

DYWIDAG Threadbar Resin Anchored Rock Bolts



Lafayette Bluff Tunnel, U.S. Highway 61, Minnesota

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Resin bolts, bonded to rock or concrete by a fast curing polyester resin grout, are used extensively for slope stabilization, tie backs, tie downs, and rock bolts. The resin grout develops a bond superior to that developed by cement grout. Fast gelling resin allows transfer of load to the rock formation within minutes after installing the bolt.

DYWIDAG THREADBAR® provides a simple, economical, and rugged solution to both tensioned and non-tensioned rock bolts and rock anchors when installed with resin grout.

Threadbar for prestressing, conforming to ASTM A722, is available in 1" (26 mm), 1¼" (32 mm), and 1¾" (36 mm) nominal diameter. Threadbar for reinforcing, conforming to ASTM A615, is available in grades 60 and 75 for sizes #6 through #8, grade 75 for sizes #9 through #18, and grade 80 for 63 mm bar.

Dywidag Threadbar for prestressing and reinforcing have a continuous pattern of threadlike deformations along their entire length. More durable than machined threads, the deformations allow anchorages and couplers to thread onto a Threadbar at any point.

The rolled-in Dywidag thread pattern has no effect on the overall strength or effective area

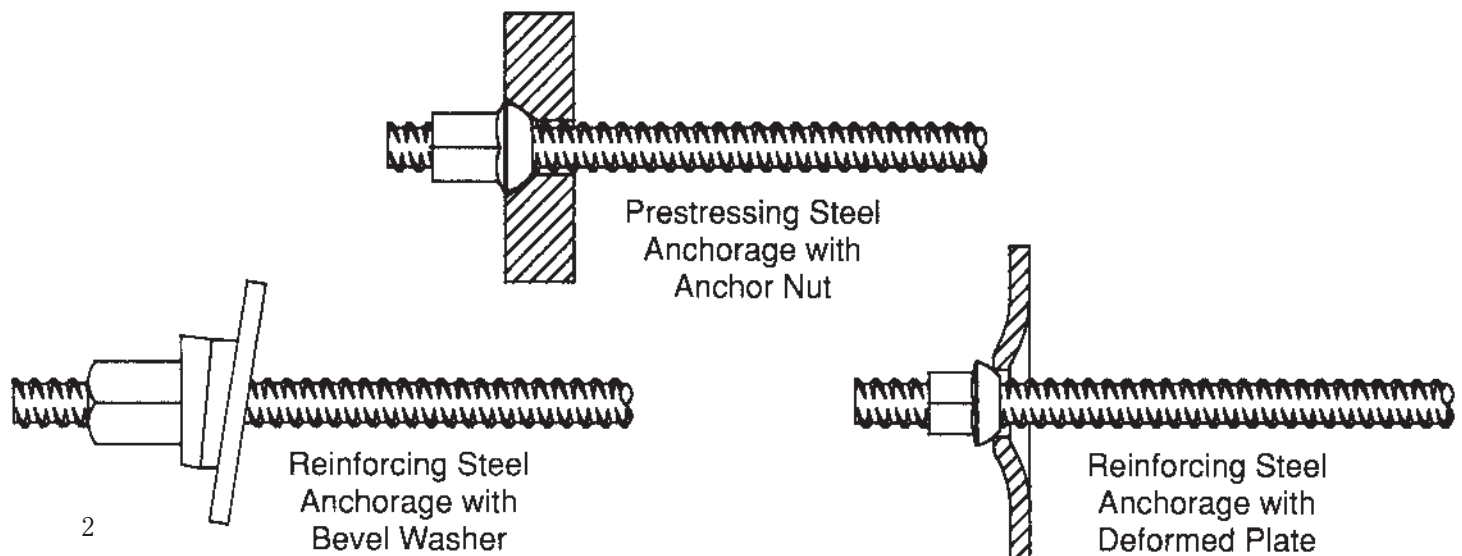
of the Threadbar. Conventional rebar and other steels have a reduction of 25% to 35% in effective area when machined threads are applied.

