

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

RUNWAY SAFE GROUP AB,
Petitioner,

v.

EARTHSTONE INTERNATIONAL LLC and W. GENE RAMSEY,
Patent Owner.

IPR2019-01490
Patent 9,382,671 B2

Before GRACE KARAFFA OBERMANN, RICHARD H. MARSCHALL,
and RYAN H. FLAX, *Administrative Patent Judges*.

FLAX, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)
Denying Petitioner's Motion to Strike, and
Denying Patent Owner's Motion to Exclude
37 C.F.R. § 42.64

I. INTRODUCTION

Runway Safe Group AB (“Petitioner”) filed a Petition for an *inter partes* review of claims 1–16 (all claims) of U.S. Patent 9,382,671 B2 (“the ’671 patent,” Ex. 1001). Paper 1 (“Petition” or “Pet.”). The Board instituted trial in this proceeding on February 20, 2020. Paper 17 (“Institution Decision” or “DI”). Earthstone International LLC and W. Gene Ramsey (together, “Patent Owner”) filed a Response. Paper 24 (“Response” or “Resp.”). Petitioner filed a Reply to the Response (“Pet. Reply,” Paper 34) and Patent Owner filed responsive Sur-Reply (“PO Sur-Reply,” Paper 37). A hearing was held on November 19, 2020. Paper 47 (“Hr’g Tr.”).

We have authority under 35 U.S.C. § 6. Petitioner bears the burden of proving unpatentability of the challenged claims, and the burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must prove unpatentability by a preponderance of the evidence. *See* 35 U.S.C. § 316(e) (2018); 37 C.F.R. § 42.1(d) (2019). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. After considering the parties’ arguments and supporting evidence, we conclude that Petitioner has proven by a preponderance of the evidence that claims 1–11 and 13–16 of the ’671 patent are unpatentable. 35 U.S.C. § 316(e). Petitioner has not met that burden with respect to claim 12.

In addition, Petitioner filed a Motion to Strike Patent Owner’s Sur-Reply (Paper 41, “Pet. Mot. Strike”) for inappropriately raising new arguments; Patent Owner opposes this Motion (Paper 43, “PO Opp. Mot. Strike”). Patent Owner filed a Motion to Exclude (Paper 42, “PO Mot. Exclude”) certain of Petitioner’s evidence, which Petitioner opposes (Paper

44, “Pet. Opp. Mot. Exclude”). Patent Owner also filed a Reply to Petitioner’s Opposition to Patent Owner’s Motion to Exclude. Paper 45 (“PO Reply Pet. Opp.”). We address these motions in this Decision.

A. REAL PARTIES-IN-INTEREST

Petitioner identifies “Runway Safe Group AB,” and also “Runway Safe LLC,” “Runway Safe Inc.,” and “Run way Safe IPR AB,” as the real parties-in-interest. Pet. vii. Patent Owner identifies “Earthstone International LLC” and “Dr. W. Gene Ramsey” as the real parties-in-interest. Paper 4.

B. RELATED MATTERS

The parties each identify as a related matter the “*inter partes* review of U.S. Patent No. 9,637,246 (“’246 Patent”) in Patent Trial and Appeal Board Case No. IPR2019-01624. The ’246 Patent is a continuation-in-part of the patent challenged in this proceeding: U.S. Patent No. 9,382,671.” Paper 8; Resp. 1–2. During the course of the proceeding, Patent Owner further identified U.S. Application 17/002,181 and U.S. Patent Application 16/573,025 as related, pending applications, and also identified U.S. Patent 10,647,447 B2 (issued May 12, 2020) as related to the ’671 patent. Paper 40, 2.

C. THE ’671 PATENT

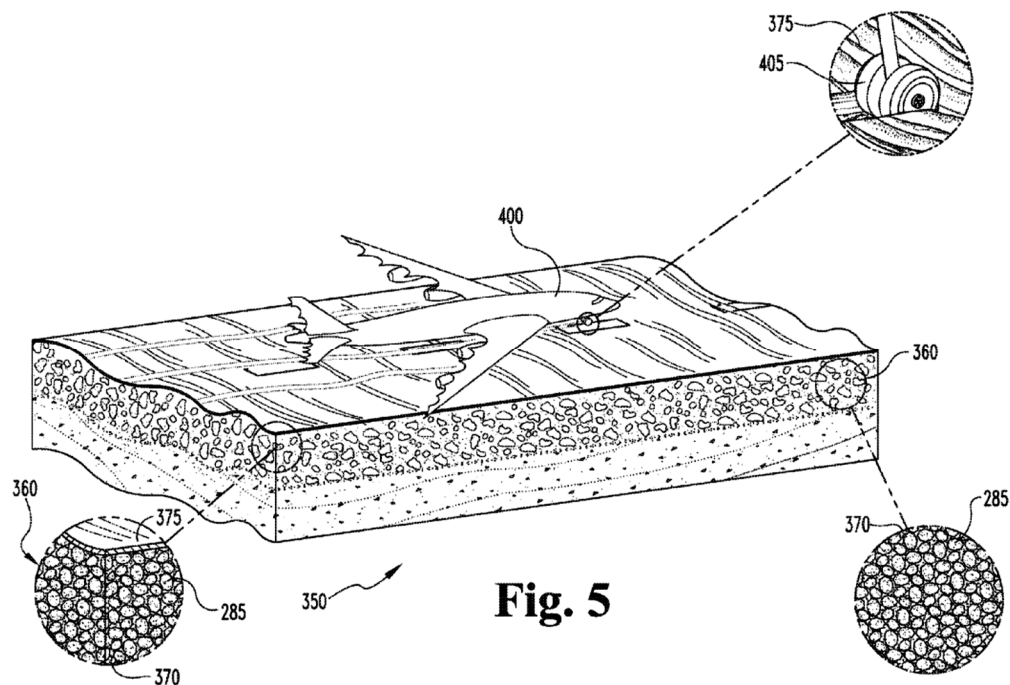
The ’671 patent issued July 5, 2016, from U.S. Patent Application 14/301,988 (“the ’988 application”), which was filed on June 11, 2014, and identifies itself as a continuation-in-part from U.S. Patent Application 11/276,193 (“the ’193 application”), filed February 17, 2006. Ex. 1001, codes (45), (21), (22) (63). However, Patent Owner states that it is “settled and undisputed” that the ’671 patent’s claims are “entitled to the June 11,

2014 priority date.” Resp. 4 (Patent Owner does not dispute that the asserted references are prior art).

