

## ENGINEERING CONTROL—MUNICIPAL IMPROVEMENT WORK

By C. B. Carpenter, City Engineer, Bloomington

As an opinion upon the various problems related to the physical improvements of a small city, the approach to an ideal situation would be one wherein all interested factors recognized the words "Sacred Trust" as being intimately associated with the municipal or city engineer. If his work were limited to details of an engineering nature only, his task would be relatively a simple one.

The success of his work is certainly dependent upon rather versatile ability. He acquires, not of his choice, for solution a grotesque mixture of materials and conditions and against indescribable obstacles accomplishes only in part results in absolute keeping with his desires. Antiquated customs are oftentimes a hazard to his foresight. In order to accomplish results coinciding with his conscientious beliefs, he must constantly practice diplomacy as well as tactful salesmanship. Likewise the success of his relations with the public is dependent to some degree upon his ability of being able to assure that his work is in keeping with the best practice elsewhere.

There are two classes of engineers interested in public work, or for that matter, any type of engineering work. There is first a group which follows custom without deviation. The second group represents a class which ventures into the field of the experimental. Both groups are necessary for a successful continuance of the profession, for upon custom rests the confidence the layman has in the engineer and experiment must provide for advances in thought and practice.

The field of highway engineering provides an example of interest in the foregoing. The individual who follows pavement construction as a means of livelihood or from general interest cannot help being impressed by the gigantic proportions the industry is assuming year by year. Experiments and the establishment of customs by the federal and state groups are of great value to municipal engineers for adoptions, with variations perhaps in establishing the confidence of the layman, a confidence which is important.

A comparatively short time ago, the performance of a public improvement contract invariably consisted of a battle of wits between the contractor and the engineer, with the contractor

at an advantage because of his superior number of representatives on the job. While the same situation may occur to some extent even today, it seemingly is not general.

From observation it would seem that the general public is demanding a different quality of public work than formerly. It would seem likewise that ultimate economy is taking precedence over first cost; that the public is beginning to recognize the fallacy that cheapness necessarily implies economy. Notwithstanding what has just been said, the public is mindful of ultimate costs. The public works engineer has been obliged, therefore, to acquaint himself with designs and methods involving the greatest returns for an amount of money spent. His specifications are tending more and more to become a useful tool instead of a necessary evil in construction operation.

To the layman the subject of specifications in construction procedure and their enforcement is a simple one. He will wave aside all possible difficulties with the phrase, "Well, that should be easy; see that the contractor builds in accordance with the plans and specifications", an expression which in itself is boresome, to say the least, to all of us.

### **Importance of Specifications**

It is true that the part played in the past and at present by some specifications with relation to construction work is capable of much criticism. We can readily acknowledge that a good specification does not necessarily imply a good product, but conversely, a good product seldom results from the use of a poor specification. Plans without specifications may mean nothing because they merely picture the physical appearance of the finished structure with nothing to give it life and quality. The specification should be the keynote of the whole construction operation. By it the contractor should be guided in assembling the parts which make up the completed whole, and the engineer should be enabled to assure himself as the various operations are performed that the finished structure will conform to the requirements of the contract.

It is obvious then that if specifications are the backbone of the construction operation, they should express the requirement which if fully complied with will result in as perfect a structure as present-day knowledge will allow.

**DAILY REPORT  
CONCRETE DESIGN**

FILE NO. \_\_\_\_\_ SHEET NO. \_\_\_\_\_  
FOR JOB NO. \_\_\_\_\_  
DEPT. OF \_\_\_\_\_  
CITY CIVIL ENGINEER  
BLOOMINGTON, INDIANA

TOTAL COMPANY JOB REPORTS NO. \_\_\_\_\_  
NAME OF IMPROVEMENT \_\_\_\_\_ CONTRACTOR \_\_\_\_\_  
DATE \_\_\_\_\_ '19 \_\_\_\_\_