The strength of Dywidag Threadbar anchorages and couplers, for prestressing, exceed the requirements of ACI 318. Test reports are available for the main components of the system. Anchorages and couplers for reinforcing Threadbar develop 100% of the ultimate nominal strength of the bar.

Available in mill lengths to 60', Dywidag Threadbar may be cut to specified lengths before being shipped to the job site or, where circumstances warrant, Threadbars may be shipped in mill lengths for field cutting with a portable friction or band saw.

Threadbars may be coupled to facilitate installation in confined areas or to allow removal of prebolted overcast and resetting of anchors. Dywidag Threadbar anchors can be extended into a structure or function as a form tie.

Dywidag Threadbars are used extensively for rock anchors because of their versatility, strength, performance characteristics, and off-the-shelf availability of most components.



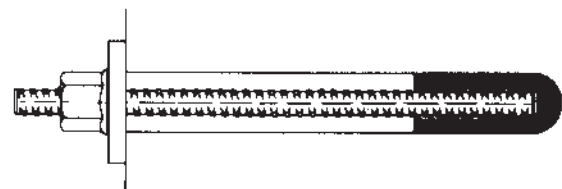
The components of the DYWIDAG THREADBAR® system are manufactured in the United States and Canada by DYWIDAG-Systems International.

Polyester resin is packaged in cartridge form and is available in various diameters and gel times. The cartridge consists of a heat sealed tube of polyester film containing both the resin and the catalyst, which are separated by a barrier which prevents chemical interaction. The resin cartridges are placed in the bore hole before the Threadbar is inserted. The resin gels after the components are mixed during the installation of the Dywidag Threadbar.

Resin anchored rock bolts are installed in all types of rock or concrete. Track drills, tire mounted drills, jacklegs or stoppers may be used to both drill the hole and install the Dywidag bolt.

Dywidag resin anchors are used where expansion shells are inappropriate. The resin anchorage length is easily adjusted to fit the varying rock conditions. Resin anchored Dywidag rock bolts may be installed in bore holes located at any angle above or below the horizontal.

Tension bolts with resin point anchorage are used to apply a compressive force across layered rock strata. Tension bolts may be applied using fast setting resin as the point anchorage in conjunction with slow setting resin as a corrosion protection for the free stressing length. Bolt tension is applied after the fast setting resin has cured but before the slow setting resin cures. Untensioned dowels are fully encapsulated with resin and rely on movement of the rock strata to load the bolts.



Tensioned bolts with resin point anchorage.



Tensioned bolts fully resin anchored and grouted.



Untensioned dowels fully resin grouted.



Prestressing Steel
Wedge Washer
Assembly



Resin Cartridge

Some important notes concerning the safe handling of high strength steel for prestressed concrete:

1. Do not damage surface of bar.
2. Do not weld or burn so that sparks or hot slag will touch any portion of bar which will be under stress.
3. Do not use any part of bar as a ground connection for welding.
4. Do not use bar that has been kinked or contains a sharp bend.

Disregard of these instructions may cause failure of material during stressing.

