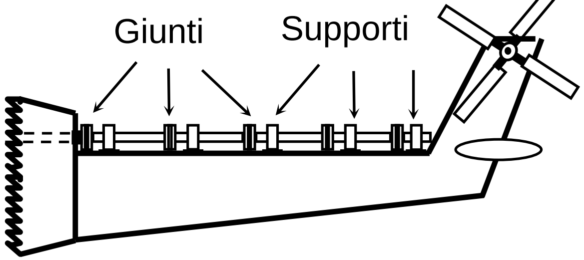
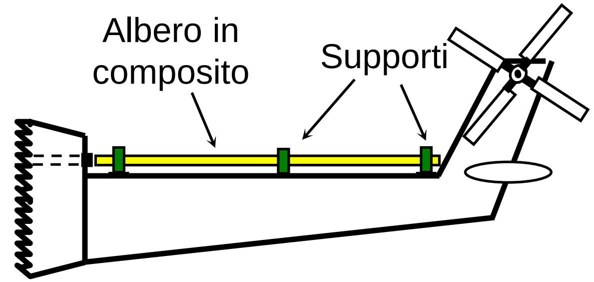
ALBERO IN COMPOSITO

ALBERO DI TRASMISSIONE: deve trasferire potenza dalle sezioni di ingresso a quelle di uscita

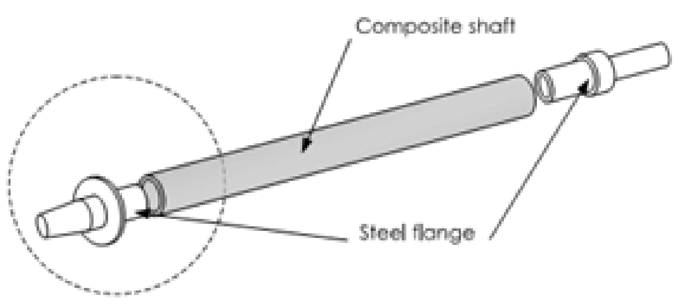
La Potenza viene trasferita trasmettendo una **COPPIA** (torcente) in combinazione con una data VELOCITA' ANGOLARE di ROTAZIONE.

