Raycap

C-Band Materials Guide

CHOOSING CONCEALMENTS FOR NEW BUILDS AND RETROFITS OF C-BAND SITES

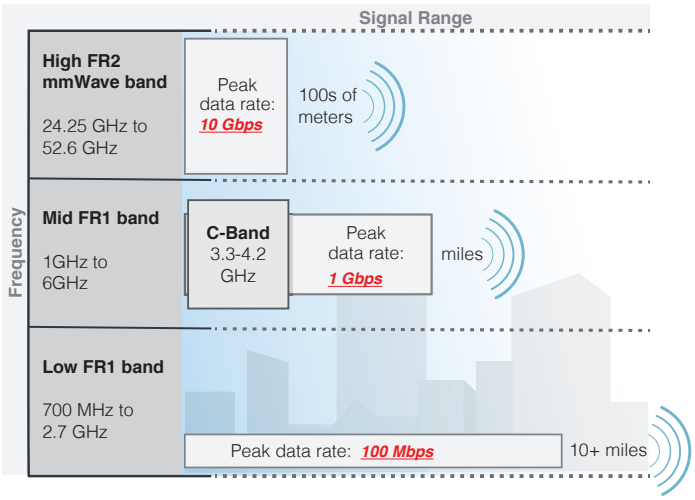
Telecom carriers have spent billions on C-band spectrum and will want to quickly deploy these frequencies using state-of-the-art radios in new and previously existing macro site concealments. Retrofitting existing macro cell site concealments can be problematic, because many of them are made of fiberglass materials that will interfere with the new band. Carriers and tower companies will need to evaluate any existing enclosures for compatibility with C-band and understand which materials will work best for retrofits.

With decades of experience in macro site concealment, Raycap has developed a range of materials that do not impact signals, making it easier to retrofit concealments at macro towers and rooftop sites. This article provides testing data on Raycap's concealment products vs. fiberglass concealment materials to illustrate the impact these materials have on the signal strength associated with C-band frequencies.

C-Band Service Fills The 5G Gap

Initial 5G deployments focused on providing mmWave services to densely populated urban areas such as downtown plazas and areas surrounding convention centers, arenas, stadiums, public rights-of-way and airports where there is potential for the most demand. Operating at the high FR2 mmWave band from 24.25 GHz to 52.6 GHz, these 5G services can support peak data rates of 10 Gbps, for high throughput and for many connections, yet the signals can only connect over hundreds of meters and are susceptible to substantial impact from concealment and other environmental factors.

Low-band services are often deployed in other areas to quickly expand 5G connections across wider distances. This low FR1 band, operating between 700 MHz and 2.7 GHz, can connect over a range of miles, but with only a 100 Mbps peak data rate, hardly a noticeable improvement over high quality-4G LTE connections.



The mid-band spectrum in the 3.0 GHz to 4.5 GHz frequency range offers an ideal balance of high speeds with solid signal propagation to help network operators expand 5G coverage.

C-band comprises a portion of this frequency range. The FCC has auctioned 280 MHz of C-band spectrum between 3.7 GHz to 3.98 GHz with the end result being 5,684 licenses awarded that are available for 5G. A new "5G land rush" has already begun and will accelerate 5G deployment in the coming years.

With a peak data rate of around 1 Gbps, C-band 5G service is the pathway to bringing more customers a noticeable improvement to 4G LTE across urban, suburban and even some rural areas. With the signal range measured in miles, existing macro cell sites delivering 4G LTE are obvious targets for C-band 5G radios and provide many advantages for fast and cost-effective expansion of 5G coverage.

- Macro tower and rooftop sites have already been identified to provide coverage for a specific population, so no new site analysis is required.
- Carriers and tower companies already own or lease many of these sites, so they may not need to enter into new leasing agreements. Instead, they may just need permission to upgrade the site.
- Similarly, electrical service and backhaul is already in place, although both may need to be upgraded for more radios and bandwidth.
- With good mechanical design, an upgrade to an existing site may not require aesthetic review by the local municipality, a process that can often slow down the installation of 5G small cell sites.

With all these benefits, carriers and tower companies need to be aware that adding equipment to an existing macro site still requires examining and meeting important engineering challenges.

In particular, existing concealment materials, especially those made using fiberglass, may degrade the signals from the C-band radios.