DYWIDAG THREADBAR® Products

Prestressing Steel Properties ASTM A722

THREADBAR® Designation	Cross Section Area		Ultimate Strength (f_{pu} A _{ps})		Nominal Weight		Maximum THREADBAR® Diameter		Coupler				Anchor Nut		Hex Nut				
									Length		Diameter		Extension		Length		Width		
	in mm	in²	mm²	kips	kN	lbs/ft	kg/m	b (in)	(mm)	c (in)	(mm)	b (in)	(mm)	e (in)	(mm)	a (in)	(mm)	d (in)	(mm)
Grade 150	1 26	0.85	548	127.5	564	3.01	4.48	1.20	30.5	6.25	158.8	2.00	50.8	1.88	47.6	2.63	66.7	1.75	44.5
	1 1/4 32	1.25	806	187.5	830	4.39	6.54	1.46	37.1	6.75	171.5	2.38	60.3	2.50	63.5	2.88	73.0	2.25	57.2
	1 3/8 36	1.58	1018	237.0	1049	5.56	8.28	1.63	41.4	8.75	222.3	2.75	69.9	2.75	69.9	3.88	98.4	2.38	60.3
Grade 160	1 26	0.85	548	136.0	603	3.01	4.48	1.20	30.5	6.25	158.8	2.00	50.8	1.88	47.6	2.63	66.7	1.75	44.5
	1 1/4 32	1.25	806	200.0	887	4.39	6.54	1.46	37.1	6.75	171.5	2.38	60.3	2.50	63.5	2.88	73.0	2.25	57.2
	1 3/8 36	1.58	1018	252.8	1120	5.56	8.28	1.63	41.4	8.75	222.3	2.75	69.9	2.75	69.9	3.88	98.4	2.38	60.3

*"p" is the minimum threadbar protrusion to accommodate prestressing, proof loading, or coupling, "p" = 1/2 c + 1/2 (12.7 mm)

* Couplers and nuts develop 100% of guaranteed ultimate strength

Resin Anchors using DYWIDAG prestressing steel may be proof stressed to 80% of the guaranteed ultimate strength of the prestressing steel. Lock off force should not exceed 70% of the guaranteed ultimate strength of the prestressing steel

Reinforcing Steel Properties ASTM A615 (Grade 60 & 75) CAN/CSA (G30 18-M1982)

THREADBAR® Designation	Yield Stress		Cross Section Area		Maximum Yield Strength		Nominal Weight		THREADBAR® Diameter		Coupler				Nut				
											Length		Diameter		Length		Width ₂		
	in-lb mm	ksi	MPa	in²	mm²	kips	kN	lbs/ft	kg/m	in	mm	c (in)	(mm)	b (in)	(mm)	a (in)	(mm)	d (in)	(mm)
Grade 60	#6 19	60	414	0.44	284	26.4	118	1.50	2.24	0.86	21.8	2.86	72.5	1.22	30.9	1.30	32.9	1.16	29.5
	#7 22	60	414	0.60	387	36.0	160	2.04	3.04	0.99	25.1	3.40	86.4	1.41	35.7	1.55	39.4	1.34	34.0
	#8 25	60	414	0.79	510	47.4	211	2.67	3.98	1.12	28.4	3.69	93.8	1.59	40.4	1.66	42.2	1.52	38.5
Grade 75	#6 19	75	517	0.44	284	33.0	147	1.50	2.24	0.86	21.8	3.12	79.2	1.22	30.9	1.43	36.2	1.16	29.5
	#7 22	75	517	0.60	387	45.0	200	2.04	3.04	0.99	25.1	3.73	94.6	1.41	35.7	1.71	43.4	1.34	34.0
	#8 25	75	517	0.79	510	59.3	264	2.67	3.98	1.12	28.4	4.03	102.4	1.59	40.4	1.84	46.6	1.52	38.5
	#9 29	75	517	1.00	645	75.0	333	3.40	5.06	1.26	32.0	5.02	127.5	1.79	45.5	2.30	58.4	1.71	43.3
	#10 32	75	517	1.27	819	95.3	423	4.30	6.41	1.43	36.3	5.70	144.8	2.02	51.2	2.56	65.0	1.92	48.8
	#11 36	75	517	1.56	1006	117.0	520	5.31	7.91	1.61	40.9	6.37	161.8	2.25	57.0	2.88	73.0	2.14	54.4
	#14 43	75	517	2.25	1452	168.8	751	7.65	11.39	1.86	47.2	7.82	198.6	2.55	64.8	3.55	90.2	2.52	64.0
	#18 57	75	517	4.00	2581	300.0	1335	13.60	20.24	2.50	63.5	9.35	237.5	3.50	88.9	4.23	107.4	3.34	84.8
63 mm ₁	80	552	4.91	3168	392.8	1747	16.70	24.65	2.72	69.1	9.68	245.7	3.86	98.0	4.50	114.3	3.67	93.2	