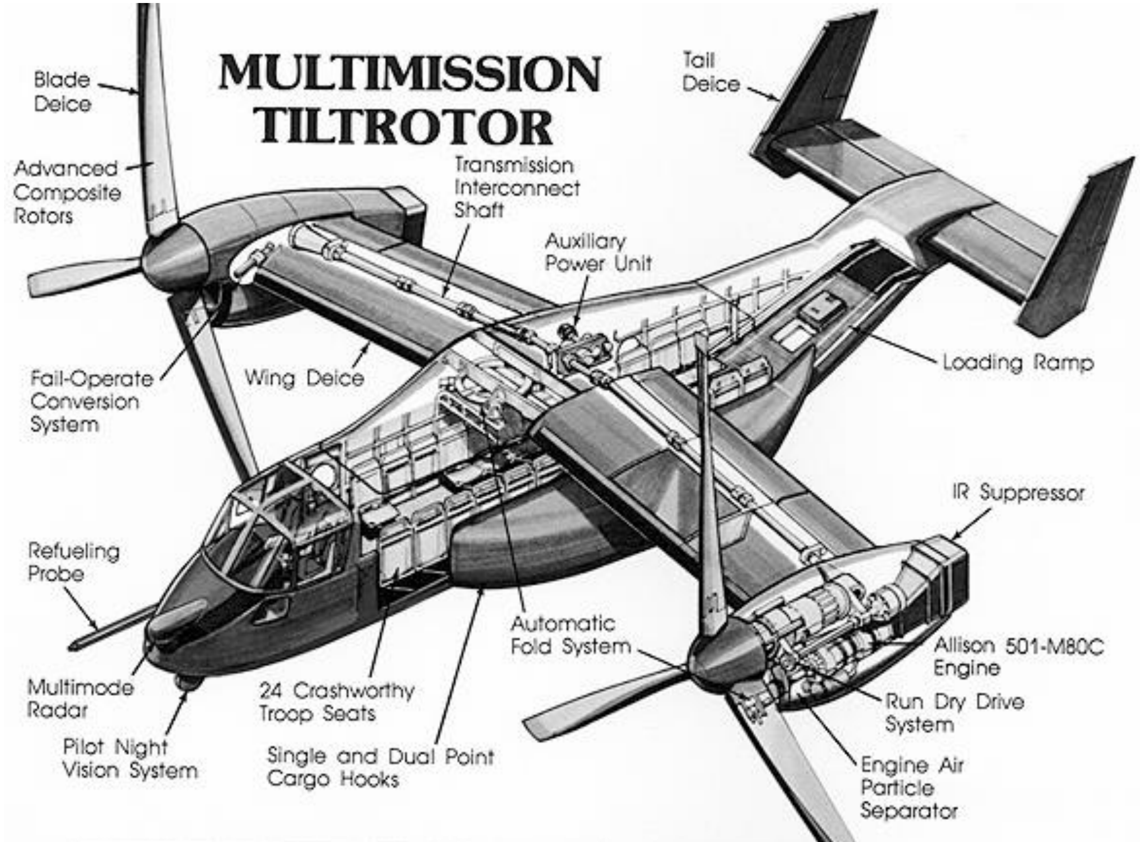


Convenzionale



Composito





BOEING V-22 OSPREY

(TILT ROTOR AIRCRAFT)