DESCRIPTION: INTERLUDED USE CONCRETE. THIS REPORT: \_\_\_\_\_

WT. OF MATERIALS PER CU FT		AGGREGATE ANALYSIS	
C.A.	UNDESIGNED (NOT ALLOWED JOINED DR)	% S	% F
C.A.			
Stone/Type Gravel Ash/Flk FA 33% 100% 100% 3 Gravel SA			
MATERIAL (EMERT) LBS. FA LBS. CA LBS			
FIELD NO.			
JOB NUMBER			
MATCH AMOUNTS			
TIME OF DAY	TEMP ° F	WIND VELOCITY MPH	MOISTURE
COLLECTION BEAMS			
NO.	CYL.	BEAM	
R <sub>c</sub> M			
W/C R <sub>c</sub>			
DESIGNED STR. LBS			
CORRECTED STR. LBS			
NOMINAL MIX 1:			
FA IN MIX	VOL. LBS		
CA IN MIX	VOL. LBS		
PROPORTIONS (DR):			
SWT			
FIELD	CUPT.		

REMARKS: \_\_\_\_\_

ASSISTANT \_\_\_\_\_

**REPORT OF TESTS  
CONCRETE MATERIALS**

FILE NO. \_\_\_\_\_ SHEET NO. \_\_\_\_\_  
USED WITH JOB REPORTS NO. \_\_\_\_\_  
FOR JOB NO. \_\_\_\_\_  
CITY CIVIL ENGINEER  
BLOOMINGTON, INDIANA

NAME OF IMPROVEMENT \_\_\_\_\_ FROM \_\_\_\_\_ BY \_\_\_\_\_  
DATE SAMPLED \_\_\_\_\_  
DATE TESTED \_\_\_\_\_  
SOURCE OF SAMPLE \_\_\_\_\_ MAPPED \_\_\_\_\_  
PROPOSED FOR USE \_\_\_\_\_

**MECHANICAL ANALYSIS**

WE TOTAL SAMPLE & CONTAINER		CONTAINER	SAMPLE
SIEVE OR SCREEN OPENING SIZE	WEIGHTS		Per Cent
	Actual & Ret.	Fraction	Retained

UNIT WT. LBS./CU FT. \_\_\_\_\_ SP GR. \_\_\_\_\_  
ORGANIC IMPURITIES (COARPER) FINER THAN NO. 4 SIEVE \_\_\_\_\_  
DEVAL ABRASION TEST PER CENT OF WEAR \_\_\_\_\_  
FRENCH COEFFICIENT \_\_\_\_\_  
IMPREVIOUS CLASSIFICATION \_\_\_\_\_  
SOUNDNESS \_\_\_\_\_  
SEC CHART \_\_\_\_\_  
REFER TO REPORTS: \_\_\_\_\_

ASSISTANT \_\_\_\_\_  
(Use Reverse Side or Additional Sheets)

Sample of forms used in City Engineer's office at Bloomington, Indiana.



Assuming that the specifications are ample, which is a large assumption, the question of "fully complied with" is the real subject in which we are interested. Strange as it would sound to the general public, there is great reason to believe that the actual number of public works engineers who know that the requirements of specifications have been correctly interpreted and carried out are in the minority.

Any attempt to analyze the cause for such a condition readily discloses innumerable factors. A phase of practical solution invariably evolves about one factor; namely, the education of all individuals affected by or connected with public improvement expenditure: the taxpayer, the contractor, and city officials. In many instances the individuals serving in a supervisory capacity upon public improvement construction are men appointed directly by the governmental body empowered to carry on such work and men whose experience has been in a line of endeavor more or less foreign to construction work. Their eligibility is too often based upon reasons other than competence or ability.

The position of the city engineer under such a system of inspection is a peculiar one. If his program is large and involves several contracts at one time, he is at best extremely handicapped in obtaining the class of work anticipated by his conscientiously prepared plans and specifications. Actually he is responsible to the public and his governmental officers for results beyond his control.

It is hardly to be regarded as strange, therefore, that a city engineer working in connection with such a system should seek a solution in part at least for more complete execution of the work in his responsibility.

Early in 1926 after considerable deliberation and with some slight misgivings our engineering department was given direct responsibility for all public improvement inspection and supervision. That year was organized upon a small scale an inspection department capable of being later enlarged upon the same general basis.