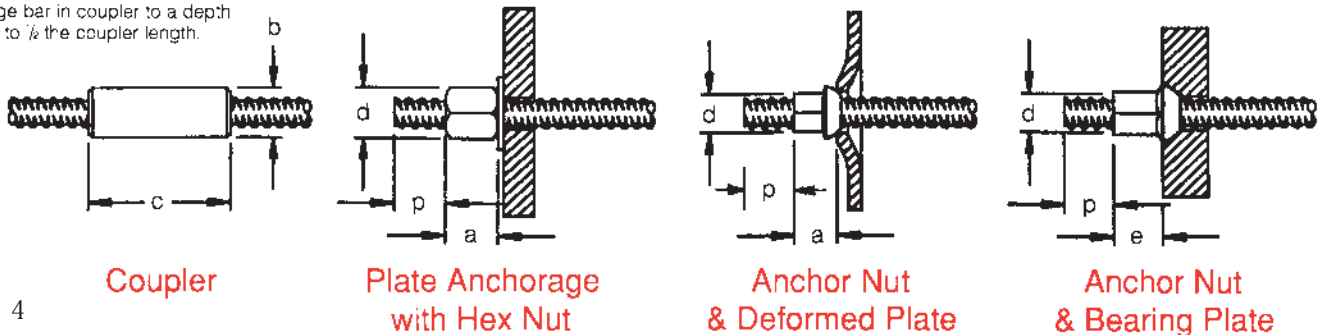
All couplers and hex nuts develop 100% of the nominal ultimate strength of the bar

63 mm bars and hardware available in grade 60 material only

1 Measured across flats

Resin anchors using DYWIDAG reinforcing steel may be proof stressed to 90% of the guaranteed yield strength of the reinforcing steel. The final working force varies with the application and function of the anchors.

Engage bar in coupler to a depth equal to 1/2 the coupler length.



DYWIDAG Resin Anchor Design

Dywidag Threadbar reinforcing steel is intended for use in relatively low strength rock bolt and rock dowel applications. Dywidag Threadbar prestressing steel is intended for use in high strength applications to permit the maximum design load in each bore hole. The use of prestressing steel may allow a reduction in the number of bolts in the pattern and thus usually reduces drilling costs.

After drilling, each bore hole must be cleaned with either air or water before the resin cartridge is installed. Standing or flowing water does not affect the resin but may cause deterioration of the hole.

The bore hole and cartridge diameter must be compatible with the diameter of the threadbar specified. Bore hole diameters other than those suggested by the Resin Yield Chart may be used under special conditions. For these applications, testing may be necessary to demonstrate that the tools and procedures selected will sufficiently mix the resin with the catalyst.

Anchor plates vary in size and thickness depending upon the function and the bearing conditions. Bevel washers, flat washers or anchor nuts are required for Dywidag reinforcing steel. Wedge washers may be used with prestressing threadbars where the plate is not perpendicular to the threadbar.

Dywidag Threadbars may be stressed to proof load an anchor or to induce a permanent load. The continuous threadlike deformations simplify stressing. Stressing is accomplished using a center hole hydraulic jack, torque wrench or air wrench.

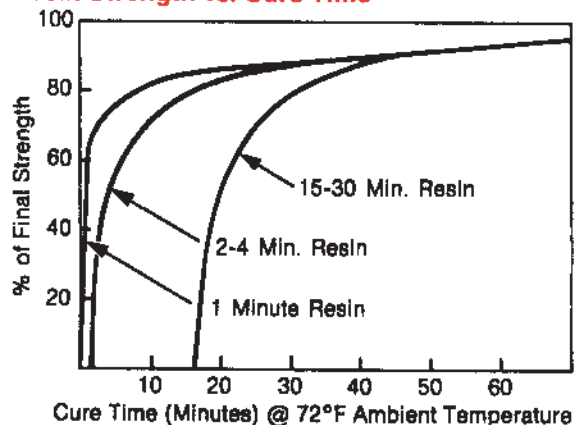
The anchorage length varies with the structure of the rock formation. The properties of the polyester resin do not govern the design of the bond zone length.

