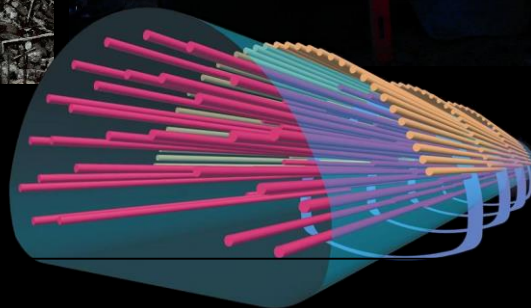


SOFT EYE

TBM passage through



RWB rebar



construction composites

Underground & Civil Works division

TBM breaking through GFRP Reinforced Wall

The typical application is the so-called “soft-eye”.

When the TBM, while advancing, must cross the stations or ventilation wells, reinforcement of piles or diaphragms with GRP makes it possible complete automation for the demolition of the same, with large savings in time and maximum safety of the operators. This is due to the characteristics of GFRP reinforcement: high strength but easy to cut and no yield, which may cause trouble to the cutters of the TBM.

In Soft-eye applications, GFRP rebar and stirrup are used as cage reinforcement.

TBM passes directly through the diaphragm wall speeding up construction schedule.

Among the numerous ongoing and recently completed projects, RWB GFRP Systems have been used for various soft-eye walls.

Recent tunneling projects have highlighted that ATP's is the premium choice in tunneling applications.

RWB rebar

High strength GFRP rebar: non-metallic composite rebar



Characteristics of rebar RWB-N and RWB-S for Soft Eye

Size	Diameter		Section (area)		Tensile strenght characteristic value		Elastic modulus	Elastic modulus
#	mm	in	mm ²	in ²	Mpa	Ksi	Gpa	psi 10 ⁶
5	16	5/8	200	0,31	725	105	40	5,8
6	19	3/4	280	0,43	690	100	40	5,8
	20		310	0,48	655	95	40	5,8
7	22	7/8	375	0,58	655	95	40	5,8
8	25	1	490	0,76	620	90	40	5,8
9	28	1-1/8	615	0,95	590	86	40	5,8
	30		700	1,09	570	83	40	5,8
10	32	1-1/4	800	1,24	560	81	40	5,8
	36		1000	1,55	560	81	40	5,8
12	38	1-1/2	1100	1,71	450	65	40	5,8
	40		1250	1,94	420	61	40	5,8
	50		1950	3,02	420	61	40	5,8

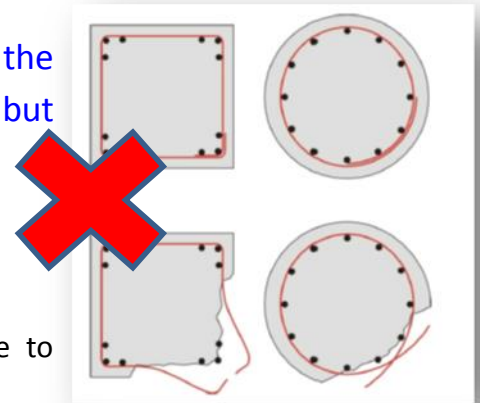


Interesting stirrup

ATP has developed a new production technology for the production of the stirrup; we do not bend the straight rebar but produce directly the closed stirrup.

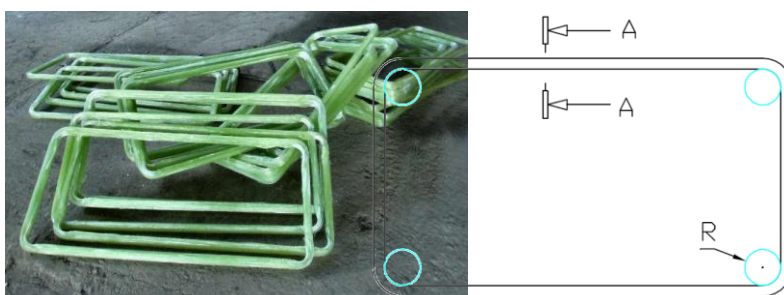
Closed stirrup: better confinement of the concrete.

Smaller radius: get the reinforcement closer to the surface to increase the total mechanical characteristics of the concrete structure.

