

# Further Studies of Epoxy Bonding Compounds

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## ABRIDGMENT\*

• THIS REPORT is a study in detail of an epoxy formulation, Formulation G, which is suitable for application in the field of heavy construction. One type of such construction has been simulated by composite beam tests; however, the investigators feel that the most important part of the study has been the development of basic information concerning the physical properties of a single epoxy formulation, both as a plastic and as an adhesive, in several ranges of conditioning temperatures and curing times. An interim report, published in October 1962, gave information on Formulation G for specimen ages of 4 through 22 days in particular, and also gave some information for specimen ages of several months. This final report concentrates on filling in the basic information on the early ages of the specimens, and also presents information of long-term studies involving the aging and creep characteristics of the material.

Formulation G consists of the following:

<u>Component</u>	<u>Parts by wt</u>
<u>Component A:</u>	
Resin (equivalent epoxide weight 175-200, viscosity 10,000-15,000 cps)	100
Silica flour No. 219	12.5
<u>Component B:</u>	
Liquid polymer, LP-3	50
Silica flour No. 219	47.3
DMP-10	6.25
DMP-30	3.75
Bentone 38	2.5
Anti-foam 24 (General Electric product or equivalent)	2.5

Several important conclusions have been drawn from the results of this additional investigation. A few of these are as follows:

1. Changes in the conditioning history, especially during the early age of the formulation, significantly affect the results of physical testing.
2. At low temperatures the curing of the epoxy formulations is temporarily interrupted. At temperatures above 60 F, curing once again continues, and the material gains strength with time.
3. Prevention of the loss of water from the concrete is important during the early age of the concrete for optimum strength of the structural system.
4. To insure the full strength of the adhesive system, it is recommended that fresh batches of the components be prepared before field use. DMP-10 is predominately responsible for the deterioration of exposed stored components.
5. Formulation G, when used as an adhesive within the working stresses for composite construction, will creep negligibly, at least up to a loading time of 1,400 hr.
6. Changes in the normal thickness of an adhesive layer that would be used for field construction will not seriously affect the strength of the structural system.

\*Five copies of the complete paper have been sent to the Chief Administrative Officers of State Highway Departments. Additional copies are available from the Highway Research Board at \$1.60 each.

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7. The physical properties of Formulation G are not too much affected by changes in the particle size of silica flour 219.

8. Creep of a composite unit, consisting of a concrete slab glued to steel beams by Formulation G, was insignificant during a  $6\frac{2}{3}$  mo testing period.

9. The composite beams of steel-to-concrete using Formulation G as a shear connector showed excellent structural interaction under a slowly increasing live load to failure during a single loading condition. However, when severely loaded, unloaded, and reloaded to failure, they were weaker in strength than stud-connected beams tested under the same conditions of loading.