The ’671 patent’s Abstract states:

A method of slowing an aircraft overrunning a runway, including paving an area immediately beyond the end of a runway with foamed glass bodies to define a bed, covering the bed with a layer of cementitious material to define a composite bed, and crushing at least a portion of the composite bed with an oncoming aircraft, wherein crushing the at least a portion of the composite bed removes kinetic energy from the oncoming aircraft to slow the oncoming aircraft. The composite bed is generally resistant to fire.

Id. at Abstract. Such a method and a related system are illustrated by the ’671 patent at its Figure 5, reproduced below:



Id. at Fig. 5. “FIG. 5 is a schematic view of [a] composite material . . . used to slow a vehicle.” *Id.* at 2:34–36. Although the ’671 patent’s specification does not further discuss Figure 5 (*see generally id.*), we note Figure 5 shows

airplane 400 on runway safety area (RSA) 350. *Id.* at 1:66–2:9, 6:17–19. RSA 350 is shown to have surface 375 composed of matrix material 370, which the '671 patent describes is concrete, asphalt, or the like, over composite material 360 composed of foamed glass bodies 285 and matrix material 370, which, again, can be concrete, asphalt, or the like. *Id.* at 6:17–51. Figure 5 includes an inset image (top-right) showing wheels 405 of airplane 400's landing gear partially embedded in surface 375 of RSA 350. Figure 5 shows tracks behind airplane 400 indicating that its wheels traveled across and partially through surface 375 of RSA 350.

To form a composite material, the '671 patent describes using “[v]itreous materials, such as soda-lime-silica glasses and metallurgical byproduct slags,” which are “foamed through a gasification process” to form “cellular product[s],” which may be physically combined with, for example, cement. *Id.* at 2:53–56, 2:67–3:2. The '671 patent describes a composite material formed of foamed slag with Portland cement, a second composite material formed of cement and less than 50% by volume foamed slag media, and a third composite material formed of an aqueous slurry mixture of gypsum with less than 50% volume foamed glass or slag. *Id.* at 3:33–4:4.

The '671 patent explains that the process of rapidly quenching foamed glass bodies and then allowing them to cool to room temperature at a typically slower cooling rate prevents annealing of the foamed glass and, by such a process, one can control its crushing failure mode, i.e., compression and torsion. *Id.* at 4:37–45. The '671 patent describes such foamed glass bodies as being oblong, ovoid, irregularly shaped, brick shaped, block shaped, or plate shaped, and that they may have closed cells or open pore structures. *Id.* at 4:63–6:62.

The '671 patent describes that its foamed glass bodies may be used in, for example, road construction, acoustic ceiling tiles, and RSAs. *Id.* at 5:63–6:19. When used in RSAs, the '671 patent describes that the foamed glass bodies can be combined with a ceramic matrix to provide a composite material, or that the foamed glass bodies may be in aggregate, shaped into foamed glass blocks, or incorporated into a structural matrix of polymer, fibrous, cementitious, or like matrix material. *Id.* at 6:22–35. The '671 patent further describes that, in such RSA embodiments, the foamed glass bodies and/or aggregate can be in a thin ceramic or structural matrix with a surface of the matrix material, which may be concrete, asphalt, or the like. *Id.* at 6:42–49.

The '671 patent has two independent claims, 1 and 10. Claim 1 of the '671 patent reads as follows:

1. A method of slowing an aircraft overrunning a runway, comprising:
 - a) paving an area with foamed glass bodies to define a bed;
 - b) covering the bed with a layer of cementitious material to define a composite bed; and
 - c) crushing at least a portion of the composite bed with an oncoming aircraft;wherein the composite bed is at least 85 percent foamed glass bodies; and
wherein the composite bed has a cementitious surface.

Ex. 1001, 10:56–67. Claim 10 reads as follows:

10. A method of slowing an aircraft overrunning a runway, comprising:
 - a) establishing an aircraft arrestor bed adjacent a runway, wherein the aircraft arrestor bed is formed from a plurality of foamed glass aggregate bodies covered by a paving layer;

- b) moving an aircraft over the aircraft arrestor bed; and
 - c) crushing at least a portion of the arrestor bed with the aircraft; and
 - d) slowing the oncoming aircraft;
- wherein the arrestor bed is [sic] has a crushing failure mode.

Id. at 12:1–10.

D. PETITIONER’S ASSERTED GROUNDS FOR UNPATENTABILITY

Petitioner asserts six grounds for the unpatentability of claims 1–16 of the ’671 patent, as follows:

	CLAIMS CHALLENGED	35 U.S.C. §¹	REFERENCES/BASIS
GROUND 1	1–16	103	ACRP ²
GROUND 2	5, 14	103	ACRP, Narmo ³
GROUND 3	6	103	ACRP, Hojaji ⁴
GROUND 4⁵	6, 7, 9	103	ACRP, Ramsey ⁶

¹ The ’671 patent was filed in the USPTO on, and has a priority date no earlier than, June 11, 2014, which is after the AIA revisions to 35 U.S.C. § 103 took effect on March 16, 2013. Therefore, the current version of Section 103 applies in this *inter partes* review. *See* 35 U.S.C. § 100 (note).

² ACRP Report 29, Developing Improved Civil Aircraft Arresting Systems (2009) (Ex. 1008 (“ACRP”)).

³ US 2012/0057931 A1 (published Mar. 8, 2012) (Ex. 1012 (“Narmo”)).

⁴ US 4,430,108 (issued Feb. 7, 1984) (Ex. 1014 (“Hojaji”)).

⁵ Petitioner does not list claim 6 as challenged under Ground 4 in its summary of the grounds at page 11 of the Petition; however, Petitioner does challenge the patentability of claim 6 under Ground 4 in the substantive portion of the Petition at pages 43–46.

⁶ US 2007/0194476 A1 (published Aug. 23, 2007) (Ex. 1011 (“Ramsey”)).

	CLAIMS CHALLENGED	35 U.S.C. § ¹	REFERENCES/BASIS
GROUND 5	1–16	103	Anglely, ⁷ Hojaji
GROUND 6	1–16	103	Anglely, Hojaji, Schirtzinger ⁸

In support of these grounds for unpatentability Petitioner submits, *inter alia*, two Declarations of Dr. Marc Zupan. Ex. 1002 (“First Zupan Declaration”); Ex. 1037 (“Second Zupan Declaration”). We determine that Dr. Zupan is qualified to opine about the level of ordinary skill in the art. *See* Ex. 1002 ¶¶ 8–17 (Dr. Zupan’s statement of background and qualifications); Ex. 1010 (Dr. Zupan’s *curriculum vitae*). Dr. Zupan’s testimony stands uncontested by cross-examination by Patent Owner in this proceeding. *See* Hr’g. Tr. 12:12–16, 33:12–21.

