



## Investigation of the Effects of Air Purge Gun Systems on Rigid Polyurethane Concrete Lifting Foams

HMI Laboratory  
4466 Custer St  
Manitowoc, WI 54220  
Tel: (800) 626-2464

---

Job ID: RLW-1104-NB1-160  
Product Name: RR 201.LIT, RR 401.LIT

---

For:

4466 Custer St  
Manitowoc, WI 54220

Signature

Date Authorized/Released: 7/17/2024

*Natalie Bird*

## Background:

The purpose of this investigation is to demonstrate HMI's polyurethane concrete lifting foams performance using the EliteOne air purge gun. It is a common misconception that the cells created during the reaction of polyol blends and isocyanate are destroyed by the force of the air coming through the gun after an injection. It is also believed that this destruction of the cells will negatively affect the foam quality and significantly reduce the yield. Although basic physics principles may support this based on a generalization of the very basic idea of what "foams" are, we aim to demonstrate the power of HMI's polyurethane foams through scientific evaluation.

## Procedure:

Two apparatuses for confined injection were assembled using 2"x4" pieces of lumber and poly laminate board. The apparatus is a 3'x3'x3.5" box secured together using wood screw. On the top side of the box, a 1/2 inch hole was drilled into the center and an injection port was inserted. The first material tested was RR 201.LIT. The material was recirculated for one hour at B-side 110 °F, A-side 100 °F, and hose heat 110 °F. The reactor which was equipped with the EliteOne air purge gun was then taken out of recirculation and pressurized to 1875 psi. A test spray into a waste box was done to confirm that the reactor is working properly and producing good foam. Once this was confirmed, the gun was then connected to the injection port on the box. ~6 pounds of material was injected into the confined space of the box. Immediately after the material had been injected the gun was switched into air mode and kept on the port for 3 minutes allowing the forced air to be contacting foam through its entire reaction process. After one hour the box was opened, and the sample extracted. This was then repeated using ~ 10 pounds of RR 401.LIT. The following day, measurements of the injection holes were taken and each sample was cut into zones which were determined by its proximity to the core sample. Blocks from each zone were measured for the density. This data was then used to determine what, if any effects the air purge gun has on yield, foam quality, and homogeneity.

## Data:



Image 1 shows the inside of the test box each formula was injected into under confinement.



## RR 201.LIT Data:

Image 2 shows the RR 201.LIT that had been injected under confinement using HMI's EliteOne gun. Immediately following the injection, the gun was put into air purge position and air was allowed to exert force on the foam through all steps in the formation of foam.

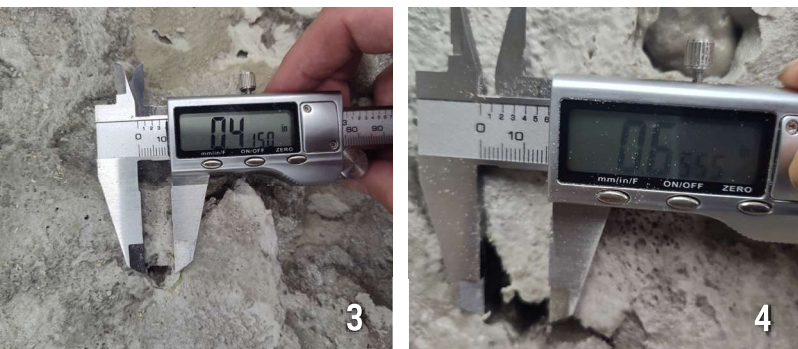


Image 3 and 4 show the length and width of the hole where the material was injected and air was purged throughout the complete reaction of the components. (3 min) The length was measured to be 0.6555" and the width 0.4810".

