

encountered in trying to use prints that have been rolled up tightly for some time. It renders them almost unfit for use. I put the matter before the commissioners and they kindly allowed me to have a cabinet made with drawers large enough for the maps to be placed without rolling. The drawers are labeled so that I can find the particular map or tracing wanted without spending a lot of time. This method leaves them in good shape to use and one does not have to unroll a map and place weights on the corners to use it. As the tracings have a definite place there should be no occasion for them to become lost, as my predecessor explained the absence of map tracings that belonged to the office at the time I took it over. I had the cabinet made by a local firm who did a very good job of it. It makes a fine piece of furniture for the office and is a fixture that I think every surveyor should have as a part of his office equipment.

There isn't much I can say on office help since I must be draftsman, inspector, instrument man, stenographer, and field-chief all at the same time. Any normal, intelligent person willing to learn and follow a certain system of keeping office records should make a satisfactory helper. It is rather difficult to find someone who can take hold of the work at once, as the work is not of routine nature and the office helper should have plenty of initiative. Good help in the office is worth a lot to the surveyor.

I am keeping records in regular form so that when the time comes to turn the office over to my successor he will have all the facts and figures at his command. He may then continue with the work intelligently, without a breach of public service. He will not be at a loss to know what already has been accomplished or what has been planned for the future.

## SPECIFICATIONS FOR COUNTY ROAD MATERIALS

By R. E. O'Connor, Vice-President, Indiana Highway  
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The proper development of this subject requires that I deliberately state to you truths, which, though they be contrary to general practice and much at odds with custom of long standing, nevertheless are true, and will so remain against all challenge. What must be said to bring out these facts may cause both the statements and myself to be for the moment classed as radical, through our great American habit of so classifying those things and persons who differ with established custom or practice, no matter how wrong or antiquated this custom or practice may be.

The subject before us comes forth for a frank discussion at a most fitting and proper moment, because our recent experiences have awakened in most of us a real desire to look

all questions squarely in the face and by proper determination to re-establish in ourselves and our system of government a faith that has been badly shaken.

In this connection let us consider some of the propositions which have a direct bearing on the subject before us.

What about the movement to do away entirely with certain branches of our government and to consolidate various other branches under one form or another, which has now developed to the point wherein a great many people are in favor of overstepping the bounds of reason in that direction?

Do you as county commissioners, surveyors, and road supervisors realize any connection between this and what I have to say to you on "Specifications for County Road Materials?" I want to state to you now that unless I do establish this connection my efforts here can definitely be classed as a failure. Because I appreciate this fact I now desire to dwell upon it.

In times of emergency or stress we are prone to grasp at straws and go off on tangents, and in haste are guilty of many foolish actions. I know of no greater example of like action than that evidenced in the misguided efforts of some to take away from the people what is their inherent right to retain, and upon the retention of which rests the only security to guarantee our form of representative government as it has, should, and must exist—the right of local representation in the truest meaning of the word.

How does it happen that we have such a movement? Is it because the system is a failure, or because we who operate it have failed to do our duty, and in so conducting ourselves have prevented it from functioning as intended?

#### A NECESSARY WARNING

It is not necessary for me to sound a warning, because it has been sounded so that all who have ears to hear certainly have heard its reverberation long before this. You officials especially should be well aware of what is in the offing.

The taxpayers when aroused, like time, wait for no man. That they are stirring needs no proof. They want relief from the tremendous costs of maintaining our present set-up; and not getting it, will, in the emergency, give their consent to consolidation of counties, and to government by boards and agencies set up by the state—surrendering their birthrights because of the cost of trying to maintain something that we call county government, which yet in nowise deserves that name.

I have said that I am against surrendering our local representation. I am just as thoroughly against losing it because of any attempt to hang on to a lot of non-essentials, the giving up of which will in nowise affect its value to the people nor to our form of government, but will, on the other hand, increase and multiply the blessings thereof.

## A TYPICAL TAXPAYER

It is my intention to step completely away from my knowledge as a contractor and material producer, or any other connection that I might have with the construction industry, and to deal with the question in the character of a wide-awake taxpayer of the year 1935, who has been thinking seriously and correctly on the whole proposition of how best to do away with the duplication he knows to exist in his government, the removal from it of the non-essential things, the breaking up of practices by which some individual has benefited at the expense of many; all of which has piled up tremendous burdens of costs on him.