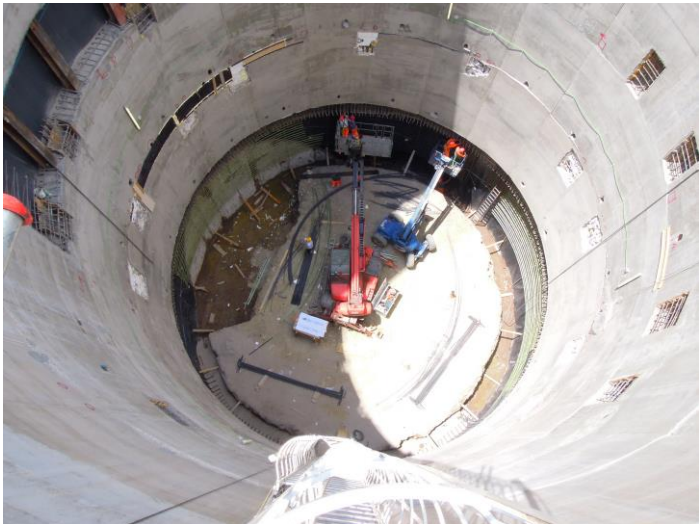
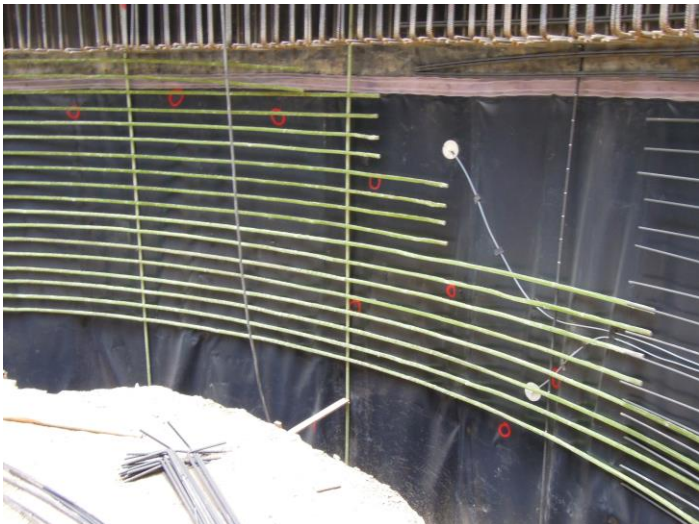


ST-RWB caratteristiche staffe RWB per soft eye

Size	Diameter	Diameter	Inside bend diameter	Inside bend diameter
#	mm	in	mm	in
3	10	3/8	20	13/16
	12		20	13/16
4	13	0,5	20	13/16
	14		40	1- 3/8
5	16	5/8	40	1- 3/8
6	19	3/4	40	1- 3/8
	20		40	1- 3/8
7	22	7/8	40	1- 3/8
	24		50	2
8	25	1	50	2
9	28	1-1/8	50	2
	30		50	2
10	32	1-1/4	50	2



Arched Rebar for Circular Shaft Soft-Eye



Engineering and Specifications

Our services includes cooperation with engineering staff of the construction company for dimensioning and full definition of the reinforcements.

■ The ATP team for dimensioning and engineering:

- Preparation of a preliminary design to be discussed with the engineer-of-record.
- Preparation the tender based on the preliminary design.
- In case of green light by the engineer-of-record and following the material order to ATP will prepare the final document based on the comments suggested with the engineer-of-record.
- The final document will include the bill of material needed and the drawing of the GFRP cages.

■ Guideline and Codes:

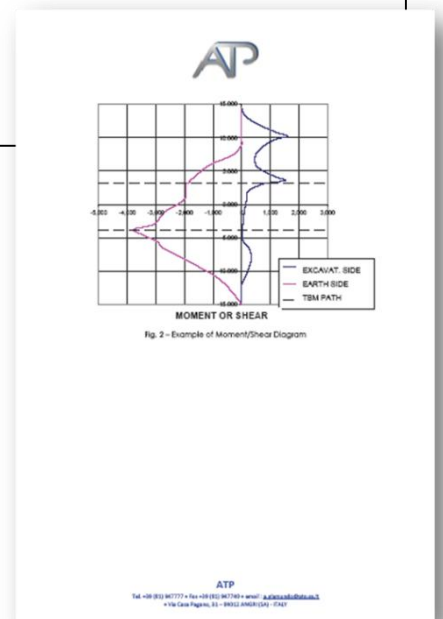
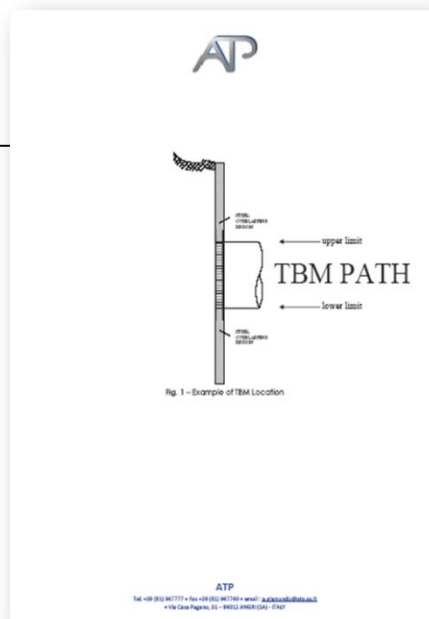
- ACI 440.1R-06
- CSA guidelines
- JSCE guidelines
- CNR Italian Guidelines
- fib Bulletin No. 40, FRP reinforcement in RC structures, 2007.