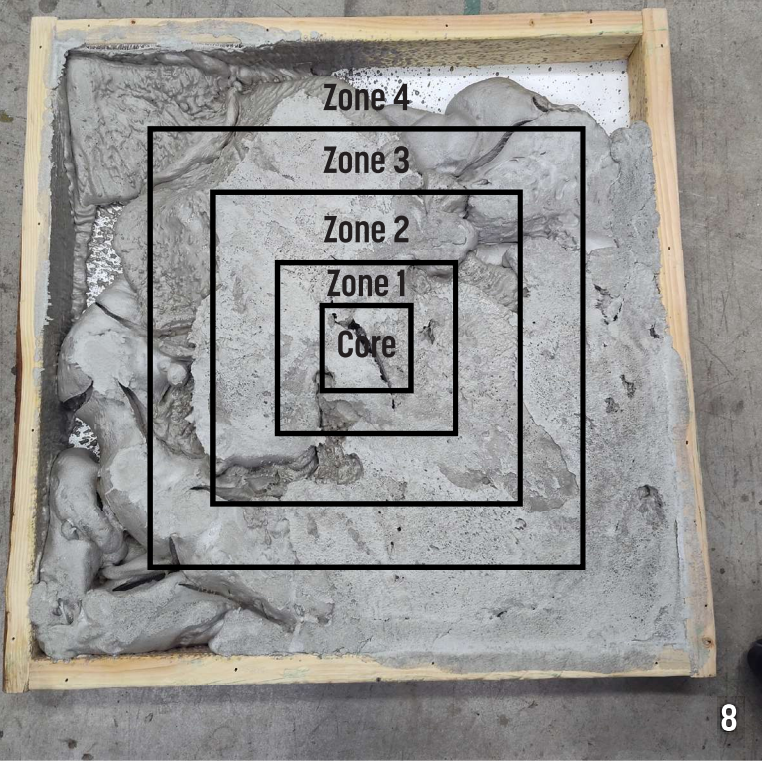


Image 5 shows the depth at which the air purge had effect on the foam. The air purge did not allow the foam to form for a depth of 1.6685". This would allow the port to remain clear for additional foam to be injected and did not negatively impact the surrounding foam quality.

Image 6 shows the width at which the air purge had effect on the foam. The air purge did not allow the foam to form at a maximum width of 0.7350". This would allow the port to remain clear for additional foam to be injected and did not impact the surrounding foam quality.



Image 7 shows the back side of the RR 201.LIT sample. The foam was not effected nor did the air purge perforate through the depth of the sample.



**RR 201.LIT Data Continued:**

Image 8 shows the mapping of the test sample where blocks would be collected for comparison. Ten block samples were cut from each zone 1,2,3,4, and core. The data from each zone is then analyzed to show any variance in the foam density. Variance in foam density from the core out would indicate the air purge having a negative impact on the foam.

Image 9 shows an example of one set of the zones block samples collected for density measurements.



## Core

Chart 1:

Length	1.398	1.368	1.414	1.4285	1.4045	1.4125	1.386	1.4275	1.4125	1.0375
Width	1.377	1.407	1.423	1.446	1.321	1.419	1.359	1.4155	1.1405	0.7415
Height	1.428	1.428	1.402	1.3905	1.4135	1.2865	1.435	1.341	1.4315	0.9685
Weight	2.62	2.56	2.56	2.6	2.31	2.55	2.38	2.38	2.33	0.7
Density lb/ft <sup>3</sup>	3.63	3.41	3.46	3.45	3.35	3.76	3.35	3.34	3.85	3.58

## Zone 1

Chart :

Length	1.394	1.427	1.434	1.4205	1.4335	1.422	1.4115	1.4285	1.4255	1.428
Width	1.414	1.42	1.434	1.437	1.399	1.3975	1.4345	1.3895	1.4225	1.406
Height	1.432	1.403	1.396	1.4145	1.398	1.2035	1.3955	1.402	1.4015	1.411
Weight	2.55	2.65	2.65	2.54	2.52	2.37	2.73	2.61	2.63	2.52
Density lb/ft <sup>3</sup>	3.44	3.55	3.52	3.35	3.42	3.77	3.68	3.57	3.52	3.39

## Zone 2

Chart 3:

Length	1.369	1.434	1.411	1.4095	1.396	1.406	1.4135	1.414	1.4085	1.394
Width	1.426	1.415	1.421	1.432	1.424	1.3895	1.44	1.399	1.4365	1.441
Height	1.382	1.397	1.441	1.3855	1.3695	1.4395	1.423	1.46	1.9705	1.4315
Weight	2.64	2.49	2.62	2.49	2.52	2.63	2.7	2.72	2.73	2.47
Density lb/ft <sup>3</sup>	3.73	3.34	3.45	3.38	3.52	3.56	3.55	3.58	3.75	3.27

## Zone 3

Chart 4:

