year
    - The costs are typical of *percent within limit* specifications used by some specifying agencies
    - Do not include costs already included in back charges for hardened concrete characteristics.
14. Internal Costs for Handling Customer Quality Complaints
    - The time spent by company staff handling quality complaints.

- Calculated based on the number of annual complaints, the average time spent on each occurrence, the average hourly rate of employees handling the complaints, the average mileage driven to investigate each issue, and the amount paid per mile.

15. Cost of Additional Testing
    - Include costs paid to third party to conduct tests – including coring for strength, air void characteristics, slab failure issues, etc.
    - Do not include costs already included in back charges for hardened concrete characteristics.

On completing the form, the output will be the total COPQ, COPQ per cubic yard of sales, and COPQ per load. Additionally, the 3 highest failure costs will be ranked to help the producer identify areas for improvement. Next to those costs is a yellow button that provides “RECOMMENDED SOLUTIONS”. This button sends the user to a sheet that gives the NRMCA’s seven suggestions to reduce COPQ and links to NRMCA reference material.