terials except an alkali soil, gypsum clay, or a gumbo-like sedimentary clay.

Experiment at Carden City, Kans.

At this point sand hills run parallel to the Arkansas River on the south side, and form a strip nearly seven miles wide. A careful inspection of the vicinity revealed no available road material except occasional deposits of gypsum clay distributed irregularly across the sandy belt. From two of these deposits was taken the material used in the construction of the road at this place. The first pit was opened about 900 feet east of the road and the other near the roadside. From the first pit 68 cubic yards was hauled, but it was then abandoned because of the distance of haul, and because the clay showed a lack of binding power. The road was completed with material from the second pit. The farther down in the pit the stickier was the clay and the better it compacted after the addition of sand.

The problem to be solved in this case was the best method of handling the local material, gypsum clay, so as to produce a road with a wearing surface capable of resisting the action of the constant winds, which are generally from the south. For this experiment a section of road 765 feet long, situated on the slope of a sand hill, was selected.

The clay was hauled directly upon the road, down the centre of which a width of 12 feet had been staked. The clay covering was spread to a depth of about nine inches immediately after it had been dropped on the road. The clay was hauled over the loads previously deposited and all holes so made were filled at once. Traffic was allowed upon it, and this compacted the clay firmly. During the time of hauling the clay no rain fell, but after the hauling was completed a heavy rain soaked the clay, and the road was finished as follows: While the road was wet a spike-toothed harrow was put on and the clay completely pulverized. Then five furrows were backfurrowed on each side of the clay, thus raising the sand shoulders above the clay centre. A split-log drag was now put on the road, and the sand thus raised by ploughing was pulled from the shoulders upon the clay and thoroughly incorporated. The road was then smoothed and left for travel.

While the construction of this road followed closely the ordinary method of sand-clay construction, still there were some variations, owing to the peculiar conditions to be met, as has already been explained. It was believed that a surface was necessary which would resist the occasional heavy showers incident to this climate and at the same time the action of the winds. Therefore, the clay having the greatest tenacity was selected. Because of the dryness of the climate it was deemed best to proportion the clay far in excess of the sand. While the clays available may not be altogether desirable, still any clay that will pack under traffic will improve greatly the heavy sands found in this locality.

The cost data of this experiment follow, and also the miscellaneous details of all four sand-clay experiments (Table 6).

Stripping clay in pit	\$ 7	17
Ploughing up clay in pit	10	50
Loading clay into wagons	33	00
Hauling clay to road	39	50
Spreading clay on road	10	00
Sanding, harrowing, and finishing road	2	33
Cost of clay on road per cubic yard		40
Cost per square yard of part clayed		IC
Rate per mile	707	45

Table 6.—Miscellaneous Data of Sand-clay Experiments.

Same and and a set	ength of Entire Width of Depth of Clay					Surface	
	road width of clayed			clay	hauled	clayed.	
Place.	treated.	road.	part.	layer.	to road.		
	Ft.	Ft.	Ft.	Ins.	Cu. yds.	Sq. yds.	
Garden Ci	ty 765	30	12	9	256	1,020	
Dodge Cit	y. 9,750	30	14	all	3,703	15,167	
Bucklin	. 4,271	30	14	12	1,883	6,644	
Ford	350	30	16	13	179	622	

a Depth of clay and sand.

Experiment at Dodge City, Kans.

The same natural conditions exist here as at Garden City, and the sand hills are on the same side of the river, though only two miles wide. A section of the road leading to Mineola, Kans., was selected, and after the work was started the citizens became much interested, and urged that the entire two miles be hard surfaced. This was done.

The general plan of construction at this place was similar to that at Garden City. A deposit of clay was found near the middle of the section to be improved, formed from silt from an old irrigation ditch no longer in use. The water had been allowed to run into a large basin, and about four acres were covered to a depth of 18 inches with this fine silt. It had thoroughly dried out, so that when ploughed up it was in excellent shape for handling with shovels. This material was almost gritless, and became very sticky when wet. Although this may be regarded as an unusual condition in this locality, nevertheless results may prove it expedient to use a river silt for road purposes in other irrigation districts when practicable. If this material had not been found the road would have cost fully 50 per cent. more.

The entire roadway was 30 feet wide. In the centre of this a 14-foot track for clay was laid out by ploughing two furrows 14 feet apart. The dirt was thrown out toward the side gutters. Beginning at the middle, the 14-foot part was ploughed by backfurrowing the dirt toward the centre. This formed a crown in the middle of the part to be clayed. Next, this was harrowed and the subgrade completed with a small grader. The shoulders were then made by running a furrow outside the subgrade and backing up the first furrow on each side. Two more such furrows were run, and in this way the shoulders were formed at least 10 inches higher than the subgrade. If the cross section is level, a toothed harrow is excellent to prepare the subgrade after it has been ploughed as has been described above. When it is necessary to move material from one side to the other, or to carry material along in the subgrade, a two-horse grader will be found useful.

After the subgrade had been prepared the clay was hauled and dropped three loads abreast. The centre loads followed the centre line exactly, and to this end a line of centre stakes was set 200 or 300 feet in advance of the clay hauling. It was then an easy matter to drop the side loads properly. It is best to keep the centre loads 30 to 50 feet in advance of the side loads. In this way three teams may be kept busy at the same time. In order to get a sufficient sand covering upon the road, drag scrapers were used and sand hauled from beyond the borders of the roadway. It was then spread with a harrow and a two-horse grader evenly over the road and mixed with the dust and fine particles of clay. After a rain the sand was quickly incorporated with the clay. Still more sand was evidently needed, and this was harrowed into the clay as the mass dried and packed under travel. Finally, a large grader was used to shape the road.

As has been stated above, the clay at this place was rather more of an accident than a natural condition of wide extent; still it is of sufficient importance to justify a careful study of its behaviour on the road. It would be an easy matter to provide settling basins along irrigation canals where this fine silt could be collected, and after the water had been shut off, the clay thus deposited could be hauled upon the road. In this way large quantities of material could be provided, and if its use proves as valuable as indications seem to show, much good may be expected from this source in the improvement of heavy sand roads along irrigation ditches. In this experiment the silt combined readily with the sand when wet and held it firmly. The addition of sand took away its sticky qualities.

The cost data of this experiment follow :----

Foreman for job	\$ 51 50
Excavation (2,539 cubic yards)	396 69
Shaping subgrade	70 00
Ploughing up clay	54.875
Loading clay into wagons	470 00
Hauling clay to road	608 38