Length	1.431	1.433	1.401	1.4255	1.423	1.3965	1.429	1.3995	1.4105	1.427
Width	1.396	1.358	1.345	1.398	1.401	1.414	1.4185	1.4265	1.43	1.391
Height	1.38	1.389	1.403	1.3855	1.393	1.4135	1.384	1.391	1.3835	1.366
Weight	2.54	2.52	2.55	2.5	2.54	2.53	2.59	2.61	2.53	2.49
Density lb/ft <sup>3</sup>	3.51	3.55	3.67	3.45	3.48	3.45	3.51	3.58	3.45	3.5

## Zone 4

Chart 5:

Length	1.429	1.377	1.41	1.4245	1.416	1.3615	1.419	1.4155	1.428	1.4205
Width	1.419	1.427	1.463	1.4185	1.4065	1.4095	1.4355	1.393	1.364	1.406
Height	1.374	1.399	1.388	1.4155	1.393	1.4131	1.4255	1.426	1.409	1.422
Weight	2.5	2.51	2.45	2.47	2.7	2.54	2.76	2.68	2.46	2.74
Density lb/ft <sup>3</sup>	3.42	3.48	3.26	3.29	3.7	3.52	3.62	3.63	3.41	3.67

Charts 1-5 show the block density measurements from each zone sampled.

Chart 6:

Zone	Core	Zone 1	Zone 2	Zone 3	Zone 4
Average Density lb/ft <sup>3</sup>	3.518	3.521	3.513	3.515	3.5
$\Delta_D$ From Core lb/ft <sup>3</sup>	x	-0.003	0.005	0.003	0.018
% Change	x	-0.085	0.1421	0.0853	0.5117

Chart 6 shows the average density, change in density from the core, and percent change in density from the core of the measured blocks from each zone.



### RR 401.LIT Data:

Image 10 shows the RR 401.LIT that had been injected under confinement using HMI's EliteOne gun. Immediately following the injection, the gun was put into air purge position and air was allowed to exert force on the foam through all steps in the formation of foam.



Image 11 and 12 show the length and width of the hole where the material was injected and air was purged throughout the complete reaction of the components. (3 min) The length was measured to be 0.4150" and the width 0.3445".



Image 13 shows the depth at which the air purge had effect on the foam. The air purge did not allow the foam to form for a depth of 0.4415". This would allow the port to remain clear for additional foam to be injected and did not negatively impact the surrounding foam quality.



Image 14 shows the width at which the air purge had effect on the foam. The air purge did not allow the foam to form at a maximum width of 0.3445". This would allow the port to remain clear for additional foam to be injected and did not impact the surrounding foam quality.

## Core

Chart 6:

Length	1.328	1.446	1.425	1.434	1.4285	1.4045	1.4225	1.479	1.3925	1.4235
Width	1.406	1.444	1.434	1.3675	1.426	1.451	1.423	1.431	1.426	1.397
Height	1.443	1.419	1.434	1.406	1.3855	1.419	1.4065	1.449	1.4325	1.4225
Weight	3.23	3.67	3.13	3.26	3.32	3.75	3.31	3.41	3.05	3
Density lb/ft <sup>3</sup>	4.56	4.72	4.07	4.5	4.48	4.94	4.43	4.23	4.08	4.04

## Zone 1

Chart 7:

Length	1.45	1.401	1.384	1.5145	1.4615	1.444	1.4525	1.468	1.459	1.434
Width	1.457	1.341	1.468	1.447	1.296	1.4585	1.3715	1.3805	1.437	1.3165
Height	1.438	1.47	1.387	1.424	1.423	1.4284	1.4515	1.4535	1.447	1.421
Weight	3.55	3.26	3.23	3.37	3.17	3.99	3.26	3.14	3.38	2.98
Density lb/ft <sup>3</sup>	4.45	4.5	4.36	4.11	4.48	5.05	4.29	4.06	4.24	4.23

## Zone 2

Chart 8:

Length	1.476	1.421	1.404	1.459	1.4705	1.4585	1.3835	1.466	1.466	1.459
Width	1.262	1.47	1.483	1.2345	1.392	1.2695	1.364	1.4	1.3865	1.4
Height	1.332	1.259	1.22	1.2625	1.2525	1.1785	1.4625	1.219	1.228	1.2475
Weight	3.03	2.99	3.07	3	3.99	2.97	2.92	2.71	2.6	2.62
Density lb/ft <sup>3</sup>	4.65	4.33	4.6	5.02	4.44	5.18	4.03	4.12	3.96	3.91