Current Fiberglass Concealment Degrades C-Band Signals

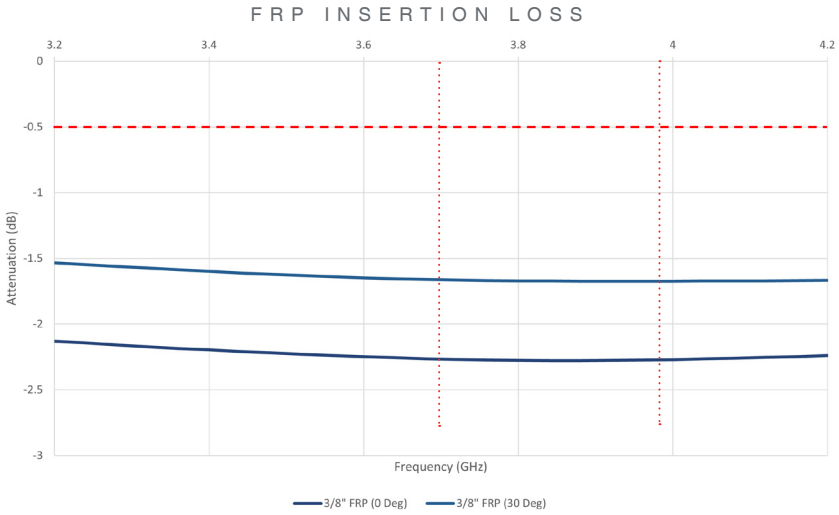
When many macro sites were built over the last 20-30 years, little consideration was given to the impact of materials on signals, aside from the importance of using non-metallic materials. Sub-GHz signals used for earlier generations of wireless service can propagate through most concealment materials (particularly fiberglass) already used in macro cell sites. In fact, commodity fiberglass panels that are not rated for use in wireless sites at all may have been deployed.

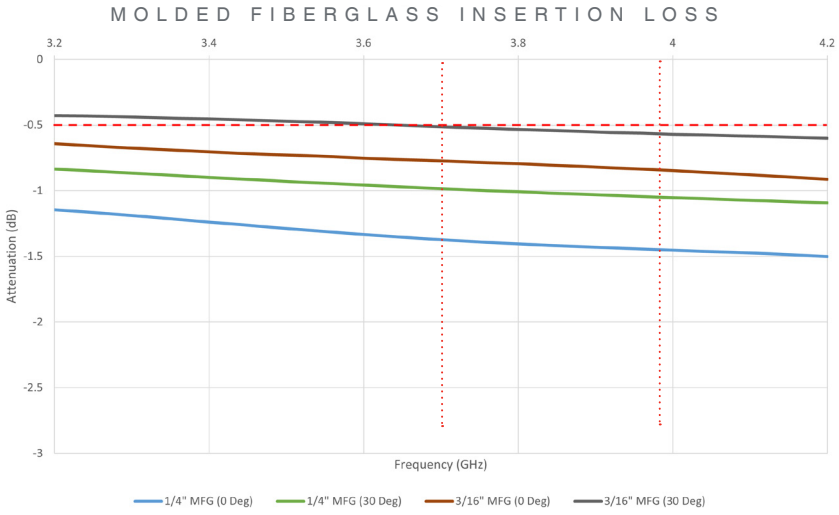
The situation is much different for C-band 5G signals. Existing frame and/or concealment materials are likely to impact and impede the propagation of GHz-level signals. In addition, while some macro towers do not conceal the radios, the need for concealment may grow as the macro sites add more radios, cabling and electronics. Typical fiberglass materials (which may come from many different sources) can and do interfere with many of the new C-band frequencies.

Most wireless operators allow a loss budget for concealment in the 0.5 dB range, and ideally below that for optimum network performance.

Through testing and the experience of tens of thousands of concealment sites constructed, Raycap understands how the type and placement of materials used for screening antennas play a vital role in their performance. Raycap recently tested the two common types of fiberglass enclosure materials: fiber-reinforced plastic (FRP) and molded fiberglass. Focusing on the 3.7 GHz to 3.98 GHz C-band range, it is clear the impact of the two materials is typically well above the generally acceptable limit of 0.5 dB.

The following graphs show performance of fiberglass based materials (FRP and molded fiberglass) as well as performance for Raycap's Stealthskin™ concealment materials (ESSV, SSV) and InvisiWave®. All results shown are for horizontal polarization for 0 Degree (perpendicular) and 30 degree angles of incidence of the signal vs. the panel face. The dashed/red line indicates the typical 0.5 dB loss budget for reference.





Clearly, fiberglass materials introduce a loss for the C-band 5G spectrum that is above the generally acceptable limit of 0.5 dB.

Raycap Stealthskin Materials Are Compatible With C-Band Signals

Knowing the constraints of fiberglass enclosures, Raycap has developed materials and products that address a broad range of macro cell concealment types, and these materials have significantly better performance with C-band signals. As one can see in the graphs on page 3, signal loss is consistently below 0.5 dB in its SSV and ESSV materials.