As part of that organization, two ideas were paramount: first, that the engineering department should be absolutely responsible and without alibi for all work performed; second, that the co-operation of the contractor demands the department's co-operation.

The reaction of the contractors generally amounted briefly

to an extreme willingness to co-operate. They were able to foresee the consequent effect of stabilization as a local industry.

### **Selection of Inspectors**

Selection of inspectors and supervisors was and is a great problem. The basis of selection has been that an individual should have as nearly as possible an appreciation for and a knowledge of the various phases related especially to construction work of a public nature.

As is indicated, our aims as to the type of individual are very high. An attempt has been made to pick when possible men with a particular ability, basing this choice primarily upon authoritative recommendation. It has been intended likewise to select men who are above all things honest and of good character; otherwise the interests of all parties would be jeopardized. It has been the belief also that each individual should be interested in his work. In brief explanation, mutual interest has been involved. We have attempted when possible to offer the individual an ideal, appealing to his sense of obligation to his work, for which he can conscientiously reciprocate by a form of zealous interest. When conditions have permitted, he has had almost from the start a responsibility which has increased with his proved ability. Some men have shown particular aptness in special phases and have then been given encouragement for increased development. The whole idea is based somewhat upon the assumption that the organization is effective only to the degree to which the members are interested.

It has been found of great assistance for a better understanding and appreciation to have regular meetings attended by all inspectors and supervisors. At these meetings, the various details related to the work have been reviewed and discussed. New ideas have been encouraged as much as possible. Every attempt has been made to impress as well as to create an appreciation of the specification intent.

As a particular aid in effecting understanding and co-operation, meetings between the city engineer and the contractor organizations have been especially helpful. There have also been instances concerning questions of general interest where both the inspectors and the contractors were brought together. These last meetings refer particularly to instances where there

were new changes in specifications with reference to previous work. Discussion by the two groups permitted a more exacting understanding. Similar meetings held as the work progressed and new problems and situations arose, likewise proved of practical worth.

One of the particular duties of the inspection department is that of making a record of each and every operation entering into the various details of the work. Such records are kept upon standard forms and are regarded as a vital part of the work.

Inspection work is divided into three major classifications:

1. Highways
2. Sewerage
3. Structures.

### **Concrete Inspection**

Because of the fact that a large portion of the work during the last few years has been in connection with the use of concrete, a general outline of the method of concrete inspection, especially of concrete pavements, might be of interest.

Crushed limestone has been used almost entirely as a coarse aggregate. For practical purposes, there are six distinct local formations which by visual inspection may be readily rejected. The acceptability of remaining formations is subject to physical and chemical examination by ledges and general location in the quarry. Depending upon the uniformity of the ledges, this is a constant problem. There have been instances where tests indicated results contrary to actual knowledge, though such instances have been few. The success of our local stone as a coarse aggregate for concrete is in my opinion dependent upon the ability of local operators to produce a material uniform as to quality and gradation. The use of local stone as an aggregate requires constant vigilance, and although there has been much improvement in the past few years in producing suitable stone, there remains a considerable amount of work to be done before our part ceases to be a strenuous one.

Unfortunately there is no sand within the radius of several miles which may be used for concrete aggregate. Our sand is examined and inspected usually upon delivery and only occasionally at the plant. It is intended to obtain a sample of every car—a process in itself laborious. Samples representa-

tive of a shipment are examined for silt, organic matter, and gradation. Mechanical analysis is made upon representative shipments in an attempt to control gradation.

Bin tests at the mill through a commercial laboratory have been used for cement inspection.

In connection with the job end of a concrete operation, the entire improvement, including necessary construction survey work, is in charge of a job supervisor responsible only to the city engineer. Assisting the job supervisor and responsible directly to him are a cement checker and a plant inspector. If more than one contractor organization is operating from the same material plant, the plant inspector is directly responsible to the city engineer. During the operation of placing concrete for pavement, communication is established between both ends of the work and an attempt is made to correct material quantities promptly.