## Zone3

Chart 9:

Length	1.427	1.47	1.344	4.455	1.4965	1.271	1.368	1.478	1.3835	1.4475
Width	1.425	1.415	1.482	1.431	1.482	1.4685	1.466	1.4655	1.451	1.403
Height	1.457	1.346	1.502	1.437	1.301	1.4525	1.4005	1.2375	1.5145	1.4905
Weight	3.89	2.95	3.06	3.01	3.17	3.61	3.86	3.26	3.51	3.28
Density lb/ft <sup>3</sup>	5	4.01	3.89	3.83	4.18	5.07	5.23	4.63	4.39	4.12

## Zone 4

Chart 10:

Length	1.41	1.405	1.393	1.3985	1.3085	1.3422	1.4315	1.3405	1.465	1.459
Width	1.412	1.43	1.399	1.417	1.4185	1.407	1.409	1.434	1.432	1.4485
Height	1.428	1.397	1.433	1.419	1.4445	1.4365	1.3915	1.4165	1.1665	1.1355
Weight	2.97	2.95	3.28	3	3.25	3.26	3.95	3.77	2.57	2.46
Density lb/ft <sup>3</sup>	3.98	4	4.47	4.06	4.61	4.57	5.36	5.27	4	3.9

Charts 6-10 show the block density measurements from each zone sampled.

## Chart 11:

Zone	Core	Zone 1	Zone 2	Zone 3	Zone 4
Average Density lb/ft <sup>3</sup>	4.405	4.377	4.424	4.435	4.422
$\Delta_D$ From Core lb/ft <sup>3</sup>	x	0.028	-0.019	-0.03	-0.017
% Change	x	0.7959	-0.5401	-0.8528	-0.483

Chart 11 shows the average density, change in density from the core, and percent change in density from the core of the measured blocks from each zone.

## Conclusion:

In this experiment we evaluated the effects of HMI's EliteOne air purge gun on polyurethane concrete lifting foam under confinement. A 3'x3'x3.5" box was built using 2x4 lumber and poly laminate board for injection of HMI's RR 201.LIT and RR 401.LIT. Approximately 6 pounds of RR 201.LIT was injected into the apparatus just as would be done on a typical concrete lifting job. Immediately after the injection, the gun was placed into air purge position while remaining on the port for 3 minutes which allowed the air to act upon the foam during the entire time the foam was reacting to completion. After 3 minutes the gun was removed and the foam was allowed to continue curing for one hour. The box was then opened and the sample was extracted. After 24 hours, measurements were taken of the hole where air was directly acting on the foam and cut into 5 different zones for sampling. The air caused a hole with surface measurements of 0.6555"x0.4810" and a depth of 1.685". Maximum width in the entire length of the hole was 0.7350". Each zone was cut into blocks and 10 samples of each were retained for density analysis. The average density of the core was calculated to be 3.518 lb./ft<sup>3</sup>, (zone 1) 3.521 lb./ft<sup>3</sup>, (zone 2) 3.513 lb./ft<sup>3</sup>, (zone 3) 3.515 lb./ft<sup>3</sup>, and (zone 4) 3.5 lb./ft<sup>3</sup>. The change in density in correlation to the core ranged from -0.003-0.018 lb./ft<sup>3</sup> which calculates to a minimum density retention of 99.49 percent. This procedure was repeated using ~10 pounds of HMI's RR 401.LIT. The air caused a hole with surface measurements of 0.4150"x0.3445" and a depth of 0.4415". Maximum width in the entire length of the hole was 0.3445". Each zone was cut into blocks and 10 samples of each were retained for density analysis. The average density of the core was calculated to be 4.405 lb./ft<sup>3</sup>, (zone 1) 4.377 lb./ft<sup>3</sup>, (zone 2) 4.424lb/ft<sup>3</sup>, (zone 3) 4.435 lb./ft<sup>3</sup>, and (zone 4) 4.422 lb./ft<sup>3</sup>. The change in density in correlation to the core ranged from -0.03-0.028 lb./ft<sup>3</sup> which calculates to a minimum density retention of 99.97 percent. From this data we are able to definitively conclude that the air purge system does not negatively effect foam quality, foam density, or disrupt the formation of polyurethane foam cells. The air purge system designed to keep the injection port clear during the chemical reaction between polyurethane A-side and B-side successfully keeps the port clear without any negative effects on the resulting foam.