As support for its positions in this proceeding, Patent Owner has filed, *inter alia*, a pair of Declarations for each of Mr. Jon Helgeland and Dr. Gregory Hilmas, a Declaration by Dr. W. Gene Ramsey, and a Declaration of Dr. Brandon D. Ribic. Ex. 2003 (“First Helgeland Declaration”); Ex. 2004 (“First Hilmas Declaration”); Ex. 2005 (“Ramsey Declaration”); Ex. 2006 (“Ribic Declaration”); Ex. 2007 (“Second Helgeland Declaration”); Ex. 2008 (“Second Hilmas Declaration”).

E. ACRP

ACRP is a publication by the Airport Cooperative Research Program, sponsored by the Federal Aviation Administration and affiliated with the Transportation Research Board and the National Academy of Sciences.

⁷ US 5,885,025 (issued Mar. 23, 1999) (Ex. 1016 (“Anglely”)).

⁸ US 3,066,896 (issued Dec. 4, 1962) (Ex. 1009 (“Schirtzinger”)).

Ex. 1008.⁹ ACRP indicates that it was published in 2009. *Id.* at 3.¹⁰ Patent Owner does not dispute that ACRP is prior art to the claims of the '671 patent. *See generally* Resp.

The foreword of ACRP states:

ACRP Report 29: Developing Improved Civil Aircraft Arresting Systems is a report that evaluates alternative materials that could be used for an engineered material arresting system (EMAS), as well as potential active arrestor designs for civil aircraft applications. Currently, there is only one manufacturer that has been approved by the FAA. This report provides an evaluation of (1) cellular glass foam, (2) aggregate foam, (3) engineered aggregate, and (4) a main-gear engagement active arrestor system.

Ex. 1008, 7.

ACRP discloses that, as of its writing, current Engineered Material Arresting Systems (EMAS) used at airports and meeting FAA standards were RSAs at the end of the runway featuring 4' x 4' blocks of cellular (foamed) cement, having narrow gaps therebetween, with their tops sealed against rain. *Id.* at 12. ACRP discloses that older EMAS designs used painted cement board tops for the individual blocks with caulking to seal the joints therebetween and that newer designs used plastic tops and silicone tape to seal the joints. *Id.*

⁹ ACRP has page numbering both at its lower right corner and its upper right corner. We follow Petitioner's convention and cite the page numbering at the lower right corner.

¹⁰ Petitioner asserts that ACRP was published on January 21, 2010, without citing any specific part of the reference, but directing us to, *inter alia*, Ex. 1021, which is an FAA press release mentioning ACRP's publication in January 2010. Pet. 12–13. Patent Owner does not dispute this date.

Of the proposed EMAS systems of focus in the report, two relevant to this proceeding pertain to a glass foam system and an aggregate foam glass system. ACRP discloses that, when using glass foam, the glass foam would be used in a large bed in the form of blocks or a monolithic structure. *Id.* at 15–16. ACRP explains that in this block structure, 4' x 4' blocks would be constructed by adhering multiple smaller blocks together, followed by the potential addition of top and/or bottom cap materials. *Id.* at 16. In the monolithic structure, blocks would be stacked, brick-patterned style, and glued into a single large structure, fitted with a continuous top cover layer composed of a polymer. *Id.* ACRP illustrates such systems at its Figure S-3, reproduced below:

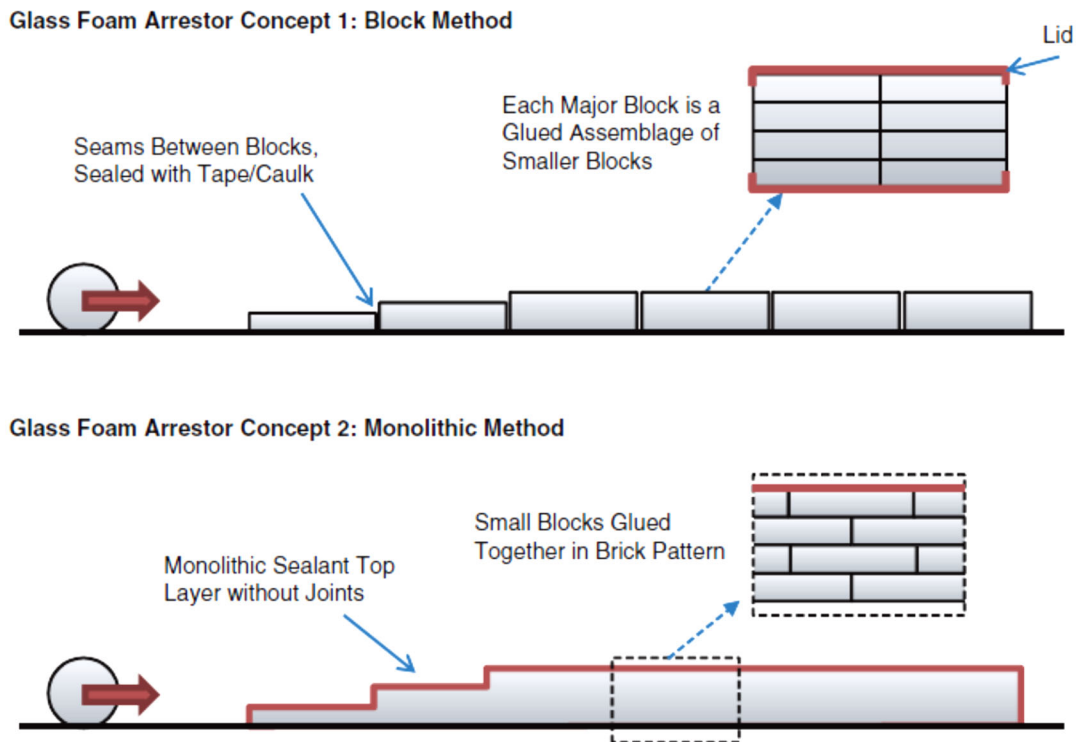


Figure S-3. Glass foam arrestor variants: block method (top) and monolithic method (bottom).