During the progress of the work, every effort is made to take advantage of reasonable practice for obtaining maximum results as to quality of pavement. For reasons of design as well as to provide for a greater ease in finishing operations, especially upon the steeper gradients—of which there are many—street pavements are built in at least two longitudinal sections. It is intended now that such widths shall not exceed fourteen feet. Tongue and groove longitudinal joints are obtained with special forms. Scratch templates are used for obtaining subgrade depth and especial attention is given to subgrade preparation and maintenance. It is believed that not enough attention can be given to our particular subsoil and soil condition.

Water control is in our opinion more important than any other single item entering into the concrete operation. An attempt is made at all times to insure first of all a workable concrete. For finishing machine work, a slump of one to two inches is used and for hand finish three to four inches.

A method of hand finishing which produces results comparable to machine finishing has been used. It is relatively easy for the finishers. Its practicability has been dependent upon a definite sequence of operations, each outlined by number and after a short time made routine. It incidentally includes at least three straight edge checks.

Included in the finishing operations and related to curing is the process of removing such laitance as appears upon the



pavement surface previous to the final belting. We believe this very important in effecting structural unity of the slab.

Great stress is laid upon both initial and final curing. Immediately behind the final belting or just as soon as the surface will permit, wetted burlap is placed and kept wet until the final cure is started. Because of a number of local reasons, calcium chloride has been generally used as a final curing agent. Distribution as to method and amount is supervised in a painstaking manner.

High spots in excess of 1/4" in 10' are removed early upon the day after the concrete is placed.

### Reports

At the end of each day, the job inspector's report, including the report of his assistants, is received at the engineer's office

FILE NO. _____		DAILY CONSTRUCTION REPORT		SHEET NO. <u>41</u>	
DATE OF LAST REPORT <u>April 20, 1929.</u>		<b>HIGHWAYS</b> OFFICE OF CITY CIVIL ENGINEER BLOOMINGTON, INDIANA		JOB NO. <u>A-127</u>	
				DATE <u>April 22, 1929.</u>	
1-CONTRACTOR <u>U. R. Price Co.</u>		3-IMPROVEMENT <u>Lincoln St.</u>			
3-WEATHER <u>Fair and Warm</u> TEMP. _____ MAX. TIME _____ MIN. TIME _____ <small>(TO BE FILLED OUT WHEN BELOW 40° F OR ABOVE 80° F)</small>					
4-LOCATION OF DAYS WORK BY STATION <u>14 plus 72 -- 15 plus 82</u>					
5-CHARACTER AND PREPARATION OF SUB-GRADE FOR THIS DAYS WORK <u>See Report April 20th.</u>					
6-DESCRIPTION OF DAYS WORK					
SACKS CEMENT					
		FACTOR CEMENT		PERCENTAGE	
		USED		REQUIRED	
		(SOFT)		(HARD)	
A-LIN. FT. COMB. CURB & GUTTER <u>190</u>		TOP		35.8	
		BASE		17	
B-LIN. FT. RADIUS CURB _____ OF FT. R. _____		TOP		50	
LIN. FT. RADIUS CURB _____ OF FT. R. _____		BASE		68	
C-LIN. FT. RADIUS CURB _____ OF FT. R. _____		TOP		1.5	
D-SQ. FT. SIDEWALK <u>465</u>		TOP		3.9	
		BASE		20	
E-LIN. FT. PAVEMENT _____		TOP		18	
		BASE		27	
F-TOTAL QUANTITIES OF CEMENT FOR THE DAY		TOP		28	
		BASE		3.5	
SLAB WIDTH _____ THICKNESS _____					
G-BATCH METER READING END OF DAY _____		REMARKS:			
BATCH METER READING BEGINNING OF DAY _____					
G-NO. BATCHES FOR DAY <u>94</u>					
H-LOCATION OF ABOVE STRUCTURES -A-B-C-D-E- BY STA AND INTERSECTION ETC. <u>A- 14 plus 72 to 15 plus 82 East ----- D. 13 plus 79 to 14 plus 72 East</u>					
I-R. P. M. OF DRUM THREE READINGS		REV. PER BATCH THREE READINGS		SIZE OF BATCH	
14   14   14		14   19   16			
J-AGGREGATE, IF ANY CHANGE FROM GENERAL REPORT _____					
K-WHAT DAYS WORK BEING CURED-DATES-FROM <u>April 16</u> TO <u>April 20</u> METHOD <u>Wetted Burlap</u> <u>Wetted burlap placed upon this days work. All burlap in place constantly sprinkled</u>					
L-CONTRACTOR BEGAN WORK AT <u>6:30 a.m.</u> STOPPED AT <u>1:00</u>					
M-FOREMAN IN CHARGE _____					
N-BRIEF REPORT OF WORKMANSHIP FOR THE DAY <u>Fair - Slight difficulty in obtaining workable</u> <u>concrete for first part of curb placed.</u>					
Tack Rogers INSPECTOR					
-USE REVERSE SIDE FOR REMARKS-					