AP

INFORMATION NEEDED FOR THE DESIGN OF GLASS FIBER REINFORCED POLYMER (GFRP) CAGES

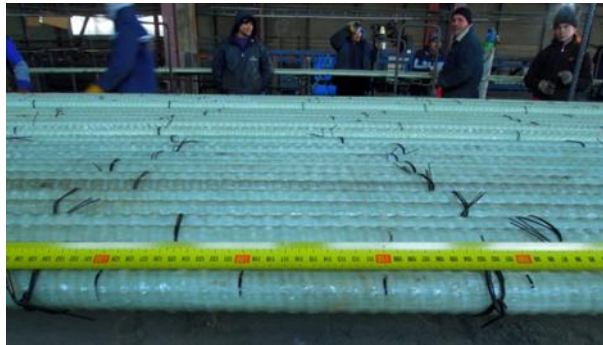
PROJECT NAME		
LOCATION		
OWNER NAME		
CONTRACTOR		
CONSTRUCTION PERIOD		
TBM DIAMETER		
CONCRETE COMPRESSIVE STRENGTH		
NUMBER OF CAGES TO BE DESIGNED		
TYPE OF CONSTRUCTION (select with an x)		
		diaphragms
		round piles
		other (please specify)
GEOMETRY	DIAPHRAGMS	width
		height
	ROUND PILES	thickness
		diameter
OTHER		width
		please indicate member geometry
TBM LOCATION (see Fig. 1)		upper limit
		lower limit
MOMENT Envelope (see Fig. 2)		U.S.S.
		Excavation Side
		Earth Side
SHEAR Envelope (see Fig. 2)		U.S.S.
		Earth Side
In case of overlapping between steel and GFRP reinforcements		N° of steel layers
		N° of reinforcements
		lap length
		increase to be done in accident
		center distance among steel bars
		bar diameter
		straps diameter
		straps cover

ATP
Tel: +39 (0)2 967777 • Fax: +39 (0)2 967788 • e-mail: atp@atp.it
• Via Case Pagan, 31 - 20122 ANGER (MI) - ITALY



Assembling of the cages

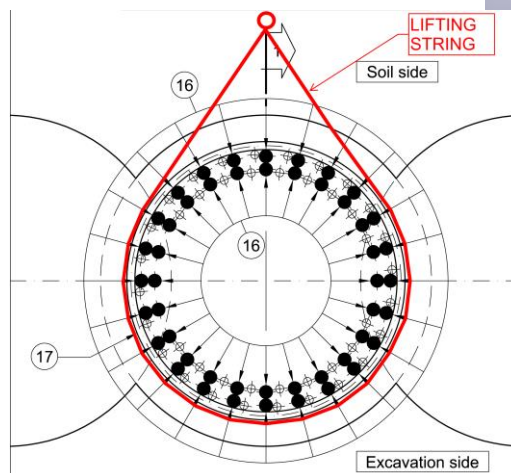
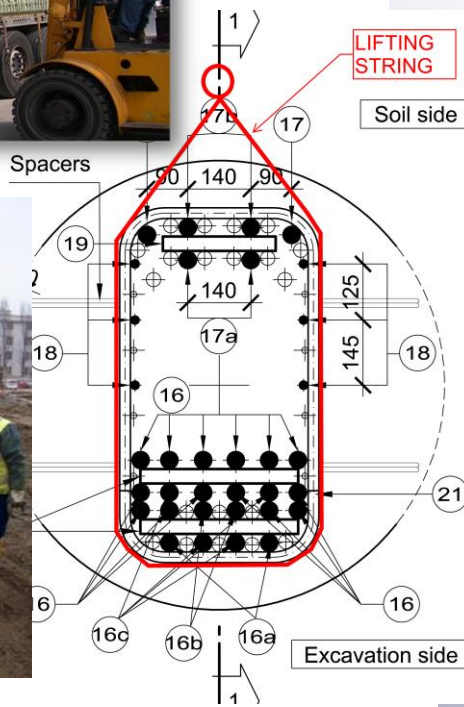
1. Reading of the drawing and pick-up of material from storage.
2. Positioning of rods and marking spacing of stirrups.
3. Positioning and spacing the stirrups.
4. Tying with wrought iron wire.
5. Positioning and fixing of steel plates for moving the cages.
6. Positioning and fixing of the stiffening plate.