Id. at 17. Figure S-3 shows (at top) an illustration of a block structure for providing glass foam; it shows a wheel (of an aircraft) with an arrow pointing to six blocks of glass foam arranged in front of the wheel in sizes of increasing height. *Id.* The figure indicates that each large block is composed of several smaller blocks glued together and covered with a lid. *Id.* Figure S-3 (at bottom) also shows an illustration of a monolithic structure for providing glass foam; it shows smaller blocks glued together in a brick pattern so that the monolith has a stair-step shape, rising in front of a wheel; the monolith is covered at its top by a sealant layer. *Id.*

ACRP explains that, in its aggregate foam system, rough-broken foam aggregate of recycled glass having a closed-cell microstructure is provided in a basin, which is then covered by engineered turf as a top cover layer. *Id.* at 16–18. ACRP illustrates such a system at its Figure S-5, reproduced below:

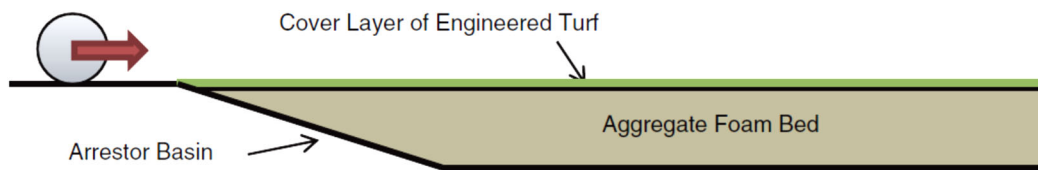


Figure S-5. Aggregate foam arrestor concept.

Id. at 18. Figure S-5 shows an aggregate foam glass bed (an “arrestor basin”) recessed below a surface on which a wheel is indicated to be traveling (red arrow), the bed has an inclined slope entryway and the aggregate foam is covered by a layer of engineered turf. *Id.*

ACRP states that both the glass foam and aggregate glass foam materials are closed-cell glass foams. *Id.* at 24. ACRP further states that

With regard to protective measures, methods for covering and sealing the three candidate materials against moisture, standing water, jet blast, and freezing conditions have been examined (see respective chapters). For the aggregate foam and engineered aggregate approaches, the use of geo-plastics and geo-textiles could render the beds essentially isolated from water entrainment and freeze–thaw damage. The glass foam material could be packaged in a manner similar to that of the current EMAS cellular cement or equipped with an alternative monolithic sealed top layer.

Id.

ACRP discloses several digital models predicting the performance of foamed glass and foamed glass aggregate EMAS systems, wherein beds composed entirely of such materials are considered to be continuous solid material. *Id.* at 73–96, 120–46. Whether considering the foamed glass arrestor system or the aggregate foam glass arrestor system, the models similarly predict how an airplane tire would interact with such materials to slow and stop an airplane. *Id.* ACRP Figure 9-21 illustrates such interaction; it is reproduced below:

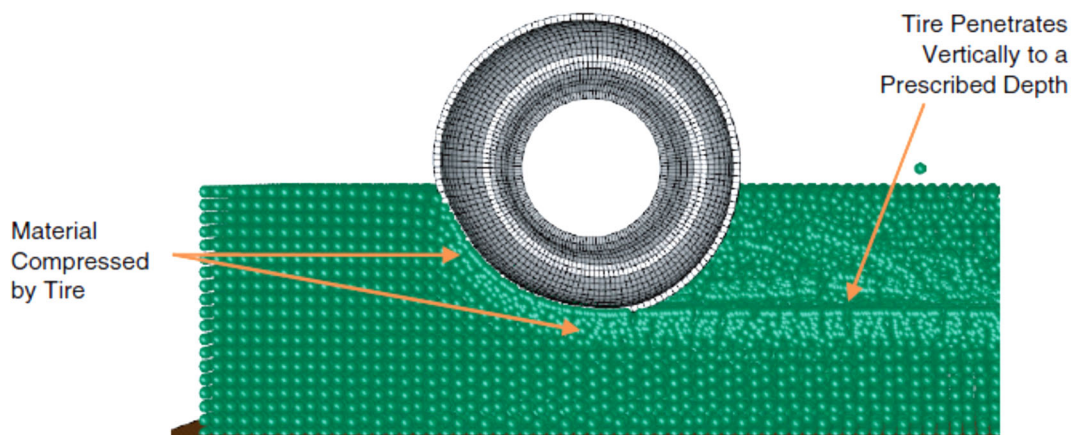


Figure 9-21. Model of combined tire and glass foam arrestor system.

Id. at 86. Figure 9-21 shows an aircraft tire passing through a bed of glass foam (green), crushing the material as it penetrates therethrough. *Id.*; *see also id.* at 131 (Figure 11-16 showing similar results for aggregate foam glass arrestor system).

ACRP also discloses another form of arrestor bed composed of a “ceramic glass aggregate,” which was “[c]rushable ceramic glass aggregate connected with a phosphate cement binder.” *Id.* at 60. ACRP states that, although “[t]his solution offered the possibility of a pour-in-place crushable material, which would reduce cost compared with prefabricated block installation,” there were “[c]oncerns regarding moisture penetration and subsequent freeze–thaw performance,” and that such a system was “[e]liminated from consideration due to lack of manufacturer interest.” *Id.* ACRP identifies (at Table 7-3) several “Arrestor alternatives,” composed of other materials and formed into different structures, including “Crushable Foams,” “Loose Crushable Fill,” “Crushable Aggregates with Binder,” “Loose Aggregates,” “Fluids,” “Breaking Devices,” “Engagement Devices,” and “Mechanical Surface.” *Id.* at 60–61.

As two of several such crushable foams, ACRP identifies “[c]ellular [c]ement” as a “[c]urrent EMAS material” and the “[b]aseline for passive system comparison,” and “[g]lass [f]oam” as a “[g]lass-based material that is chemically inert and has moisture resistant properties.” *Id.* at 60. As a loose crushable fill, ACRP identifies “crushable aggregate foam” as a “[g]lass-based material that is chemically inert and has moisture-resistant properties” that is “[m]ade of recycled glass [and] offers potential cost savings over cellular glass foam.” *Id.* As a crushable aggregate with binder, ACRP identifies “[c]eramic glass aggregate,” which is “[c]rushable ceramic glass

aggregate connected with a phosphate cement binder,” further stating “[t]his solution offered the possibility of a pour-in-place crushable material, which would reduce cost compared with prefabricated block installation.” *Id.* ACRP did not explore the specifics of these alternative embodiments.