Fig. 1. Report form used in street improvement work.

and briefly examined and checked not later than early the next morning. It is intended that repetition of possible deficiencies or questionable factors possibly having occurred upon the previous day be eliminated at once. It should be mentioned incidentally that cement yields are checked periodically during the day.

FILE NO. B-73 DAILY CONSTRUCTION REPORT SHEET NO. 3  
 DATE OF LAST REPORT June 2, 1928. OFFICE OF CITY CIVIL ENGINEER BLOOMINGTON, INDIANA JOB NO. B-73. DATE June 7, 1928.

WEATHER \_\_\_\_\_

CONTRACTOR Buekirk and Dodds  
 NAME OF IMPROVEMENT So. Madison St., - Local San. Sewer.  
 FOREMAN IN CHARGE Elmer Poling

1-EXCAVATION FOR SEWER TO A DEPTH OF 10.5 FEET BETWEEN STA. 8 + 00 AND STA. 8 + 50  
 2-EXCAVATION FOR SEWER TO A DEPTH OF \_\_\_\_\_ FEET BETWEEN STA. \_\_\_\_\_ AND STA. \_\_\_\_\_  
 3-EXCAVATION FOR SEWER TO A DEPTH OF \_\_\_\_\_ FEET BETWEEN STA. \_\_\_\_\_ AND STA. \_\_\_\_\_

PROGRESS OF WORK FOR THE DAY

STATIONS	8 + 00	25	50	75	100	125	150	175	200	225	250	275	300
CUTS AS SHOWN BY STAKES	12"												10"
DIAMETER OF SEWER (IF SET) GRADES	36"		26"										12"
CUT LATH PLANS	9.16		9.90										10.51
PIPE L.A.D.	8+10		8+50										
COND. TYP. OF FOUNDATION	STONE FOUNDATION - 6" E-RICH CR. BLK												
DEPTH OF STONE	3.50		8"±										3.50

See Sketch Report p. 2.

TILE INSPECTION

SIZE	NO. TILES LAYED	NO. TILES PASSED	NO. TILES REJECTED	REASONS FOR REJECT	REMARKS
8"	16	16			

HOUSE CONNECTIONS

NO.	LENGTH	HEAD-TO-HEAD MAIN TO END	STA. AT HEAD	STA. AT T. E.	DEPTH OF LAY AT T. E.	APPROX. FALL	REMARKS
5	20'	21.5	8+93.5	8+94.5	5'	48"	W. Side
6	20'	21.5	8+91.5	8+92.5	4.2'	54"	E. Side
7	20'	22.0	8+37.5	8+39	4.2'	48"	E. Side

MANHOLE CONSTRUCTION

LOCATION STA. M. H. 8+00 EXCAVATED TO DEPTH OF 9.5 FT.

REMARKS (OTHER THAN GENERAL REPORT) NEW STAKES NEEDED TOMORROW

Otto Doenker

INSPECTOR

—USE REVERSE SIDE FOR REMARKS—

Fig. 2. Report form used in sewer construction work.

The job supervisor's daily report, carrying a brief summary of his assistants' reports, is intended to give a brief review of all activities of the day. It is intended likewise that a complete set of such reports and concrete test reports be actually an authentic history of the work for future reference.

