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LAMPIRAN 1

**HASIL PENGUJIAN KARAKTERISTIK
MATERIAL**



Tyfo® SEH-51A Composite using Tyfo® S Epoxy

DESCRIPTION

The Tyfo® SEH-51A Composite is an ICC-ES ESR-2103 listed material comprised of Tyfo® S Epoxy and Tyfo® SEH-51A reinforcing fabric. Tyfo® SEH-51A is a custom weave, uni-directional glass fabric used in the Tyfo® Fibrwrap® System. The glass material is orientated in the 0° direction with additional yellow glass cross fibers at 90°. The Tyfo® S Epoxy is a two-component epoxy matrix material.

USE

Tyfo® SEH-51A Fabric is combined with Tyfo® epoxy material to add strength and ductility to bridges, buildings, and other structures.

ADVANTAGES

- ICC-ES ESR-2103 listed product
- Component of UL listed, fire-rated assembly
- NSF/ANSI Standard 61 listed product for drinking water systems
- Good high & low temperature properties
- Long working time
- High elongation
- Ambient cure
- 100% solvent-free
- Rolls can be cut to desired widths prior to shipping

COVERAGE

For typical applications approximately 62.6m² surface area with 3 to 4 units of Tyfo® S Epoxy and 1 roll of Tyfo® SEH-51A Fabric when used with the Tyfo® Saturator. Consumption may vary depending on surface, temperature, applicators experience.

PACKAGING

Order Tyfo® S Epoxy in pre-measured units comprised of Component A (bucket weighing 12.23kg) and Component B (bucket weighing 4.22kg). Order Tyfo® SEH-51A Fabric in 1.37m x 45.7m rolls. Typically ships in 305mm x 330mm x 1626mm boxes.

EPOXY MIX RATIO

100.0 component A to 42.0 component B by volume. (100 component A to 34.5 component B by weight.)

SHELF LIFE

Epoxy - two years in original, unopened and properly stored containers.

Fabric - ten years in proper storage conditions.

STORAGE CONDITIONS

Store epoxy at 40° to 90° F (4° to 32° C). Avoid freezing. Store rolls flat, not on ends, at temperatures below 100°F (38°C). Avoid moisture and water contamination.

TYPICAL DRY FIBER PROPERTIES		
PROPERTY	TYPICAL TEST VALUE	
Tensile Strength	470,000 psi (3.24 GPa)	
Tensile Modulus	10.5 x 10 ⁶ psi (72.4 GPa)	
Ultimate Elongation	4.5%	
Density	0.092 lbs./in. ³ (2.55 g/cm ³)	
Minimum weight per sq. yd.	27 oz. (915 g/m ²)	

COMPOSITE GROSS LAMINATE PROPERTIES			
PROPERTY	ASTM METHOD	TYPICAL TEST VALUE	DESIGN VALUE*
Ultimate tensile strength in primary fiber direction	D3039	83,400 psi (575 MPa) (4.17 kip/in. width)	66,720 psi (460 MPa) (3.3 kip/in. width)
Elongation at break	D3039	2.2%	1.76%
Tensile Modulus	D3039	3.79 x 10 ⁶ psi (26.1 GPa)	3.03 x 10 ⁶ psi (20.9 GPa)
Ultimate tensile strength 90 degrees to primary fiber	D3039	3,750 psi (25.8 MPa)	3,000 psi (20.7 MPa)
Nominal Laminate Thickness		0.05 in. (1.3mm)	0.05 in. (1.3mm)

* Gross laminate design properties based on ADI 440 suggested guidelines will vary slightly. Contact Fyfe Co. LLC engineers to confirm project specification values and design methodology.

EPOXY MATERIAL PROPERTIES		
Curing Schedule 72 hours post cure at 140° F (60° C).		
PROPERTY	ASTM METHOD	TYPICAL TEST VALUE*
T _g	D4065	180° F (82° C)
Tensile Strength ¹	D638 Type 1	10,500 psi (72.4 MPa)
Tensile Modulus	D638 Type 1	461,000 psi (3.18 GPa)
Elongation Percent	D638 Type 1	5.0%
Flexural Strength	D790	17,500 psi (123.4 MPa)
Flexural Modulus	D790	452,000 psi (3.12 GPa)

¹ Testing temperature: 77° F (25° C) Creashield speed: 0.5 in. (13mm)/min. Grip load: 2716-0055 - 30 kips

* Specification values can be provided upon request.

CERTIFICATE OF COMPLIANCE

- Will be supplied upon request, complete with state and federal packaging laws with copy of labels used.
- Material safety data sheets will be supplied upon request.
- Possesses 0% V.O.C. level.

HOW TO USE THE TYFO® S COMPOSITE SYSTEM

DESIGN

The Tyfo® Fiberglass System shall be designed to meet specific design criteria. The criteria for each project is dictated by the engineer of record and any relevant building codes and/or guidelines. The design should be based on the allowable strain for each type of application and the design modulus of the material. The Fyfe Company engineering staff will provide preliminary design at no obligation.