All design assumptions should be verified by field tests.

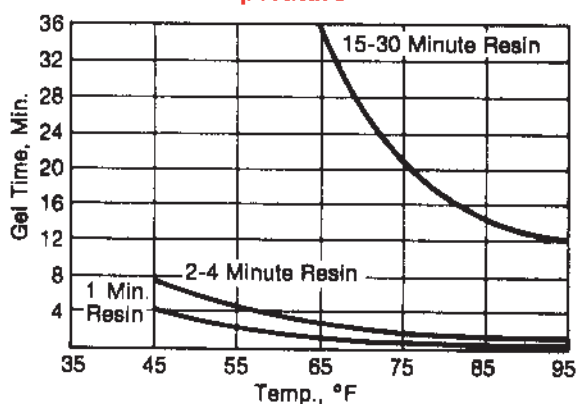
Polyester resin grout is unaffected by blasting and provides a corrosion protection equal to cement grout. Resin is unaffected by fresh water, salt water, mild alkalies and mild acids.

The resin gel time and cure time are temperature sensitive. To insure proper behavior, the ambient temperature of the rock, or concrete must be monitored.

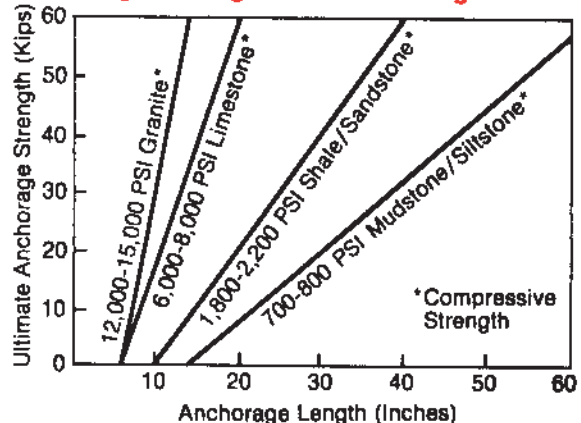
Resin Strength vs. Cure Time



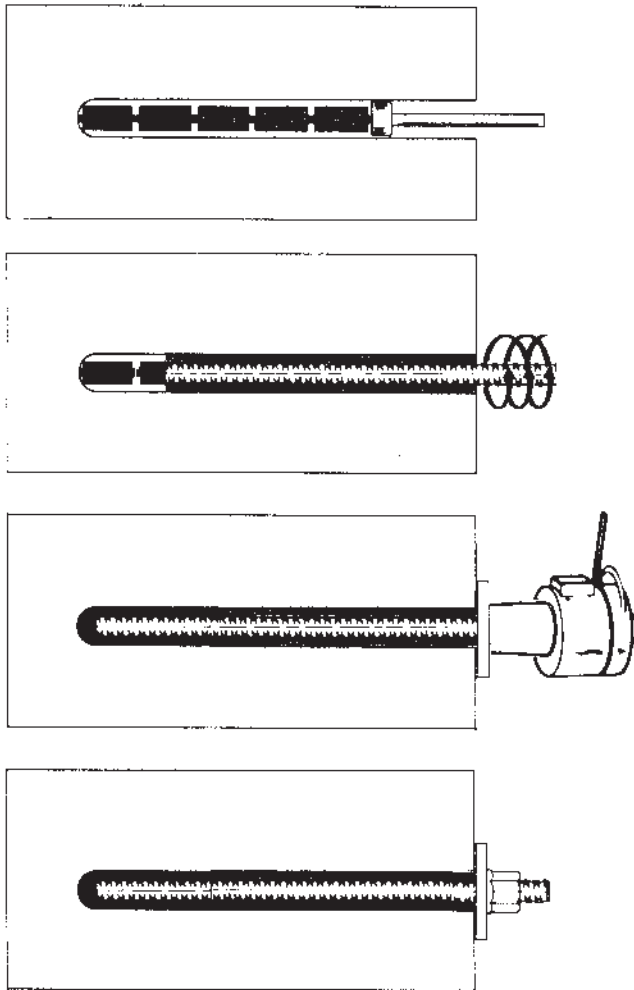
Gel Time vs. Temperature



Anchorage Strength vs. Bond Length



DYWIDAG Resin Anchor Installation



Drill and clean hole.

Drill smallest diameter hole which is compatible with the bolt and cartridge diameter selected.

Insert Resin Cartridges.

Use fast setting resin for bond length. If full encapsulation is desired, use slow setting resin or cement grout in the upper length to accommodate stressing.

Insert DYWIDAG Threadbar.

Spin bar with drill tool at about 100 rpm. Advance threadbar through cartridges while spinning. Spin for 30 to 60 seconds after reaching the bottom of the hole. Total spinning time should not exceed gel time.

Mount bearing plate and secure plate with anchor nut.

Wedge washers are required when anchor plate is not perpendicular to bolt.