F. NARMO

Narmo is a March 8, 2012 publication of U.S. Patent Application 13/142,985, which was filed January 13, 2011. Ex. 1012, codes (43), (21), (22). Narmo asserts priority to British patent application 1000544.5, indicated to have been filed January 13, 2020. *Id.* at code (30). Patent Owner does not dispute that Narmo is prior art. *See generally* Resp. The Abstract of Narmo states that its invention relates to:

Arresting beds for decelerating vehicles, especially passenger air-crafts unable to stop on available run-way, including a vehicle arresting system. The vehicle arresting system also includes a bed filled with foamed glass aggregate with particle sizes ranging from 0.25 cm to 15 cm and nominal void fractions from about 70 to 98%, and a top cover covering the upper surface of the bed of foamed glass aggregate.

Ex. 1012, Abstract.

Narmo discloses that its foamed glass aggregates may have a cover to prevent environmental contamination. *Id.* at ¶ 28. Examples of such covers include “any cover able to protect the aggregate mass but unable to carry the vehicle’s wheels,” but specifically, “polymeric tarpaulins, plastic foils, artificial turf, etc.” *Id.* Narmo illustrates an arrestor bed at its Figure 2, reproduced below:

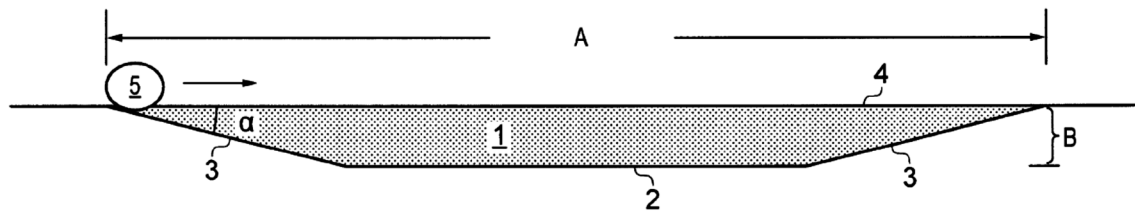


FIG. 2

Id. at Fig. 2. “FIG. 2 is a schematic drawing of one example embodiment of [Narmo’s] invention seen from the side.” *Id.* ¶ 47. Figure 2 shows a “vehicle arresting system is formed into the ground” 2, having upper surface 4. *Id.* ¶ 53. The bed of the system is disclosed as “filled with foamed glass aggregate 1” and “[t]he top surface of the aggregate bed is covered with a cover layer 4 of artificial turf. A wheel 5 of an aircraft entering the arresting system is schematically shown.” *Id.* ¶ 54.

Narmo discloses that “soda-lime glass or soda-glass” may be used for its foamed glass aggregate, which is melted, aerated, solidified, and then crushed to particles for use. *Id.* ¶ 17. At its Table 1, reproduced below, Narmo discloses various foamed glass aggregate compositions’ compression rate, force and resistance, as related to density:

TABLE 1			TABLE 1-continued		
Compression tests on aggregate of three nominal void fraction, each with the particle size distribution as shown in FIG. 4.			Compression tests on aggregate of three nominal void fraction, each with the particle size distribution as shown in FIG. 4.		
Compression rate [%]	Compression force [N]	Compression resistance [MPa]	Compression rate [%]	Compression force [N]	Compression resistance [MPa]
Aggregate with nominal void fraction of 94.6% (corresponds to a density of 135 kg/m ³)			Aggregate with nominal void fraction of 94.0% (corresponds to a density of 150 kg/m ³)		
20	32 500	0.46	20	38 000	0.54
25	48 000	0.68	25	50 000	0.71
30	55 000	0.78	30	58 000	0.82
40	90 000	1.28	40	92 000	1.30
			Aggregate with nominal void fraction of 92.8% (corresponds to a density of 180 kg/m ³)		
			20	55 000	0.78
			25	61 000	0.86
			30	90 000	1.28
			40	120 000	1.70

Id. ¶ 60 (Table 1).

G. HOJAJI

Hojaji is a U.S. Patent issued February 7, 1984, from U.S. Patent Application 418,078, filed September 14, 1982. Ex. 1014, codes (45), (21), (22). Patent Owner does not dispute that Hojaji is prior art. *See generally* Resp. Hojaji's Abstract indicates that its invention is directed, *inter alia*, to:

A method of making foam glass by impregnating diatomaceous earth, fly ash or mixtures thereof, and insoluble modifiers, if any, with at least one water soluble glass former in an amount expressed as its oxide of about 2.5 to 20 weight percent of the impregnated diatomaceous earth, fly ash or mixtures thereof; at least one water soluble flux in an amount expressed as its oxide of about 8 to 20 weight percent of the impregnated diatomaceous earth, fly ash or mixtures thereof; and at least one gas generator.

Ex. 1014, Abstract.

Hojaji discloses “[t]he most common technique for making foam glass on a commercial scale involves the melting of a window-type glass composition followed by fritting and grinding, in a continuous action ball mill while adding gasifiers.” *Id.* at 1:46–49. In one embodiment, the foamed glass of Hojaji includes, by weight, 70% SiO₂, 2.8% Al₂O₃, 7.0% B₂O₃, 11.5% Na₂O, 6.4% K₂O, and 2% other oxides (including Fe₂O₃, MgO, CaO, TiO₂, and P₂O₅). *Id.* at 18:56–67. Hojaji teaches that such foamed glasses can have closed pore structures, which can be controlled by manipulating the temperature and heating time during production. *Id.* at 16:63–65, 27:11–12. Hojaji indicates that its “[f]oam glass materials such as shown in Example 23 can be used for ‘composite concrete-foam glass.’” *Id.* at 25:58–60.

H. RAMSEY

Ramsey is an August 23, 2007 publication of U.S. Patent Application 11/276,193, which was filed February 17, 2006. Ex. 1011, codes (43), (21), (22). Patent Owner does not dispute that Ramsey is prior art.¹¹ *See generally* Resp. Ramsey’s Abstract indicates that its invention is directed, *inter alia*, to:

A method of making a foamed glass composite, including crushing a vitreous precursor material, such as waste glass, frit, metallurgical slag or the like, sizing the crushed vitreous precursor to segregate an amount of crushed particles of a predetermined size and pelletizing the crushed particles. The pellets are preheated and passed through a high-temperature flame to foam the pellets. The foamed pellets are air-quenched to a temperature below their dilatometric softening point and then cooling to room temperature. The foamed pellets are then mixed with Portland cement and water to form a composite material.

Ex. 1011, Abstract.