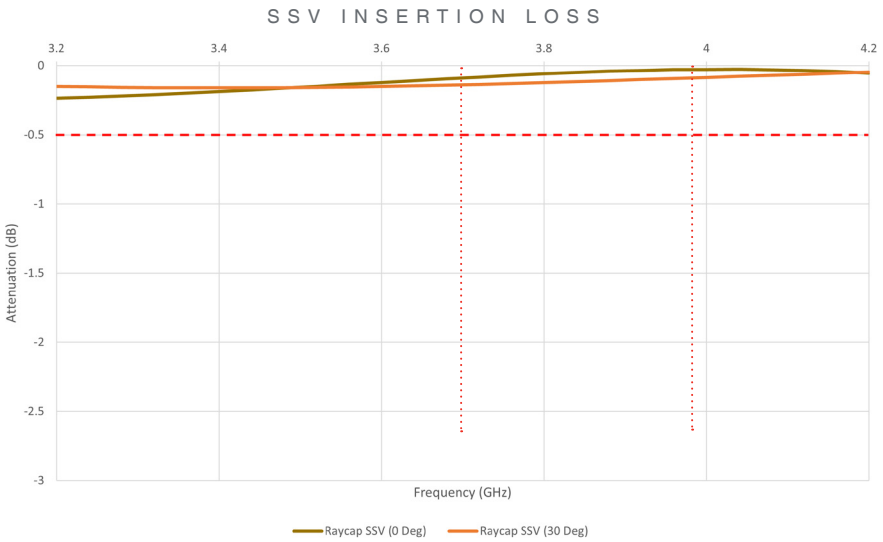
Stealthskin materials are specified for a variety of rooftop and tower-type concealment retrofits including screenwalls, wall replacements, side-mounted boxes, clock towers and bell towers. These concealment panels allow for superior antenna signal transmission compared to fiberglass without the durability problems of fiber blooming or cracking over time.

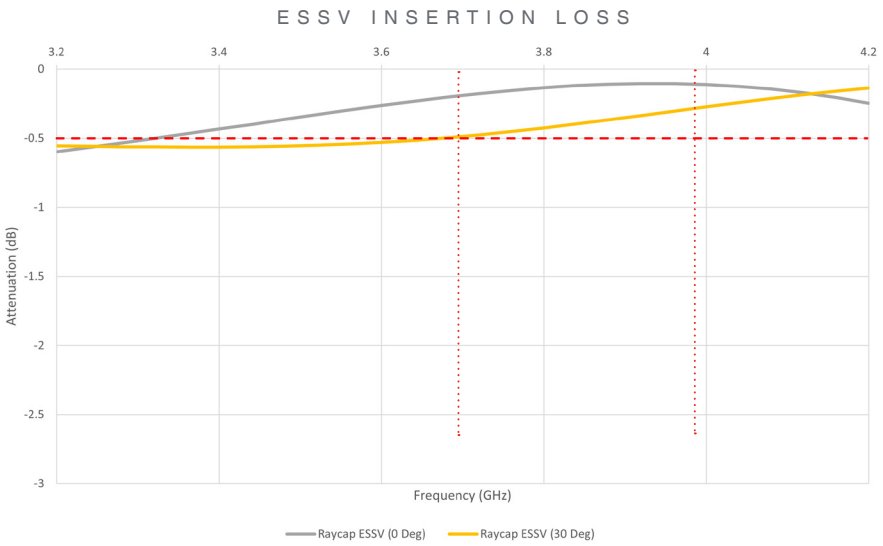
Raycap manufactures its thermoplastic Stealthskin material into panels engineered and manufactured to become part of the existing concealment structure and withstand extreme weather conditions while maintaining their original appearance. These panels offer superior RF performance over the C-band frequency range compared to fiberglass. C-band signal loss is below 0.5 dB, and provided in a panel that is strong and rigid enough to replace some support structure in a macro cell retrofit.

Raycap uses proprietary ESSV and SSV panels to manufacture a variety of rooftop and tower-type concealment products including screenwalls, wall replacements, side-mounted boxes, clock towers and bell towers.

The ESSV and SSV panels are constructed using sandwich panel geometry with nominal thickness of 2-3/16" for both panels. Structural panels like ESSV or SSV require fewer supports, so the supporting structure itself is less likely to interfere with the C-band signals as well.

These panels can easily be factory textured or painted by Raycap's team of custom artists who can match most existing architectural appearances such as brick, stucco, aggregate and split face block as well as custom applications. Panels are available in 4' x 8', 4' x 10' and 4' x 12' standard sizes and custom sizes are available upon request. The ESSV panels are generally specified for dark colors and desert climate applications. Raycap can fabricate the panels in various sizes, bent into corner panels or other shapes, including radius applications.





Raycap StealthSkin panels demonstrate C-band signal loss that is below 0.5 dB, and they are strong and rigid enough to replace some macrocell support structures.