This taxpayer will, as a matter of course, direct his attention to the total tax set-up, and on account of his experience, will start with that collected by the state, and then consider the county and local taxes.

He will be a very serious, inquisitive, and thorough individual, who will draw a chart of the various departments of state government, the duties they perform, and their cost. He will do this also with his county government, and by comparison of the two individually and collectively will bring forth the overlapping and duplication of effort that is present in and between them.

He will be so seriously interested in his study that he will forget politics, and therefore will study his problem without prejudice, recognizing that the thing he is analyzing is in part the result of the consolidated efforts of all political parties.

He will be cold-blooded in his determination, yet logical and fair in his conclusion. While he strives to carry out what he has determined to do, he is acting not to destroy but to prevent destruction of something very dear to him.

We will, for the sake of brevity, assume that he has completed his investigation. Are we logical in contending that he has discovered the vast importance of roads, and the situation that exists in connection with them? Let us see how he has marked this item. He has noted:

1. Their necessity.
2. The need for continuing a program of construction and maintenance.
3. The agencies set up to carry on this work.
4. The way these agencies are functioning.
5. The vast amount of work and the money it has cost to develop information and to establish the standards used by them.
6. The way this information is actually used by the divisions of government in this state.
7. The use of the facilities of these agencies by these divisions.
8. The vast amount of materials used for road construction and maintenance.

In regard to this last item he asks:

How is it purchased?

By whom is it supplied, and how delivered to the roads?

He also asks:

How is the work of construction and maintenance carried on?

Who pays for it?

What does it all cost?

How can the same or better results be obtained and yet reduce this cost?

Toward items 1 and 2 we need have no fear of his reaction, but toward the others—that's another story. What are we going to do about most of them to keep him from going off the reservation? Would you like to defend our actions under them before this gentleman, and the many others like him? Do you think you could make a success of it?

For your information, we, personally, have a great interest in seeing this fellow and his crowd satisfied, because most of us agree with them and do not fear that they will go crazy in what they ultimately will do.

#### WHAT "SPECIFICATION" MEANS

I have had a great experience in trying to develop a definition of the word "specification" for use in this paper. One engineer defined it as "a rule and a guide to faith." Although I can't use his offering, it does contain plenty of food for thought.

Another engineer gave the following definition: "a mysterious mingling of words in a green book, which the contractor does not realize is in existence until he has been awarded a contract."

For our purpose, we must confine ourselves to describing or defining it as "an act or particularizing or naming in detail, or a definite and full statement of such particulars, broadening into a detailed statement of the requirements for carrying out a contract or to establish standards; any one of the details in a list of things so required, describing the manner or method by which this shall be accomplished; the kind and quality of materials to be used or furnished in order to obtain a result on which determination has been made before the provisions or requirements are written."

This definition in itself causes me to hesitate before going forward in our discussion, for, even though I might be guilty of crediting myself with great powers of discernment, I do not in this instance lack a full understanding of the magnitude of the questions involved.

In recognition of the fact that our subject has the word "materials" rather than "material" set forth in it, and since it would be mere pretense for me to attempt to speak with authority in connection with many of these materials, I shall

confine my remarks to those on which I may in some way be qualified to speak.

#### USE STATE HIGHWAY SPECIFICATIONS

I have said before that I claim no qualifications as an expert on all materials, but that does not bar me from citing the authority of experts to make up what I may lack. This it is now my pleasure to do by saying that in the Indiana State Highway Specifications and the standards set out therein, you will find all that is necessary to completely set forth the requirements and the information to establish what can truly be said to constitute a real "Specification for County Road Materials."

The Indiana State Highway Specifications do qualify under our definition, not only in part by meeting some of the requirements of it, but wholly so because they meet them all.

In them not only have we represented the best efforts and determinations of many men trained for the purpose, but we also have these efforts and determinations made and passed upon and backed by the full experience of the department throughout all the time it has existed, and likewise by that of many other highway departments as well, all considered and made applicable to the conditions which must be met in our state.