Stress after resin has cured (when required).

Setting time varies from 1 to 20 minutes depending upon temperature and the resin type used. Apply tension with hydraulic jack, torque wrench or air wrench.

Monitor bolt tension.

The bolt tension is monitored by reading the pressure gauge where the hydraulic jack is utilized. Where torque or air wrench is utilized, the bolt tension is monitored by developing a tension-torque relationship curve for the specific application.

Resin Yield Chart*

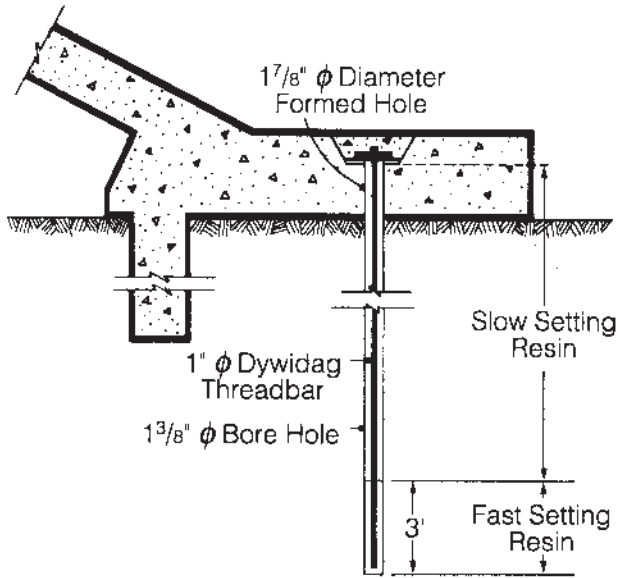
ASTM A 615 THREADBAR Size Designation	ASTM A 722 Nominal THREADBAR Diameter		Hole Diameter													
			1	1¼	1½	1½	1¾	1¾	1¾	1¾	1¾	2	2¼	2	2¼	in
			26	32	36	38	42	38	42	45	48	51	58	51	58	mm
		Cartridge Diameter														
		1¼	1½	1½	1½	1¾	1¾	1¾	1¾	1¾	1¾	1¾	1¾	1¾	1¾	in
		23	32	32	32	32	36	36	40	40	40	40	45	45	mm	
#6			1.87	1.22												
#7				1.52	1.41			1.27								
#8	1	26		2.16	1.78	1.27		1.52	1.16	1.19						
#9						1.61	1.15	1.94	1.38	1.37						
#10	1¼	32					1.47		1.76	1.65	1.30			1.28		
#11	1½	36								2.12	1.53	1.21		1.52	1.00	

*Ratio of resin column length after insertion of Dywidag Threadbar to resin column length before inserting Dywidag Threadbar. Resin yield chart information provided by Celcite, Inc.