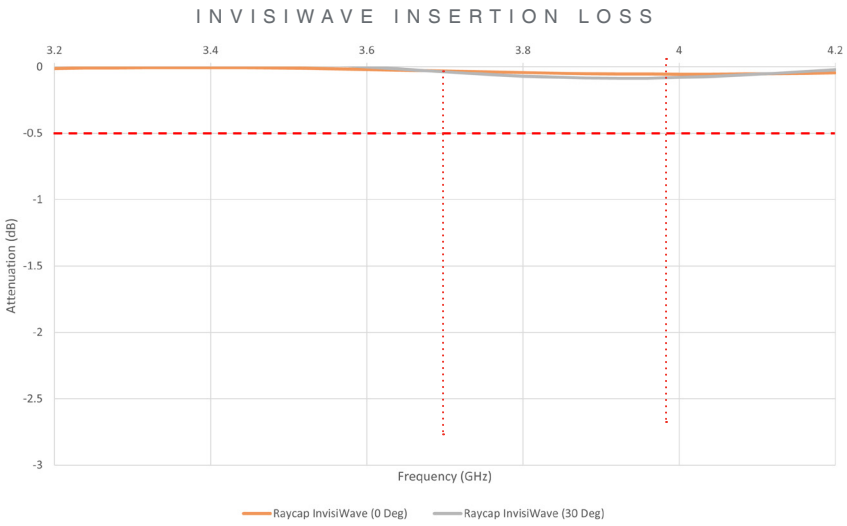
These rooftop macro cell sites use Raycap's SSV/ESSV panels and SSV/ESSV with InvisiWave apertures to conceal the wireless radio equipment inside.

InvisiWave Is Nearly Invisible To C-Band

In response to the deployment of mmWave signals, Raycap now offers InvisiWave concealment products, the result of extensive research and testing on signals ranging from 700MHz, through the C-band and all the way up the mmWave spectrum to 100GHz. Raycap's InvisiWave material is practically invisible to GHz wireless signals and so provides the most freedom and flexibility in upgrading macro sites for C-band. With its mmWave capabilities, it ensures performance and futureproofs sites for upgrades down the line.

InvisiWave can be used on new site builds and for retrofit projects. For retrofit projects, an aperture or a full panel replacement can be manufactured. For new macro site concealment structures, Raycap designs and builds panels with InvisiWave surrounding C-band and mmWave 5G radio locations. InvisiWave panels are available only with smooth textures.

- Designed and manufactured to fit and easy to install
- Thoroughly tested to identify beamforming impact
- Custom sizes available based on a case-by-case basis
- Field painting is not recommended
- Many factory painted and film options are available



Raycap's InvisiWave material is practically invisible to GHz wireless signals like those in the C-band.

Meet The Full Engineering Challenge Of Macro Site Retrofits With Raycap

No matter what material is used, the wireless carrier or tower company may need to re-engineer the mechanical structure. For concealed macro sites being considered for C-band addition, carriers should start by identifying the existing concealment materials from inspection documents, engineering drawings or other records – a site survey may be needed to confirm if the information is not available. Once identified, the materials should be evaluated and potentially tested for compatibility. The measurement results in this paper can set expectations for what the tests might reveal.

Typically, new equipment is added to the macro site, but older equipment is not necessarily removed, so more room is needed for the radios. In addition, the C-band beam pattern is wider than earlier generations so structural elements may interfere. The owner may need to replace all panels and redesign the supporting infrastructure of the existing macro site.

Retrofitting or building new macro sites requires a combination of electrical, mechanical and thermal engineering expertise to make sure the sites operate successfully now and going forward. Given the need for rapid rollout of C-band-based services, carriers and tower companies should look for a vendor with a proven capability for rapid scale-up and multiple high production manufacturing facilities. Raycap has been a provider for thousands of retrofits and is an industry leader in new 5G site concealment.

Raycap has experience working with Tier-1 carriers and the industry's top tower companies to design, engineer and manufacture its Stealth enclosures and hardware to satisfy the constraints of wireless sites across the U.S. With expert design and engineering consulting, carriers and tower companies can deploy mid-band 5G services more quickly and efficiently by retrofitting existing macro sites.

About Raycap

Raycap is an international manufacturer and technology leader with decades of experience providing innovative infrastructure solutions for customers in the telecom, energy, defense, transportation, and other industrial markets. Its solutions protect mission-critical applications and ensure the best possible system availability. The company's product portfolio includes lightning and surge protection technologies, structured cabling and connectivity solutions, power management systems, custom enclosures, cabinets, and wireless network concealments. Since its founding in 1987, the company has experienced continuous growth. Its engineering expertise, test laboratories, and multiple manufacturing facilities guarantee quality, reliability, and innovation. Product design, testing, and approval processes comply with all international safety standards. Raycap operates in the United States, Germany, Greece, Cyprus, Slovenia, and Romania.

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