Ramsey discloses foamed glass and methods of making foamed glass, but no specific applications or uses for the product. *See generally id.* Ramsey teaches that “[v]itreous materials, such as soda-lime-silica glasses and metallurgical byproduct slags, are typically foamed through a gasification processes to yield a typically predominately vitreous, typically silaceous resultant cellular product.” *Id.* ¶ 9. Ramsey discloses that, “typically, the vitreous starting material will have a traditional soda-lime-

¹¹ Ramsey is the published patent application from which the ’671 patent asserts to be a continuation-in-part; however, as noted above, Patent Owner concedes that the ’671 patent’s claims can only be accorded their actual filing date of June 11, 2014. Because Ramsey published before this date, Ramsey is prior art, which is not disputed by Patent Owner.

silica glass composition.” *Id.* Ramsey further teaches that “[a]fter the vitreous precursor is foamed, the foamed glass is physically combined with cement to form a composite material suitable for building or structural applications or the like.” *Id.*

Ramsey teaches that composite materials can be produced by combining slag or foamed glass with common cement, Portland cement, gypsum, and additional binders, fillers, and setting agents. *Id.* at ¶¶ 13–15.

I. ANGLE

Angle is a U.S. Patent issued March 23, 1999, from U.S. Patent Application 796,970, filed February 7, 1997. Ex. 1016, codes (45), (21), (22). Patent Owner does not dispute that Angle is prior art. *See generally* Resp. Angle introduces its invention as follows:

Vehicle arresting beds, for installation at the ends of aircraft runways, are effective to safely decelerate aircraft entering the bed. The arresting bed is assembled of a large number of blocks of cellular concrete having predetermined compressive gradient strength, so that aircraft landing gear is subjected to drag forces effective to slow a variety of types of aircraft, while providing deceleration within a safe range of values. . . . Arresting bed systems may be provided in alternative configurations, such as a bed formed of an aggregate including pieces of cellular concrete with or without interspersed pieces of other compressible material and covered by a hardcoat layer.

Ex. 1016, Abstract.

Angle teaches that its inventors settled on foamed cellular concrete for vehicle arresting bed systems after considering the benefits and drawbacks of other materials, such as phenolic foam. *See id.* at 1:51–2:13. Angle teaches a cellular concrete made of Portland cement, a foaming agent, and water. *Id.* at 4:51–53. The cellular concrete is provided as blocks, which are provided in a bed, over which a hardcoat of cellular

concrete is formed (cured-in-place), which permits maintenance personnel to walk on the bed without damaging it, but the hardcoat is kept to a thickness of no more than 10% of the average height of the blocks so that it does not impede the functionality of the arresting bed. *Id.* at 3:55–4:14.

Angley illustrates such an arrestor bed at its Figure 1B, reproduced below:

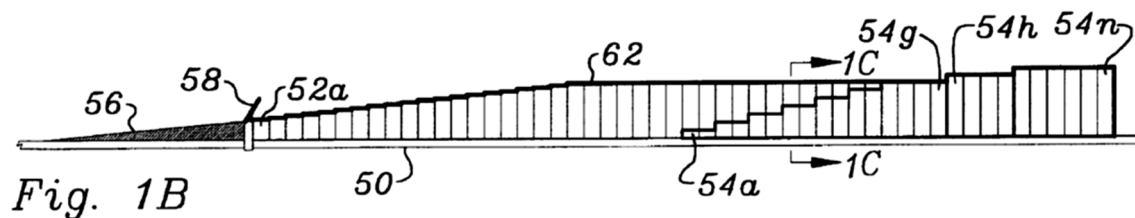


Figure 1B shows a side-view of a cross-section of a vehicle arresting bed system using block construction. *Id.* at 4:21–24. Figure 1B shows subsurface 50 supporting the system, which has rows 54 of blocks of cellular concrete, which increase in height as a stepped inclined plane over a portion of the structure. *Id.* at 6:36–8:9. Figure 1B also shows hardcoat layer 62, which is “a relatively thin protective layer of cellular concrete material, overlaying the blocks.” *Id.* at 8:60–64. Hardcoat layer 56 can have a thickness of about an inch and is preferably close to 5% the thickness/height of the blocks. *Id.* at 9:7–13.

In another embodiment, Angley teaches a similar arresting bed formed of an aggregate of pieces of cellular concrete, rather than blocks. Such a bed is shown in Angley’s Figure 2B, reproduced below:

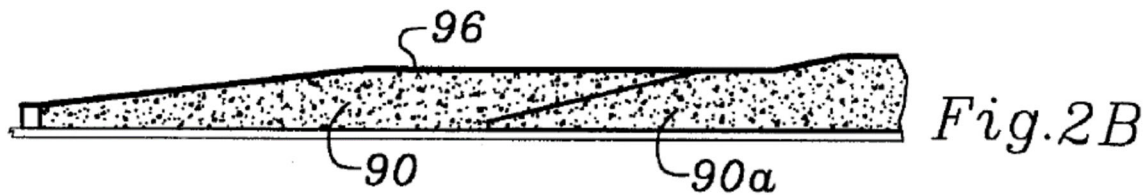


Figure 2B shows bed 90 composed entirely of pieces of cellular concrete or optionally including some other compressible material mixed therewith, such as hollow glass spheres or hollow ceramic spheres; bed 90 “includes a stabilizing layer, represented by line 96 in FIG. 2B, overlaying bed 90 to limit movement of the aggregate within the bed. Stabilizing layer 96 may typically be a relatively thin hardcoat layer of cellular concrete as described above.” *Id.* at 10:1–65.

J. SCHIRTZINGER

Schirtzinger issued December 4, 1962, from U.S. Patent Application 809,027, filed April 27, 1959. Ex. 1009, cover page, 1:2–8. Patent Owner does not dispute that Schirtzinger is prior art. *See generally* Resp.

Schirtzinger states that its “invention relates to a method and means for decelerating rolling aircraft in a manner which will prevent runway overrun and underrun accidents that may result in loss of life and serious damage to the aircraft and other valuable property.” Ex. 1009, 1:10–14.