It is well that we also mention the important part our engineering schools have taken in this work. Of course Purdue University has had much influence on specification writing in this and other states.

It is impossible to deal with all that is covered by them directly bearing on our subject, and it is unnecessary that we do so, as they are available for you as needed. We can, however, touch upon their provisions covering mineral aggregates for construction and maintenance work, some copies of which we have available.

You will note that these are a revision of recent date brought about by a realization that a change was necessary to enable more satisfactory results to be obtained in their use, and that the limit which had controlled the specifying of the quality and grading could be widened, without seriously affecting the cost, to the gain in the resultant work in which they were to be incorporated.

It is well in this connection that we understand some of the factors governing an engineer in applying what it is necessary that he does apply in his determinations in order that he can justify them as truly the acts of an engineer.

First, he must establish in his mind the standard for which he is striving, which, in credit to him, usually approaches perfection.

Second, he must consider how to obtain this in the best and most economical way, yet without sacrifice of quality in the standard he has fixed.

TABLE I  
SIZE OF AGGREGATES  
(Article J 406, Indiana State Highway Specifications)

*Gradation:* Mineral aggregates shall be furnished in the sizes specified and shall meet the grading requirements as shown in the following table. Material shall be uniformly mixed when received on the work.

Size	Use of Aggregate	Total Per Cents Retained on Sieves Having Square Openings												
		3½"	2½"	2"	1½"	1"	¾"	½"	.187" No. 4	.0937" No. 8	.0232" No. 30			
No. 1	Base Course Stone.....	0	15-50	75-100	90-100	95-100	98-100							
No. 2	Base Course Stone Concrete Agg. "U"*		0	0-5		80-100	95-100	98-100						
No. 3	Crusher Run Stone 1-Course Sur- face, Etc.....			0	0-5			20-60	55-85					90-100
No. 4	Light Base Aggregate, Heavy Binder Aggregate, and Leveling Course.....				0	5-25	20-50	55-85	95-100	98-100				
No. 5	Concrete Aggregate "L".....				0	0-15	15-40	40-70	90-100	96-100				
No. 6	Plant Run Gravel.....				0	0-15	5-30		40-70					80-100
No. 7	Maintenance Aggregate.....					0	5-35	20-75	70-100	90-100				95-100
No. 8	Light Binder (AC & AH) Bitumi- nous Mulch.....					0	0-10	40-80	95-100	98-100				
No. 9	Type A Surface (AC) Fine Binder for Resurface.....						0	10-35	85-100	96-100				98-100
No. 10	Screenings—Stone or Slag.....						0	10-35	40-80	70-90				90-100

\*When used for concrete aggregate "U", no particles shall be retained on a 2¼" sieve.

Total Per Cents Retained on Sieves Having Square Openings

Size	Use of Aggregate	Total Per Cents Retained on Sieves Having Square Openings												
		1/2" No. 4	3/8" No. 6	.093" No. 8	.0232" No. 30	.0117" No. 50	.0070" No. 80	.0059" No. 100	.0029" No. 200					
No. 11	Type "B" Surface	0	0-10	75-95	0-60	95-100								
No. 12	Grits	0			0-60	65-100	96-100					99-100		
No. 13	Type "C" Surface		0	50-100		98-100								
No. 14	Concrete Sand		0	0-5		0-25	50-80	80-95				95-100		
No. 15	Mortar Sand					0-10	25-50	60-85				90-100		
No. 16	Mineral Filler					0				0				5-25

Fractional Percents Between Sieves Having Square Openings

Retained No. 4	Fractional Percents Between Sieves Having Square Openings										Passing No. 200	
	4-8	8-16	8-40	16-50	40-80	50-100	80-200	100-200				
No. 17	Coarse (AH & AC) Surface Types "A", "B", "C" and Binder	0	0-10	15-35		25-60		5-35			1-10	0-5
No. 18	Fine (AH) Surface Type "D"	0	0-5	12-40		25-60				25-45		0-5

Usually this engineer comes squarely up against a realization that this is impossible for the moment because of the limitations involved by cost. Therefore he must and does give his full attention to coming as near to it as he is permitted so to do, and works out a specification covering performance and materials on that basis.