Transportation

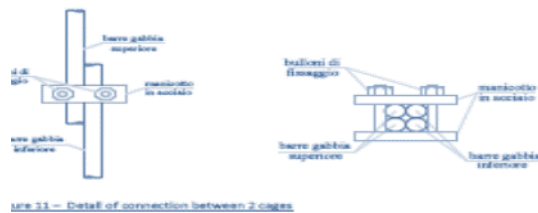
Usually to tighten all the clamps connecting the steel and the GFRP cages a lot of time is required; consequently, some slush may enter the diaphragm excavation making it necessary to lift the cages in order to clean the bottom of the bore.

ATP's system to connect cages is much faster and represents a big advantage.



Installation

The idea of connecting the two cage parts by an installed steel rebar in the fiberglass cage works perfectly this part of the assembly takes 10 minutes instead of an hour. Feedback from the workers: a lot easier and safer than the other way (hands could be stuck). The total assembling of the secondary cages still takes long time, due to the amount of rebars that has to be fit together.



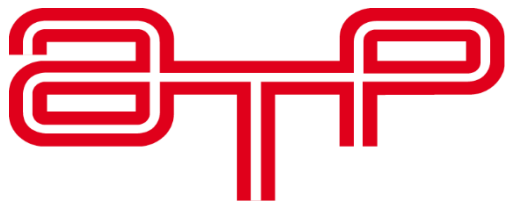
Technical recommendations for handling and installation

Here follows some precautions to be taken, in order to safely handle and store the material supplied:

- Wear protective working gloves in order to avoid possible wounds caused by exposed fibers or sharp / cutting edges, when handling glass fiber bars and stirrups.
- In case glass fiber bars and stirrups have to be cut, use a flex or a high speed grinding, wearing protective working gloves, protective glasses and dust mask.
- Don't leave fibreglass bars and stirrups in direct contact with the ground, but store them on pallets, in order to keep the material clean and easy to handle.
- Avoid high temperatures, UV rays and contact with chemical substances, because they could compromise the mechanical features of fiberglass bars and stirrups.
- Clean with solvent those substances (e.g. lubricants, oil, grease, etc) that in case would come accidentally in contact with glass fiber bars and stirrups could decrease their bond capacity.
- Avoid any accidental falling of heavy or cutting / sharp materials on fiberglass bars and stirrups, in order to avoid any damage to their surface and to their integrity.
- Avoid to dirt stored glass fiber bars and stirrups with concrete, resins, mortars and other substances, which can decrease the adherence of the material.
- Never shear glass fiber bars and stirrups.
- Never try to bend glass fiber bars and stirrups on jobsite.

ATP's jobs and projects references

- Tunel Trojana – Lubiana - **SLOVENIA**
- Corralito II - UTE AVE Girona – **SPAIN**
- CERN LHC – Nuclear European Laboratory Cessy - **FRANCE**
- Girona Puntales - **SPAIN**
- Metro de Panama – **PANAMA**
- Umiray Angat – Chamyre - **PHILIPPINES**
- OHL Toronto Metro – **CANADA**
- Boschungssicherung - Coesfeld - **GERMANY**
- UTE Sabadell - **SPAIN**
- Florence High Speed Railway Connection - **ITALY**
- Salonicco Metro - **GREECE**
- Tunnel Pilot de Sauges – Vaumarcus - **SWITZERLAND**
- Metro Line 6 Naples - **ITALY**
- MetroB1 Roma LineB - **ITALY**
- METROC Roma LineC - **ITALY**
- Metro Line Brescia - **ITALY**
- Metro Milan Line5 - **ITALY**
- HighwayA1 - Sparvo Tunnel - **ITALY**
- Ute Estaciones Linea9 Besos – **SPAIN**
- Lake Mead Intake Las Vegas - **USA**
- Metro Warsaw - **POLLAND**
- Metro Bucarest - **ROMANIA**
- Copenhagen Metro Ring - **DENMARK**
- Highway A1 Bologna/Florence - Santa Lucia Tunnel - **ITALY**
- Val di Sambro Soft Eye Poles 2500 mt diameter – **ITALY**
- Ankara Metro – **TURKEY**
- Milan New M4 Metro Line – **ITALY**
- Sighisoara/Atel Railway Tunnel – **ROMANIA**
- Istanbul Strait Road Tube Crossing Project under Bosphorus – **TURKEY**
- HUSP - Haram Utility Services Project - Saudi Binladin Group – **Makkah – KINGDOM of SAUDI ARABIA**



AZIENDA CON SISTEMA
DI GESTIONE QUALITÀ
CERTIFICATO DA DNV
= ISO 9001 =



ATP srl

▪ via Casa Pagano, 31 - 84012 Angri (SA) - tel 081 94 77 77 (pbx) - fax 081 94 77 40 -
www.atp-frp.it