Schirtzinger illustrates one embodiment of such a decelerating runway at its Figure 15, which is reproduced below:

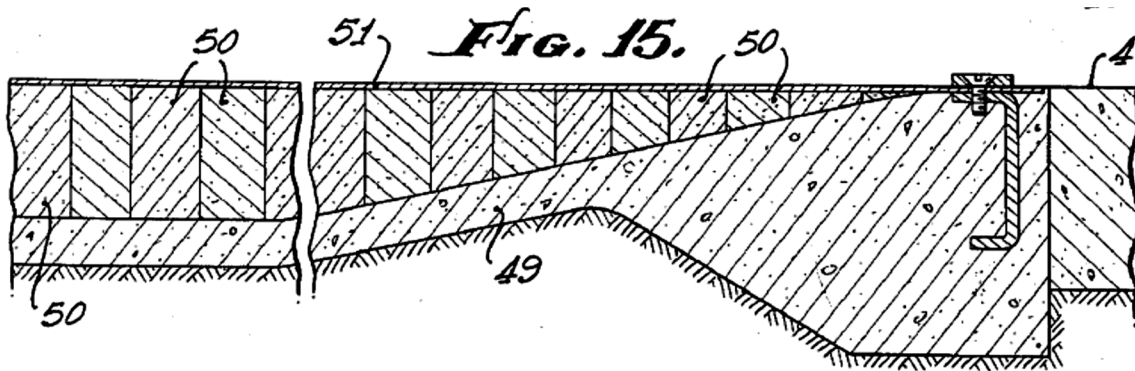


Figure 15 shows “an enlarged fragmentary transverse sectional view” of a decelerating runway having basin-like structure 49 containing a series of slabs or blocks 50 of depressible, crushable material and flexible cover 51, recessed in runway 4. *Id.* at 5:12–22, 9:16–22. Schirtzinger discloses that

Any number of materials may be used for forming the depressible, crushable blocks. Preferably, however, the material should be inert and cellular with the cells closed, but these qualities need not be present. Certain expanded polystyrenes and a foam glass product known as “Foamsil” or the equivalent thereof, are suitable. It is desired that the blocks or slabs will have a density of approximately 5 to 10 pounds per cubic foot and a field strength of between 100 and 125 pounds per square inch, as well as a shear strength of approximately 60-80 pounds per square inch, although these factors may be varied.

Id. at 9:32–43. Schirtzinger discloses that blocks or slabs 50 are to be crushed by aircraft wheels to bring the aircraft to a safe stop. *Id.* at 9:48–52.

Schirtzinger discloses that its “flexible cover” is configured to give way to the rolling landing gear wheels of an aircraft so that the wheels displace the yieldable depressible means or material below the cover to decelerate the aircraft. *See, e.g., id.* at 6:13–22. Schirtzinger further

discloses that the cover for the embodiment shown in Figure 15 above prevents water and foreign matter from getting between the blocks and may be destroyed by the wheels of the aircraft rolling onto the decelerating section. *Id.* at 9:23–28.

II. DISCUSSION

A. ORDINARY LEVEL OF SKILL IN THE ART

Petitioner states,

With respect to the ‘671 Patent, a POSA as of June 11, 2014, would be a person who has, among other attributes, obtained a civil engineering, mechanical engineering, or a material science degree or equivalent and accrued about four years of practical experience with energy absorbing materials. Additional graduate education might substitute for experience, while significant experience with energy absorbing materials, such as ceramic foam and foam glass, in industry might substitute for formal education.

Pet. 9 (citing Ex. 1002 ¶¶ 26–29).¹² Patent Owner states, “Patent Owner does not dispute the definition of a person of ordinary s[k]ill in the art (hereinafter “POSITA”) as set forth in the Petition.” Resp. 6.

We accept, as has Patent Owner, Petitioner’s proposed definition of the skilled artisan, which is consistent with the level of skill in the art reflected in the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (“the prior art itself [may] reflect[] an appropriate level” as evidence of the ordinary level of skill in the art) (quoting *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 163 (Fed. Cir. 1985)).

¹² The parties refer to the person of ordinary skill in the art as “POSA” or “POSITA.”

B. CLAIM CONSTRUCTION

The Board interprets claim terms in an *inter partes* review using the same claim construction standard that is used to construe claims in a civil action in federal district court. 37 C.F.R. § 42.100(b) (2019). Like district courts, unless a special definition is needed, we give claim terms their ordinary and customary meaning, which is “the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention.” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc).

Should claim terms require further construction, sources for claim interpretation include “the words of the claims themselves, the remainder of the specification, the prosecution history [i.e., the intrinsic evidence], and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art.” *Id.* at 1314 (quoting *Innova/Pure Water, Inc. v. Safari Water Filtration Sys., Inc.*, 381 F.3d 1111, 1116 (Fed. Cir. 2004)). “[T]he claims themselves [may] provide substantial guidance as to the meaning of particular claim terms.” *Id.* However, the claims “do not stand alone,” but are part of “a fully integrated written instrument,” consisting principally of a specification that concludes with the claims,” and, therefore, the claims are “read in view of the specification.” *Id.* at 1315 (quoting *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 978–79 (Fed. Cir. 1995)).

In an *inter partes* review proceeding, “only those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.” *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

We analyze the parties' positions on claim interpretation in view of these standards of law.

The parties present various positions over the claim term “composite bed,” which appears in independent claim 1 and dependent claim 2. Pet. 10; Resp. 8–12; Reply 3–8; Sur-Reply 1–4. In our Institution Decision we found that this claim language needed no express interpretation and it was accorded its ordinary meaning as it would have been understood by the person of ordinary skill in the art. DI 27–30. We found, and maintain, that this claim language is clear on its face, when read as a whole within the context of the claims and in view of the Specification. *Id.* at 28. According to the plain language of claim 1, the claimed “composite bed” is *a paved area of foamed glass bodies with, and defined by, a layer of cementitious material thereover*, as the claim states (it is also at least 85% foamed glass bodies, has a cementitious surface, and gets crushed, but these elements are not essential to understand the meaning of the disputed term). *Id.*; Ex. 1001, 10:59–67, Abstract.

Subsequent to the Institution Decision, Petitioner argued, and Patent Owner does not meaningfully dispute, that the Board properly construed “composite bed” according to its plain and ordinary meaning, and that no special definition of the term “composite bed” was assigned by the inventors in the Specification. Resp. 9 (“The Board rejected Petitioner’s construction of ‘composite bed’ in favor of understanding the claim term to have its ordinary meaning within the context of the claims, assigning the plain and ordinary meaning of the phrase that would have been understood by the skilled artisan.”); Pet. Reply 3 (“As the Board preliminarily found, the plain language of the claims is clear.”); PO Sur-Reply (“The Board’s adopted

construction of a ‘composite bed’ was to assign the term its plain and ordinary meaning as it would have been understood by a skilled artisan.”); Hr’g Tr. 7:5–7 (Petitioner: “I do think that the plain meaning of the claims that was adopted at the Institution decision is the appropriate read for how the claims should be interpreted.”).