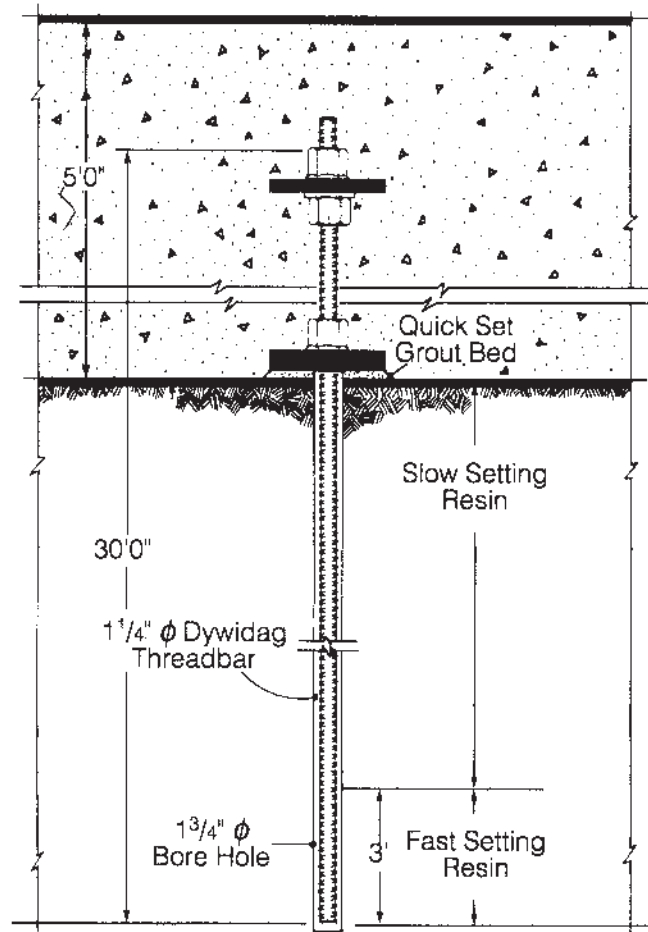
Yields are calculated; no waste or allowance for over drilling is included. Site trials should be conducted to determine actual resin requirements.

Example: When using 1" (26 mm) Dywidag Threadbar in 1½" (38 mm) diameter hole with 1¼" (32 mm) diameter resin cartridge, resin yield multiplier is 1.27. A 12" (305 mm) resin column yields 15" (381 mm) of resin after the insertion of the Dywidag Threadbar.