The Indiana mineral aggregate specification is a true example of this, and more, for in addition it also reflects the results of many conferences between engineers and producers of these materials in the state, and their consent and recognition of needs for quality and grading of material set forth. (Table I.) You will note that this has been specified for every design and type of construction, and for maintenance work as well.

Now let us see what our taxpayer thinks of this specification after his investigation. He has found that in each of the ninety-two counties of this state, there is a so-called specification covering, or intending to cover, things that are covered in these State Highway Specifications that have cost him so much.

He discovers that there are so much disagreement and differences of opinion set forth in these county specifications as compared to each other and to the state specifications, that he knows positively that somebody must be wrong.

He has examined, say, the aggregate specifications, if any, that exist in these counties, and the methods by which the material is purchased and used under them. He has found that in many cases the counties have purchased and paid for piles of material and let it lie for months and years before using it; and that the only specification under which thousands of tons of material were purchased and used by some counties was one which provided for little in quality, and much passing a one-quarter inch screen. In fact, this taxpayer has found that many counties are using material that contained less than 10 per cent so retained. (See Table II.)

He has found out the amount the counties were paying for this and other like material, and has prepared Table II to determine what the actual cost was in comparison with that provided for in the state specifications.

What he has discovered as to comparative prices has further opened his eyes and set him to investigating the handling and hauling of the road material, and the places and purposes in and for which it was used. In this he has also found much to add to his balance in favor of the use of processed materials under a positive and definite specification, and to further decrease the cost over that of the material being used by many of the counties.

He has asked many questions concerning the reason for having such wide separation of interest between the counties and the state when there should be such very close contact



in order to carry out properly what is to the best interest of the public.

It was a further shock to him, along with other things mentioned here, when he inquired if there were any instances where some counties made a practice of using the state highway department for any special purpose and found out that this was not done except in very rare cases. Here again money was being expended where it could have been saved by such use.

But what need is there for our going into this further? Enough has been said, and while much more could be added, it certainly is not necessary. I want, therefore, to close by again giving to you the Indiana State Highway Specifications as my recommendations for "Specifications for County Road Materials." I say to you, "Don't forget the taxpayer." Since we all serve him, let us do now what in right and justice we know we certainly should do, so that we can lay proper claim to a continuation of our services.

TABLE II  
COMPARATIVE COST SCALE OF PROCESSED AND PIT RUN AGGREGATES

Per-centage Retained on 1/4" Screen	Actual Cubic Feet Retained on 1/4" Screen	Cost Per Cubic Yard of Pit Run Material on Which Figures Are Based													
		\$ .10	\$ .15	\$ .20	\$ .25	\$ .30	\$ .35	\$ .40	\$ .45	\$ .50	\$ .55	\$ .60	\$ .65	\$ .70	
		Actual Cost Per Cubic Foot of Material Retained on 1/4" Screen													
5 %	1.35	\$ .074	\$ .1111	\$ .148	\$ .185	\$ .222	\$ .259	\$ .296	\$ .333	\$ .37	\$ .407	\$ .444	\$ .481	\$ .518	
7 1/2 %	2.025	.049	.074	.0987	.1234	.1481	.1728	.1975	.222	.2469	.2716	.2963	.3209	.3456	
10 %	2.70	.037	.0555	.074	.0926	.1111	.1296	.1481	.1666	.1851	.2037	.2222	.2407	.2590	
12 1/2 %	3.375	.0296	.0415	.0592	.074	.0888	.1037	.1185	.133	.1481	.1629	.18	.195	.2074	
15 %	4.050	.0247	.0370	.0493	.0617	.074	.0864	.0987	.1111	.1234	.1358	.1481	.160	.1728	
17 1/2 %	4.725	.0211	.0317	.0423	.0529	.0635	.07407	.0846	.0952	.1058	.1164	.127	.137	.1481	
20 %	5.400	.0185	.0277	.037	.0463	.0555	.0648	.074	.0833	.0926	.1018	.1111	.1203	.1296	
22 1/2 %	6.075	.0164	.0246	.0324	.0411	.0493	.0576	.0658	.074	.0823	.0905	.0987	.107	.1150	
25 %	6.750	.0148	.0222	.0296	.0370	.0444	.0518	.0592	.066	.074	.0814	.0888	.0962	.1036	
27 1/2 %	7.425	.0134	.0202	.027	.0336	.0404	.0471	.0538	.0606	.0673	.0740	.0808	.0875	.0953	
30 %	8.100	.0123	.0185	.0247	.0308	.0370	.0432	.0493	.0555	.0617	.0679	.07407	.0802	.0864	
32 1/2 %	8.775	.0114	.0170	.0228	.0285	.034	.040	.0455	.0512	.0570	.0627	.0683	.0740	.080	
35 %	9.450	.0106	.0158	.0211	.0264	.0317	.037	.0423	.0476	.0529	.0582	.0635	.0688	.074	
37 1/2 %	10.125	.0098	.0148	.0197	.0247	.0296	.0345	.0393	.0444	.0491	.0543	.0589	.0642	.0688	
40 %	10.800	.0092	.0139	.0185	.0231	.0277	.0324	.0370	.0416	.0463	.0509	.0555	.0601	.0648	