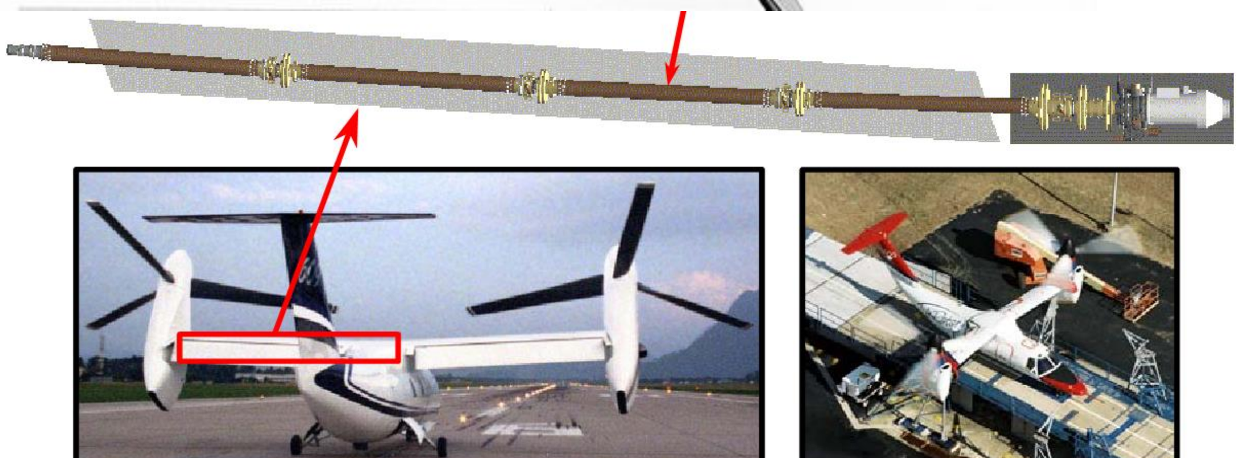
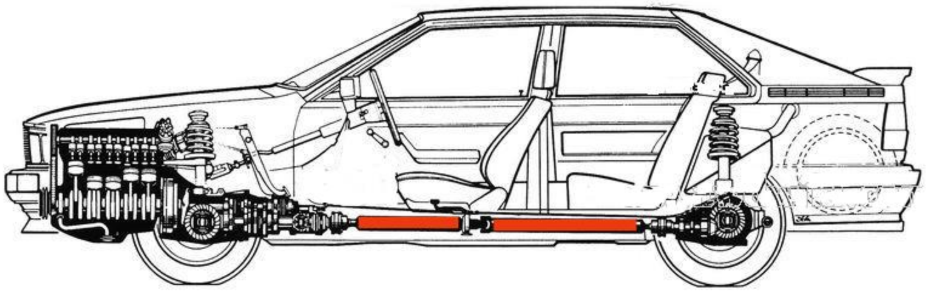
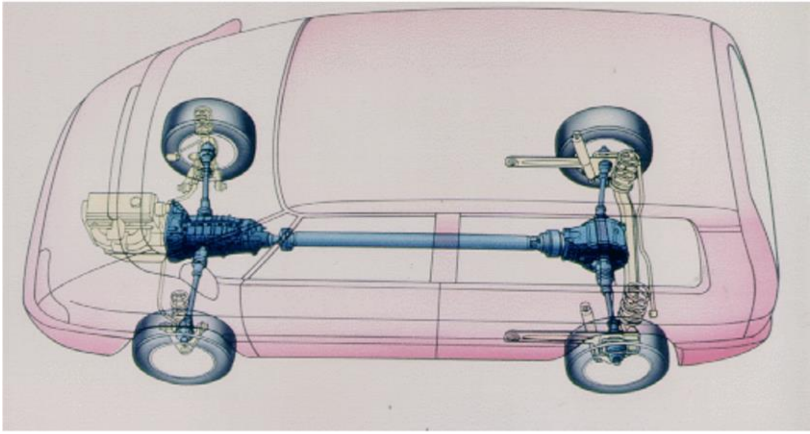