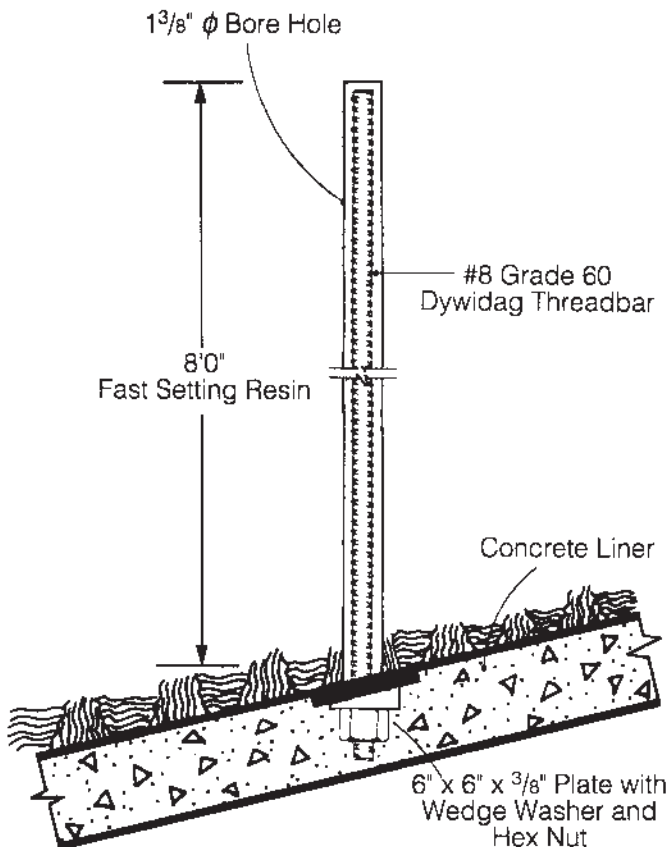
DYWIDAG Resin Anchor Applications



Toe Slab Rock Anchors. R.D. Bailey Lake Dam. Guyandot River, West Virginia. U.S. Army Corps of Engineers, Huntington District. 1" ϕ Grade 150 Dywidag Threadbars.

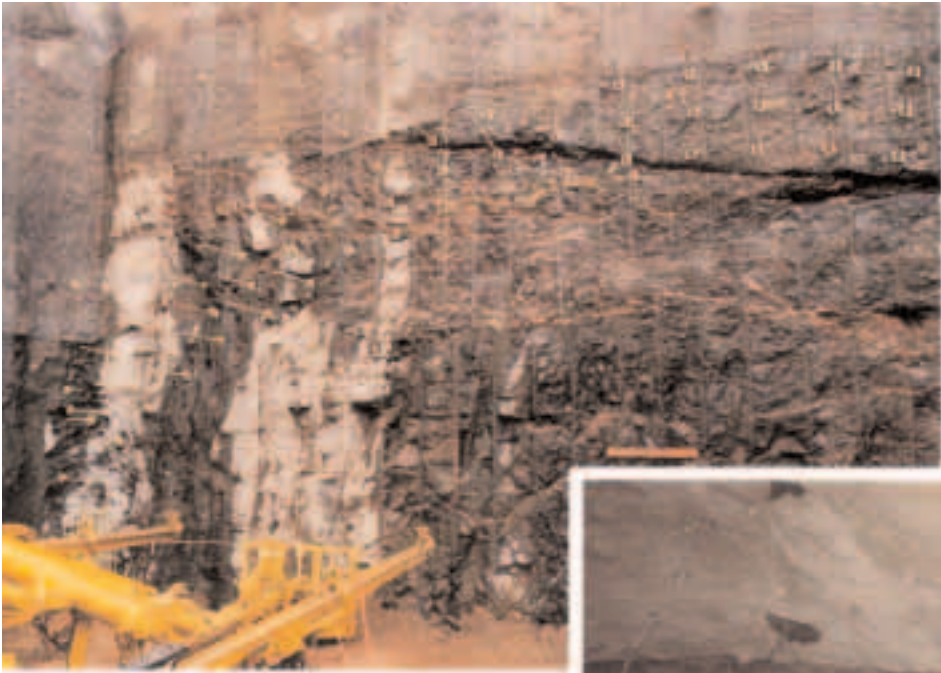


Stilling Basin Rock Anchors. Smithland Dam, Ohio River. U.S. Army Corps of Engineers, Nashville District. 1 1/4" ϕ Grade 150 Dywidag Threadbars.



Roof Bolts in Diversion Tunnel. Paintsville Lake Dam, Kentucky. U.S. Army Corps of Engineers, Huntington District. #8 Grade 60 Dywidag Threadbars.

DSI reserves the right to change the design or details of its products without notice. Specific information for job details and drawings should be obtained from your DSI Sales Engineer.



Portal and open cut face of Lafayette Bluff tunnel stabilized by 1,076 twenty foot long epoxy coated #11 Threadbar bolts.



3,214 #11 epoxy coated, resin anchored Threadbar bolts together with shotcrete form reinforced rock arch inside tunnel.