INSTALLATION

Tyfo® System to be installed by Fyfe Company trained and certified applicators. Installation shall be in strict compliance with the Fyfe Company Quality Control Manual.

SURFACE PREPARATION

The required surface preparation is largely dependent on the type of element being strengthened. In general, the surface must be clean, dry and free of protrusions or cavities, which may cause voids behind the Tyfo® composite. Column surfaces that will receive continuous wraps typically require only a broom cleaning. Discontinuous wrapping surfaces (walls, beams, slabs, etc.) typically require a light sandblast, grinding or other approved methods to prepare for bonding. Sharp and chamfered corners will be rounded off by grinding or using thickened Tyfo® S epoxy or approved repair mortar. At the time of application, the substrate shall not have any free moisture on it. If moisture cannot be avoided, the use of Tyfo® WP (Wet-Prime epoxy) is recommended. Tyfo® Fibers Anchors are incorporated in some designs. The Fyfe Company engineering staff will provide the proper specifications and details based on the project requirements.

MIXING

For pre-measured units of "PACKAGING", pour the contents of Component B (Hardener) into the pall of Component A (Epoxy). In general, mix 100 parts of Component A to 42 parts of Component B by volume or 100 parts of Component A to 34.5 parts of Component B by weight. Mix thoroughly for five minutes with a low-speed mixer at 400 - 600 RPM until uniformly blended. Air bubbles should be avoided during the mixing.

APPLICATION

Apply one prime coat of Tyfo® S Epoxy on the substrate by using a roller. Saturate the fabric by feeding it through the Tyfo® Saturator. Apply using the Tyfo® Wrapping equipment or approved hand methods (See the Tyfo® Saturator Manual). Prior to the application of the saturated fabric, fill any uneven surface with thickened Tyfo® S epoxy. Saturate and apply subsequent layers of the fabric according to the Specifications and the Design Requirements. The use of a roller or hand pressure, ensure proper orientation of fibers, release or roll out entrapped air and ensure that each individual layer is firmly bedded and adhered to the preceding layer or substrate. Apply a final coat of thickened Tyfo® S Epoxy and detail all fabric edges, including butt splice, termination points and jacket edges.

PROTECTIVE COATINGS

In case of plaster final coating, apply sand by hand for better bonding surface while the final coat of epoxy is still tacky. In case of paint final coating, paint between 24 and 72 hours after final application of epoxy. If more than 72 hours after application, prepare the surface of the final coat of epoxy by light sandblast or hand sanding to slightly etch the surface.

LIMITATIONS

Application temperature of the epoxy is a minimum 40° F (4° C) and maximum of 100° F (38° C). DO NOT THIN, solvents will prevent proper cure.

FIELD QUALITY CONTROL

Record batch numbers for fabric and epoxy used each day and note locations of installations. Measure square feet of fabric and volume of epoxy used each day.

SAFETY PRECAUTIONS

Avoid breathing vapors. Avoid contact with eyes and skin. Use of an approved respirator with an organic absorption cartridge is recommended for possible vapors. Rubber gloves, rubber boots, and protective suits are recommended for handling and application of this material. Safety glasses or a face shield are recommended to prevent eye contact.

FIRST AID

In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately. For respiratory problems, remove to fresh air. Wash clothing before reuse.

CLEANUP

Collect with absorbent material, flush with water. Dispose of in accordance with local disposal regulations. Uncured material can be removed with approved solvent. Cured materials can only be removed mechanically.

SHIPPING LABELS CONTAIN

- State specification number with modifications, if applicable
- Component designation
- Type, if applicable
- Manufacturer's name
- Date of manufacture
- Batch name
- State lot number, if applicable
- Directions for use
- Warnings or precautions by law

KEEP CONTAINER TIGHTLY CLOSED.
NOT FOR INTERNAL CONSUMPTION.
CONSULT MATERIAL SAFETY DATA SHEET
(MSDS) FOR MORE INFORMATION.
KEEP OUT OF REACH OF CHILDREN.
FOR INDUSTRIAL USE ONLY.

CAUTION

COMPONENT A - Irritant:

Prolonged contact to the skin may cause irritation. Avoid eye contact.

COMPONENT B - Irritant:

Corrosive. Contact with skin may cause severe burns. Avoid eye contact. Product is a strong sensitizer. Use of safety goggles and chemical resistant gloves recommended. Remove contaminated clothing. Avoid breathing vapors. Use adequate ventilation. Use of an organic vapor respirator recommended.