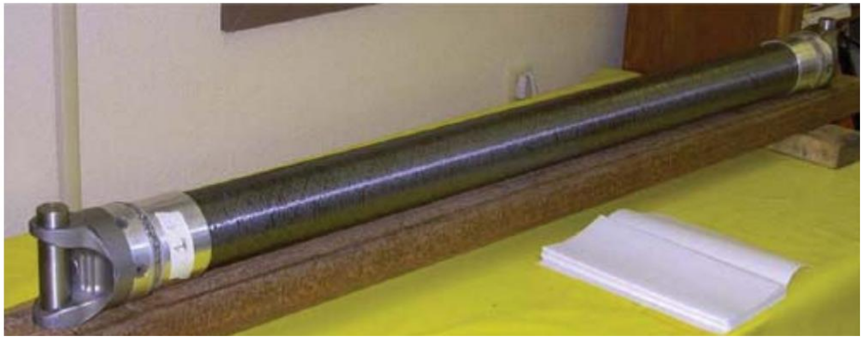
Fig. 1. BA609 interconnect drive system and drive shafts.

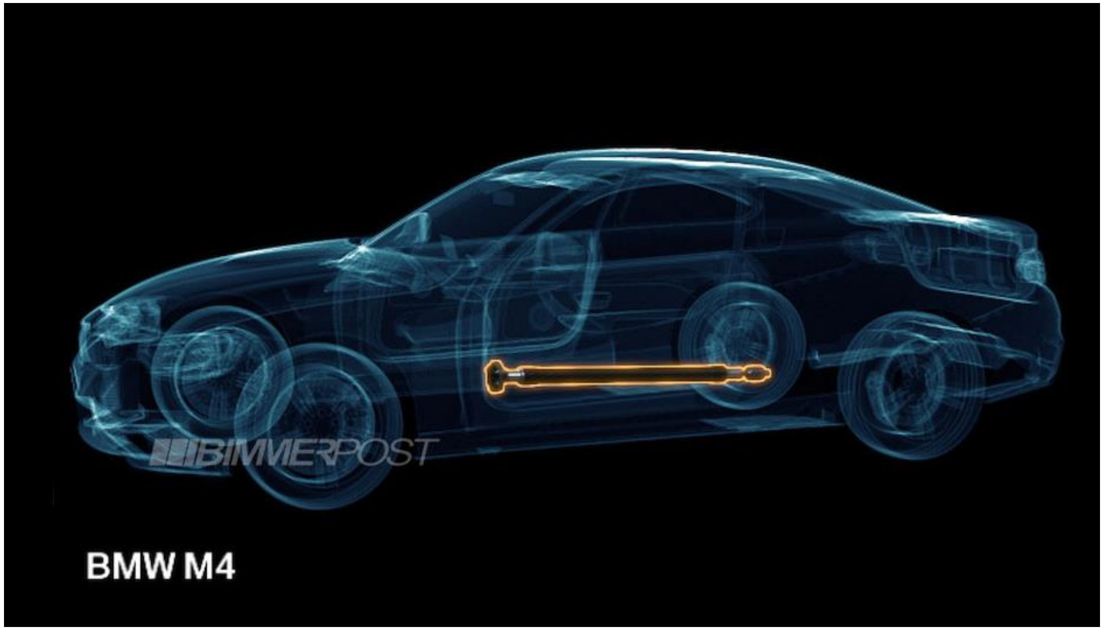
ALBERO METALLICO



ALBERO IN COMPOSITO



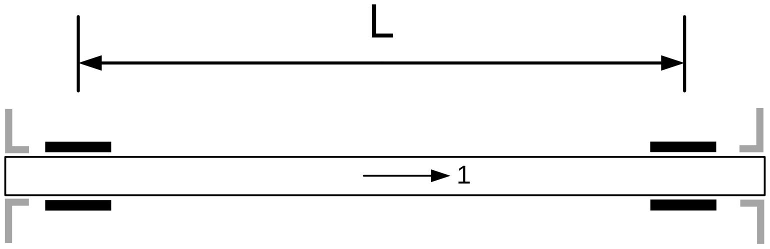



BIMMERPOST
BMW M4

Verifiche per la scelta della sequenza di laminazione

Dati di progetto:

- **Lunghezza albero L (distanza tra I supporti)**
- **Diametro interno dell'albero**
- **Velocità di rotazione ω**
- **Coppia torcente Mt**



1) VERIFICA A RESISTENZA (FPF)

2) VERIFICA ALLA VELOCITA' CRITICA FLESSIONALE

3) VERIFICA ALL'INSTABILITA' TORSIONALE

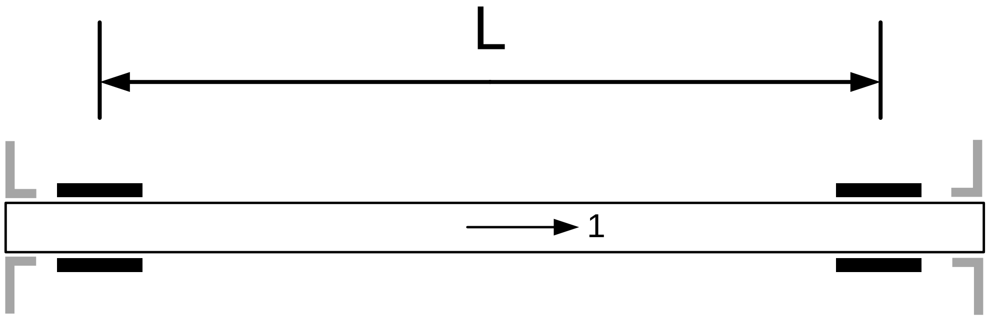
1) VERIFICA A RESISTENZA (FPF)

- Sollecitazioni: Momento torcente + velocità di rotazione (forza radiale)
- Teoria dei laminati per il calcolo degli sforzi
- Criterio di resistenza di TSAI-WU per individuare FPF

↓

Coefficiente di sicurezza η_{FPF}

2) VERIFICA ALLA VELOCITA' CRITICA FLESSIONALE



Velocità critica flessionale Ω_{cr}

$$\frac{\overline{E}_1}{\rho}$$

150 - Compositi
25 - Acciaio - Al

$$\Omega_{cr} = \frac{\pi^2}{L^2} r_m \sqrt{\frac{\overline{E}_1}{2\rho}} \cdot K_s \quad (rad/s)$$

$$\frac{1}{K_s^2} = 1 + \frac{\pi^2 r_m^2}{2L^2}\left(1 + \frac{\overline{E}_1}{\overline{E}_6}\right)$$

Coefficiente di sicurezza

$\eta_\Omega = \Omega cr / \omega$

VANTAGGI DI UN ALBERO IN COMPOSITO RISPETTO AD UN ALBERO IN MATERIALE METALLICO

$$\Omega_{cr} = \frac{\pi^2}{L^2}\, r_m \sqrt{\frac{\overline{E}_1}{2\rho}} \cdot K_s \quad (rad/s)$$

Per aumentare la velocità critica flessionale , si puo’