Concrete curb and gutter and walk are handled virtually in the same manner as described above for pavement, excepting for contractor organizations. As mentioned above, every

effort is made to produce workable concrete first of all and to see that the materials and operations entering into the product are in keeping with the standards of good concrete. Incidentally every effort is made in such class of work to check for cement in accordance with predetermined factors.

Attention is called to the report form (Fig. 1) used in connection with street improvement work. It has been found especially helpful in making up final reports upon the entire job to use the three colored sheets, one color for each type of structure. White is used for a general report, yellow for curb and walk, and pink for pavement.

File No. <u>C-21</u>	INSPECTION REPORT	Sheet No. <u>7.</u>				
Date Last Report <u>July 25, 1929.</u>	FIELD MADE CONCRETE PIPE	Job No. <u>C-21.</u>				
		Date <u>July 26, 1929.</u>				
Contractor <u>Independent Concrete Pipe Co. (W. C. Stewart Co.)</u>						
Name of Improvement <u>N. Walnut St., District Storm Sewer</u>						
Description of Days Work						
PIPE:--						
NO. PCS.	DIA.	LENGTH	VOL. PER LIN. FT.	CEMENT		
				PER CU. YD.	REQ.	USED PER CENT
9	48	4'	.214	6.8	51.38	56 + 8.9
5	33	4'	.111	6.8	9.05	10 +10.5
5	36	4'	.129	6.8	17.54	16 - 2.5
6	48	4'	.214	6.8	34.92	36 + 3.1
8	42	4'	.169	6.8	36.77	37 + 0.6
R.P.M. OF DRUM Three Readings		REV. PER BATCH Three readings		SIZE OF BATCH		SUMP
20	20	19	14	10	12	1:2. 1:38
Aggregate, if any change from general report				<u>Refer Agg. Report T-2 6</u>		
What Days Work Being Cured -- Dates -- From				<u>7-17-29.</u>		to <u>7-25-29.</u>
Method <u>Sprinkling</u>						
Contractor Began Work at				<u>7:00 A.M.</u>		Stopped At <u>4:15 P.M.</u>
Foreman in Charge <u>N. J. Morehead</u>						
Brief Report of Workmanship for the Day <u>Fair -- Mixing Time. Inclined to be cut short. Understanding effected. One load stone rejected.</u>						
D. Rathburn						Inspector.

Fig. 3. Report form used in field-made concrete pipe.

A special form is used for structural concrete in its various classes. The intent has been for the same method of control as has applied to the concrete mentioned heretofore.

General sewer construction work has been with a few exceptions handled under a separate department of inspection

(Fig. 2). It is further divided into material inspection and supervision of construction.

All factory-made pipe is inspected at the car and the variations allowed by A.S.T.M. specifications are adhered to. As a general rule, sewer construction supervisors have been made to qualify as material inspectors before being placed in charge of the construction work. The pipe examined at the car is likewise inspected upon the job just previous to placing.

Field-constructed concrete pipe is controlled by the methods mentioned in connection with concrete inspection. For this type of pipe, a separate material report (Fig. 3) is kept with the sewer construction report.

In connection with the general system of inspection and supervision mentioned herein, it is not intended to express the belief that an even partial cure-all for the common ailments of small city construction has been effected. Likewise it is not the intention to flatter ourselves into believing that our work is without criticism. The way ahead for such an attainment is a long route.

The principal satisfaction enjoyed, however, is that of establishing a new local custom of practical worth. If we are permitted to enlarge upon the idea from year to year, it will be possible in time for the quality of our work to keep astride of, rather than attempt to follow, the best results attained elsewhere.

## NEW DEVELOPMENTS IN THE OPERATION OF THE BARRETT LAW

By E. P. Brennan, Examiner, State Board of Accounts,  
Indianapolis

This is rather a wide subject, and because the Barrett Law has been amended and re-amended until it presents the appearance of a crazy quilt, it doesn't make much difference where we begin in the discussion. For that reason, we will begin by taking the last of the new acts first.

Section 9 of the act provides that "this act shall be deemed and construed to be supplemental to all of the acts relating to the collection, payment and enforcement of payment of assessments for public improvements of the character herein designated". You will note from this section that the law repeals nothing, leaving everything in force that was on the