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UNIVERSITAS HASANUDDIN**

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Waktu Penelitian : Maret - Juli 2013
Penelitian : Pengaruh ikatan diagonal GFRP pada hubungan balok-kolom pracetak terhadap kekuatan sambungan
Peneliti : Teguh Hilmansyah

PENGUJIAN KUAT TARIK BELAH SILINDER BETON UMUR 28 HARI

No. Sampel	Umur (hari)	Berat (kg)	Tinggi (mm)	Diameter (mm)	Berat Isi (kg/m ³)	P maks (kN)	Kuat Tarik Belah (Mpa)	Kuat Tarik
1	28	12,842	300	150	2423,6	330	4,67	4,67
2		12,680	300	150	2393,0	340	4,81	
3		12,605	300	150	2378,9	320	4,53	

Catatan : Kuat Tarik Belah = 2P/HD

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Peneliti : Teguh Hilmansyah

PENGUJIAN UJI LENTUR BALOK BETON UMUR 28 HARI

Benda Uji	Umur	Panjang	Lebar	Tinggi	Berat	Beban	Tegangan Lentur	R
		L	b	h	Benda Uji	Lentur, P	$R = (P \cdot L) / (b \cdot h^2)$	rata-rata
		(mm)	(mm)	(mm)	(gr)	(N)	(MPa)	(Mpa)
1	28 hari	400	100	100	10010	12850	5,14	4,78
2	28 hari	400	100	100	10005	14450	5,78	
3	28 hari	400	100	100	10925	12010	4,804	
4	28 hari	400	100	100	10870	11660	4,664	
5	28 hari	400	100	100	9970	8770	3,508	

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Waktu Penel : Maret - Juli 2013

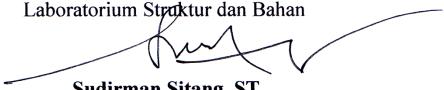
Penelitian : Pengaruh ikatan diagonal GFRP pada hubungan balok-kolom pracetak terhadap kekuatan sambungan

Peneliti : Teguh Hilmansyah

PENGUJIAN KUAT TEKAN SILINDER BETON UMUR 28 HARI

No	Umur (hari)	Berat (kg)	Tinggi (mm)	Luas (mm ²)	Berat Isi (kg/m ³)	P maks (kN)	Kuat Tekan (Mpa)	Kuat Tekan Rata-rata (Mpa)
	28	12,515	300	17662,5	2361,9	445	25,195	
	28	12,658	300	17662,5	2388,9	425	24,062	
	28	12,645	300	17662,5	2386,4	498	28,195	25,82

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Penelitian : Pengaruh ikatan diagonal GFRP pada hubungan balok-kolom pracetak terhadap kekuatan sambungan
Peneliti : Teguh Hilmansyah

Sampel : 1 f_c = 25 Mpa
Beban P : 510 kN FAS = 0,5
Kuat Tekan : 28,87 Mpa Slump = 10 cm

Diameter (mm)	Panjang (mm)	Luas (mm ²)	Pembebatan (P) (N)	Perpendekan (Δ V) (mm)	Tegangan (σ = P/A) (N/mm ²)	Regangan (ε = ΔV/H) (mm/mm)	Elastisitas S2 - S1			
							S2	S1	ε2	ε1
150	300	17662,5	0	0	0.0000	0,000000	11,549894	0,913179	0,002910	0,000167
	300	17662,5	100000	0,31	5,6617	0,001033				
	300	17662,5	120000	0,45	6,7941	0,001500				
	300	17662,5	150000	0,65	8,4926	0,002167				
	300	17662,5	210000	0,9	11,8896	0,003000				
	300	17662,5	250000	1,2	14,1543	0,004000				
	300	17662,5	310000	1,5	17,5513	0,005000				
	300	17662,5	360000	1,85	20,3822	0,006167				
	300	17662,5	460000	2,25	26,0439	0,007500				
	300	17662,5	480000	2,65	27,1762	0,008833				
	300	17662,5	510000	2,84	28,8747	0,009467				

Makassar, Juli 2013
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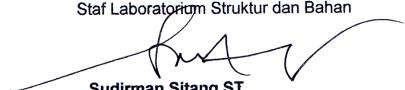
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Waktu Penelitian	:	Maret - Juli 2013									
Penelitian	:	Pengaruh ikatan diagonal GFRP pada hubungan balok-kolom pracetak terhadap kekuatan sambungan									
Peneliti	:	Teguh Hilmansyah									
Sampel	:	2				f_c	=	25	Mpa		
Beban P	:	560 kN				FAS	=	0,5			
Kuat Tekan	:	31,71 Mpa				Slump	=	10	cm		

Diameter (mm)	Panjang (mm)	Luas (mm ²)	Pembebatan (P) (N)	Perpendekan (Δ V) (mm)	Tegangan (σ = P/A) (N/mm ²)	Regangan (σ = ΔV/H) (mm/mm)	Elastisitas S2 - S1			
							S2	S1	ε2	ε1
150	300	17662,5	0	0	0,0000	0,000000	12,6622	0,3539	0,006068	0,000167
	300	17662,5	110000	0,88	6,2279	0,002933				
	300	17662,5	180000	1,37	10,1911	0,004567				
	300	17662,5	240000	1,95	13,5881	0,006500				
	300	17662,5	300000	2,5	16,9851	0,008333				
	300	17662,5	360000	3	20,3822	0,010000				
	300	17662,5	420000	3,8	23,7792	0,012667				
	300	17662,5	490000	4,8	27,7424	0,016000				
	300	17662,5	540000	5,7	30,5732	0,019000				
	300	17662,5	560000	6,7	31,7056	0,022333				2089,20

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