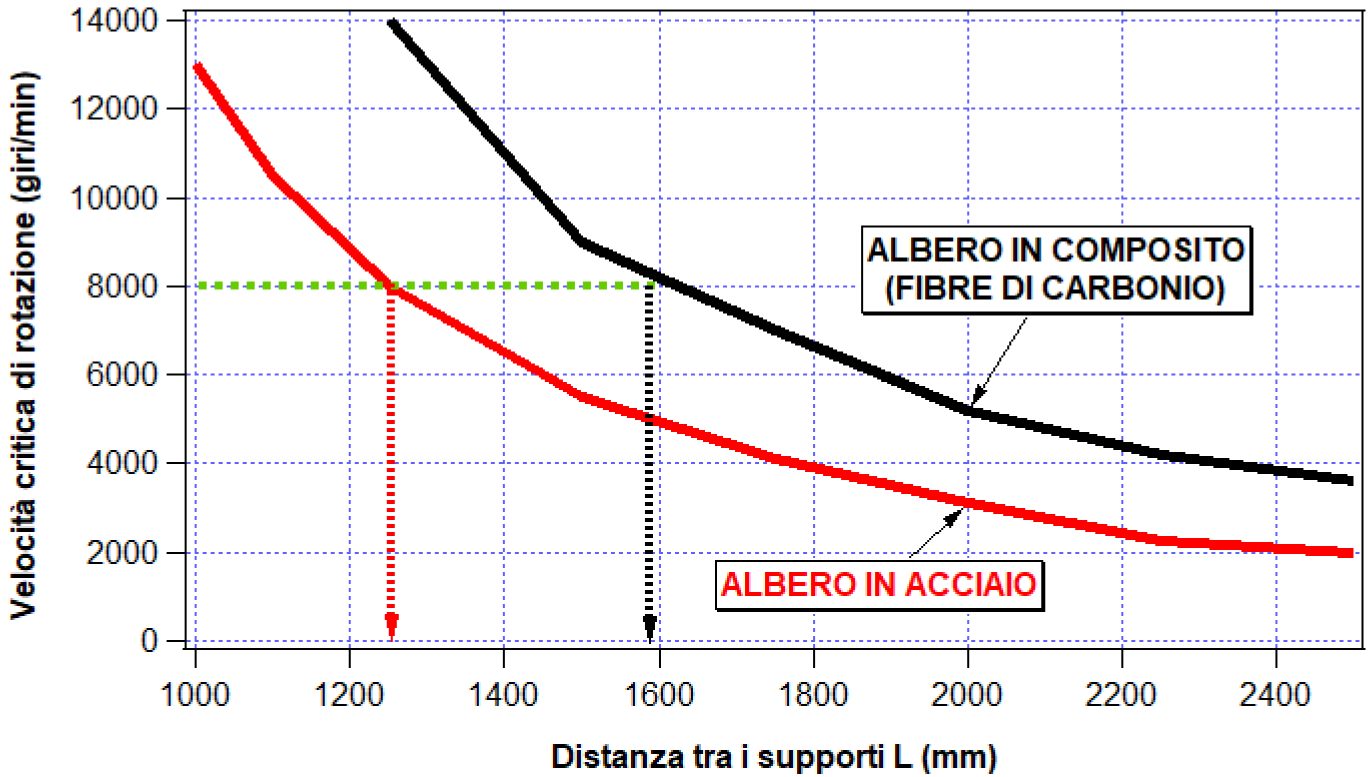
- Incrementare il rapporto E/ρ
- Ridurre la distanza tra i supporti *L*

L'elevato rapporto E/ρ dei compositi permette di garantire la stessa velocità critica flessionale con distanze tra i supporti più elevate, con vantaggi su:

- riduzione delle masse complessiva (albero + giunti + supporti)
- riduzione complessità del componente, tempi di assemblaggio, tempi di manutenzione, etc.