Actual Cost Per Cubic Yard of Pit Run Material if Transposed Into Cubic Yard of Material Graded to Retain 100% on 1/4" Screen

Cost Pit Run Per Cubic Yard	5%	7 1/2%	10%	12 1/2%	15%	17 1/2%	20%	22 1/2%	25%	27 1/2%	30%	32 1/2%	35%	37 1/2%	40%
\$ .10	\$1.99	\$1.32	\$1.00	\$.80	\$.666	\$.57	\$.50	\$.44	\$.38	\$.36	\$.33	\$.31	\$.28	\$.26	\$.25
.15	2.99	2.00	1.50	1.12	.999	.85	.75	.66	.60	.54	.50	.46	.42	.40	.37
.20	3.99	2.64	2.00	1.60	1.33	1.14	1.00	.89	.80	.73	.66	.61	.57	.53	.50
.25	4.99	3.33	2.50	2.00	1.666	1.43	1.25	1.11	1.00	.91	.83	.77	.71	.66	.62
.30	5.99	3.99	3.00	2.39	2.00	1.71	1.50	1.33	1.19	1.09	1.00	.90	.855	.80	.75
.35	6.99	4.66	3.50	2.80	2.33	2.00	1.75	1.54	1.40	1.27	1.17	1.08	1.00	.93	.875
.40	7.99	5.33	4.00	3.20	2.65	2.28	2.00	1.77	1.60	1.45	1.325	1.23	1.14	1.06	1.00
.45	8.99	5.99	4.50	3.60	2.98	2.57	2.25	2.00	1.80	1.63	1.49	1.38	1.285	1.19	1.125
.50	9.99	6.66	5.00	4.00	3.31	2.85	2.50	2.22	2.00	1.81	1.655	1.54	1.425	1.32	1.25
.55	10.99	7.33	5.50	4.40	3.64	3.14	2.75	2.46	2.20	1.99	1.82	1.69	1.57	1.455	1.375
.60	11.99	8.00	6.00	4.80	3.97	3.43	3.00	2.66	2.40	2.17	1.985	1.84	1.765	1.59	1.50
.65	12.99	8.66	6.50	5.20	4.30	3.70	3.25	2.89	2.60	2.35	2.15	2.00	1.85	1.735	1.625
.70	13.99	9.33	7.00	5.60	4.66	4.00	3.50	3.10	2.80	2.54	2.33	2.16	2.00	1.88	1.75

This scale has been established on the basis of material retained on one-quarter inch (1/4") screen, because by so doing, we feel that we have used the most logical and fair position from which to develop our comparative figures. We realize that there must enter a certain adjustment of the figures set forth to compensate for the allowances in specifications which permit of a small percentage of materials minus one-quarter inch (1/4"). We, however, suggest that in this connection proper consideration be given to the fact that the allowances mentioned do not originate from any consent which is founded on the necessity for any material minus one-quarter inch (1/4") being present in these specifications to add to their completeness, but rather that this does enter through a realization by engineers that there is a limit to the perfection with which processing can be carried out, particularly in the light of the deposits from which the material is taken for such processing.