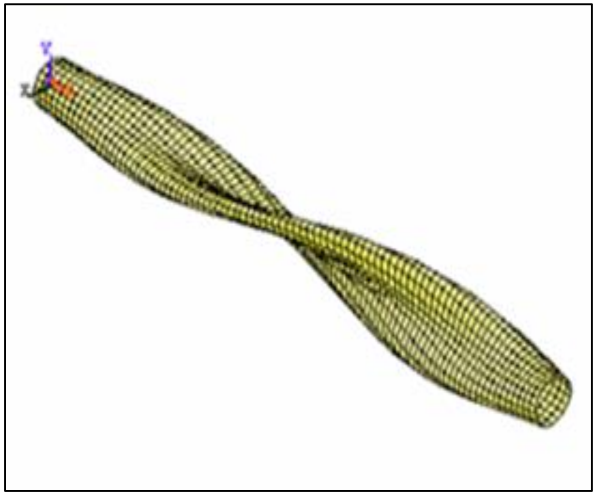
Ulteriori vantaggi sono legati al migliore smorzamento delle vibrazioni dei materiali composite rispetto ai materiali metallici

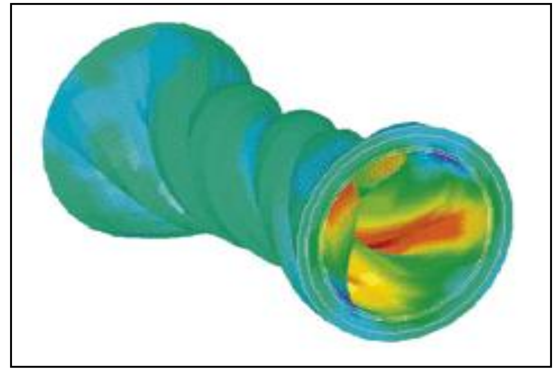
VELOCITA' CRITICA FLESSIONALE DI ALBERI METALLICI E COMPOSITI



$$\Omega_{cr} = \frac{\pi^2}{L^2} \, r_m \sqrt{\frac{\overline{E}_1}{2\rho}} \cdot K_s \quad (rad / s)$$

3) VERIFICA ALL'INSTABILITA' TORSIONALE





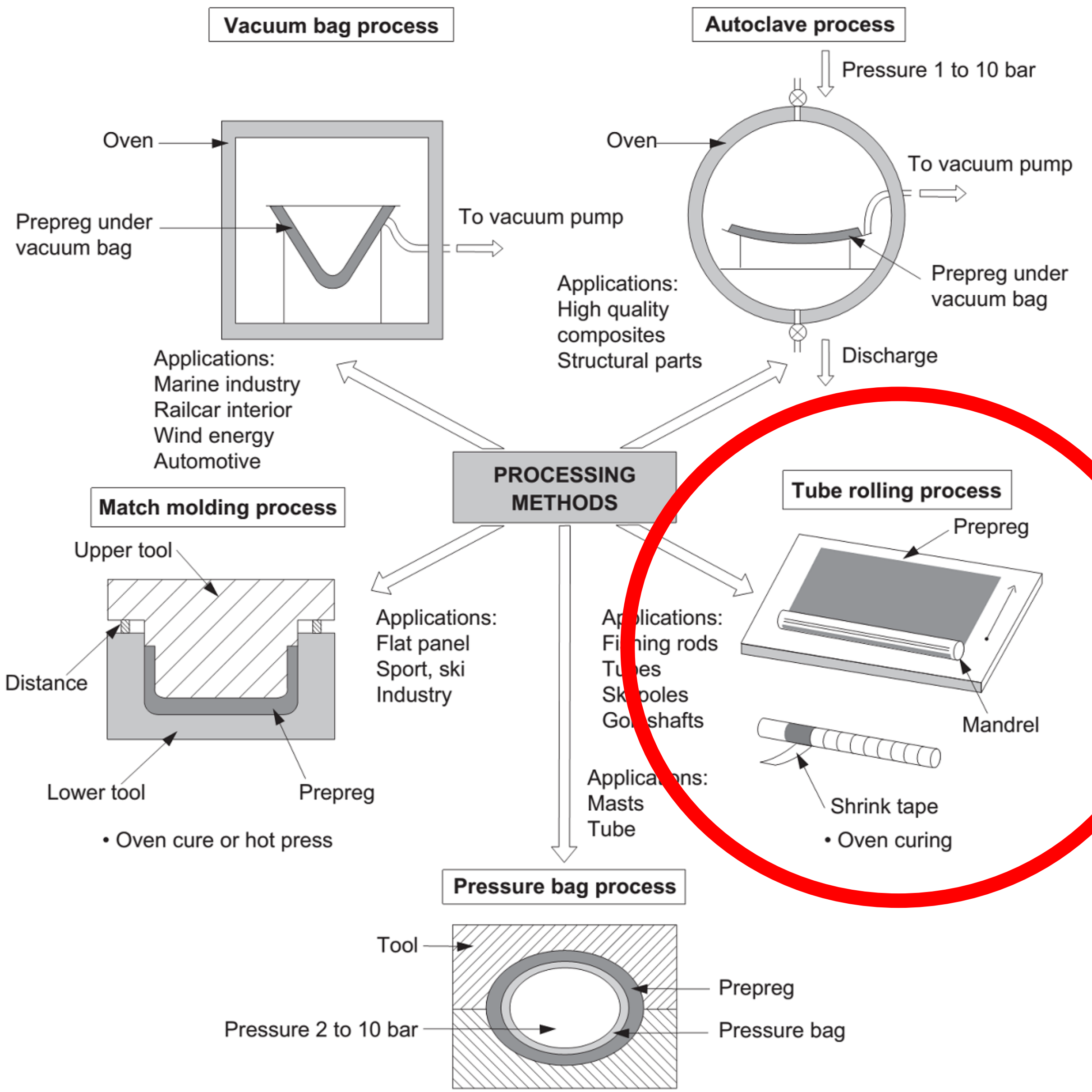
Momento critico torsionale $M_{t\,cr}$

$$M_{t\,cr} = 2\pi r_m^2 \cdot \frac{\pi^2 D_{22}}{L^2} \cdot K_{cr}$$

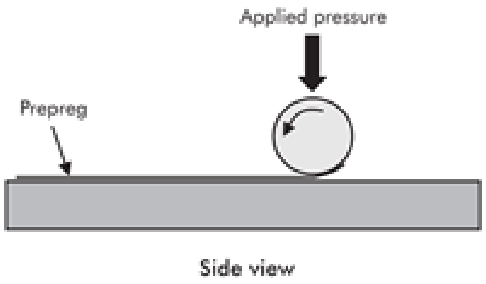
Coefficiente di sicurezza η_T **= Mt$_{cr}$ / Mt**

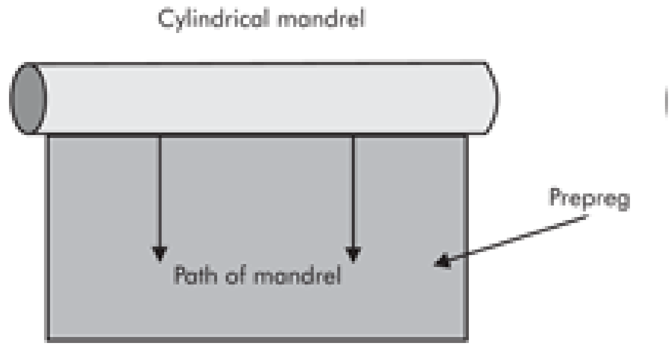
$$K_{cr} = 0.925\left(\frac{L^2}{r_m}\sqrt{\frac{A_{11}A_{22} - A_{12}^2}{12\,A_{22}D_{22}}}\right)^{3/4}$$

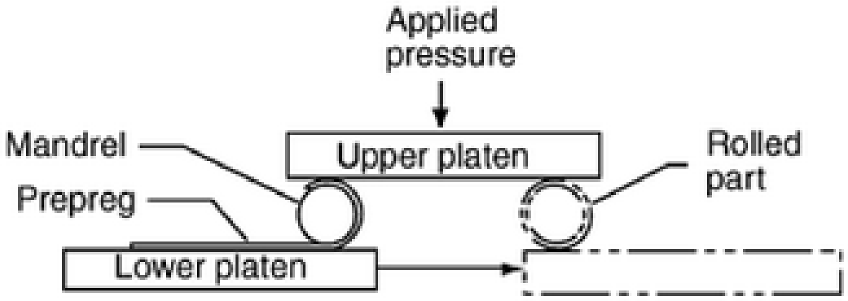
Tecnologie di produzione con prepreg



REALIZZAZIONE SEGMENTO DI ALBERO MEDIANTE **TUBE ROLLING**







Componenti realizzati con **Tube rolling**

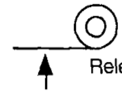
- Frecce
- Canne da pesca
- Mazze da golf
- Remi
- Componenti per biciclette
- Racchette da tennis
- Componenti aerospaziali
- Antenne
- Telescopi
- Alberi per imbarcazioni

30,000 componenti/giorno
(procedure automatizzate)

- sezioni circolari, ovali, quadrate
- diametri da 2 a 500 mm
- lunghezze fino a 10 m

Application of HI-SHRINK TAPE:

1. HI-SHRINK TAPE may be applied directly to the composite part or over clamping forms. If the part is a tube, rod or cylinder shape, apply directly over the prepreg, and uniform pressure will be applied. (Fig. 1) The outer surface of HI-SHRINK TAPE has been Release Coated with a Teflon based release agent. When wrapping your part, be sure the Release Coated surface is in contact with the prepreg.



2. If the part has a rectangular section, taping directly over the prepreg will exert compressive force mainly on the corners. You may wish to apply the tape over simple clamping forms instead, so that compressive forces will be applied to the flat sections. (Fig. 2)

3. When wrapping, the start end of the tape can be secured by one or two overlaps on itself or secured by a small piece of adhesive tape. The finish end of the tape can be secured by a generous overlap of an adhesive tape. Even a paper backed masking tape will work to secure the finish end of the shrink tape. The masking will usually turn brown and overcook, but will generally hold.

4. When wrapping, use reasonable hand tension. Generally, HI-SHRINK TAPE is 1/2 lapped on itself, resulting in two layers of tape. If additional compression force is desired, do another 1/2 lapped wrap, starting from the finish end of your first wrap. During your cure cycle, HI-SHRINK TAPE will shrink and apply considerable compressive force to your composite part. Each additional layer of tape will apply additional force.

5. After wrapping your part with HI-SHRINK TAPE, put the part through the cure cycle called for by the prepreg materials being used.

6. Once the cure cycle is complete, HI-SHRINK TAPE can be removed, either while hot or after cooling down.

Fig. 1
Wrapping Cylindrical Part
1/2 Lapped

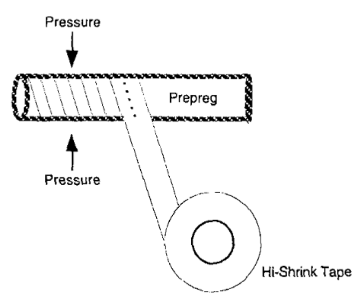
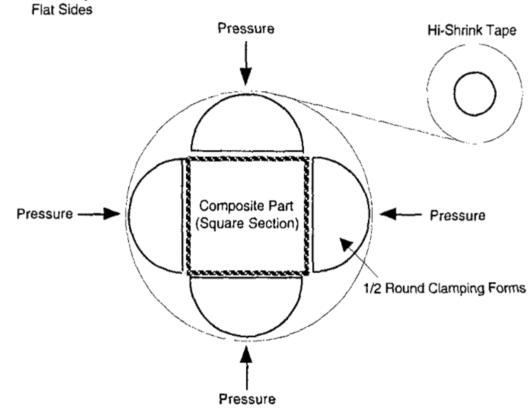


Fig. 2
Wrapping a Part with
Flat Sides



DUNSTONE
HI-SHRINK TAPE

DUNSTONE COMPANY, INC.
2104 CROWN VIEW DR.
CHARLOTTE, NC 28227 USA
TEL: 704/841-1380
FAX: 704/841-1383

Compression Force calculation for:

HI-SHRINK TAPE

Simplified formula for determining approximate PSI compression force exerted by HI-SHRINK TAPE when used over cylindrical shaped objects.

1 PSI= 0.069 bar

Compression Force (PSI) $= \frac{2 \times 2500 \times \text{Thickness} \times \text{Laps}}{\text{Dia.}}$

300 °F = 148° C

Where: *2500* = PSI Shrink Force of Tape @300F (Longitudinal Force)

Thickness = Thickness of HI-SHRINK TAPE (.002" or .005")

Laps = Number of Layers of HI-SHRINK TAPE (If tape is 1/2 lapped, the number of laps is 2)

Dia. = Outside Diameter of Cylinder (inches)

NOTE: *This formula will give approximate values to determine suitability of HI-SHRINK TAPE for an application. It is not to be used as an engineering standard or for writing specifications. Other variables must be taken into account when determining final compression force.*