Patent Owner further argues that the person of ordinary skill in the art would have had a certain understanding of the ordinary meaning of “composite bed.” *See* Resp. 10–12. Patent Owner does not cite the intrinsic record for support, but relies on its witness, Dr. Hilmas, who states that “composite bed” would have been understood to mean “[a] bed of material that consists of a composite architecture, such that it contains two or more distinct phases with one phase being a continuous matrix within which is contained at least one dispersed second phase.” *Id.* (citing Ex. 2008 ¶ 11). Patent Owner also relies on its witness, Mr. Helgeland, who states that the skilled artisan would have understood “composite bed” to mean “a region, laying approximately flat, on or in the earth, consisting of composite material.” *Id.* (citing (Ex. 2007 ¶ 12). Mr. Helgeland also testifies that the word *composite* would have had a specific meaning to those working in the relevant field, who would understand that “[c]omposites are mixtures of two (or more) different materials.” Ex. 2003 ¶ 7; Ex. 2007 ¶ 12; *see also* Ex. 2002, 448 (McGraw-Hill Dictionary of Technical and Scientific Terms, indicating a composite is “[a] material that results when two or more materials, each having its own, usually different characteristics, are combined, giving useful properties for specific applications.”).¹³

¹³ Mr. Helgeland also states that such materials, “when combined *in the proper way*, enhance certain properties of the overall body,” however, the

We remain unpersuaded that any special meaning should be ascribed to the word *composite* or the claim term “composite bed” and maintain our position that the claim language needs no express construction. Other than its witnesses’ testimony (and the noted dictionary definition at Ex. 2002), which is conclusory, Patent Owner does not cite persuasive evidence supporting its position. *See* Resp. 10–12. Through its witnesses’ testimony, Patent Owner presents two quite different understandings and competing interpretations of the term “composite bed,” offers no way to reconcile the differences between the two, and Patent Owner’s witnesses proposing these two definitions merely *conclude* that these are the proper understandings of the term without citing persuasive supporting evidence. We therefore give no weight to either witness’s definition and are not persuaded by Patent Owner’s argument, which is not tethered adequately to any intrinsic supporting evidence, such as a disclosure in the ’671 patent.

Moreover, even were Patent Owner’s witnesses correct that *composite* and “composite bed” would have been understood by the skilled artisan in the ways asserted, ultimately it would not affect the outcome in this case. As discussed below (*see infra* Sections II.D and E), even under the narrowest construction of the word *composite* and the claim term “composite bed” proposed by Patent Owner, Petitioner has shown that the prior art teaches the recited “composite bed.”

There also remains some apparent dispute between the parties as to the scope to be accorded this claim language; specifically, whether or not “composite bed” encompasses (as opposed to being limited to)

claims do not recite or require any specific way of combining, such as, “the proper way.” Ex. 2003 ¶ 7; Ex. 2007 ¶ 12 (emphasis added).

infiltrating the foamed glass bodies with the fluid cementitious material to create a composite consisting of foamed glass bodies suspended in the continuous matrix of cementitious material; if this action is performed by pouring the fluid over the top of the foamed glass bodies it will penetrate the interstices and bond the aggregate together to form a composite material.

Resp. 9–12; Ex. 2007 ¶ 10 (a claim construction chart for a proposed claim including similar language to claim 1, but omitting the term “composite bed” in favor of “foamed glass bodies”), ¶ 12 (discussing the meaning of “composite”).

The Specification fails to mention forming a *composite bed* in any manner, much less in the manner proposed by Patent Owner, which involves infiltration of foamed glass bodies with a fluid cementitious material. *See* Ex. 1001. Nevertheless, for purposes of this Decision, we accept Patent Owner’s view that the scope of “composite bed” encompasses a bed formed in this manner. We do not accept, however, that claim 1 is limited to (that is, requires) a structure formed in such a way (“by pouring the [cementitious] fluid over the top of the foamed glass bodies.”). *See* Resp. 9–12. Further, we acknowledge that Petitioner takes issue with the way Patent Owner has presented this position and with Patent Owner’s expert’s experience, or lack thereof, with arrestor bed technology. Reply 4–5. On this point, however, Petitioner asserts, and we agree, that the “covering . . . with a layer of cementitious material” that claim 1 recites as defining a *composite bed* may include covering in whatever form so that the covering *defines* the *composite bed*. Reply 3–8; Hr’g Tr. 8:2–6. We agree with this position as it is supported by claims depending from claim 1 that further define the composite bed’s composition.

According to the claims, the recited *covering with cementitious material* may *form* and *define* the composite bed (e.g., when fluid cementitious material is poured over and then infiltrates the foamed glass bodies the composite bed is formed and defined as asserted by Patent Owner) because dependent claim 8 recites that “the bed is [initially] comprised entirely of foamed glass bodies,” thus, a composite material need not be provided or present when the area is first paved with the foamed glass bodies (as in step (a) of claim 1). Ex. 1001, 10:56–67, 11:22–23. The second component of the composite bed can be provided by the cementitious layer, deposited in whatever form, as provided in step (b) of claim 1.

To summarize, we conclude the claim language “composite bed” retains its ordinary meaning as would have been understood by the person of ordinary skill in the art. Further, the scope of the claimed “composite bed” language includes (but does not require) its forming by pouring fluid cementitious material over foamed glass bodies.

Regarding claim 10, Patent Owner asserts that the claim language “arrestor bed is formed from a plurality of foamed glass aggregate bodies covered by a paving layer” means that the foamed glass aggregate bodies are completely covered with, and thus, immersed in, matrix material. Resp. 14 (citing Ex. 1001, 6:43–51; and citing generally Ex. 2007 and Ex. 2008). We do not adopt this interpretation.

We first note that, although Patent Owner relies upon them for support, the cited Helgeland (Ex. 2007) and Hilmas (Ex. 2008) declarations do not specifically discuss claim 10 and, when they discuss language similar to that at issue, neither witness testifies that the meaning urged by Patent Owner is correct. *See* Ex. 2007, 6–7 (regarding similar language of

proposed amended claim 21, Mr. Helgeland indicates that it means “[t]he foamed glass aggregate is made up of many pieces of foamed glass surrounded by the structural matrix material and covered by a structural material”¹⁴; Ex. 2008, 8–9 (Dr. Hilmas’s chart discussing proposed amended claim 21 indicates the language at issue relates to a ceramic matrix, or to concrete asphalt or the like being matrix material). Thus, even Patent Owner’s witnesses do not agree upon Patent Owner’s proposed interpretation.

Moreover, Patent Owner cites a portion of a single paragraph from the Specification of the ’671 patent as requiring such a narrowing definition of the language of claim 10. However, the cited portion of the Specification does not require Patent Owner’s interpretation, but expressly describes only a “typical” embodiment of an RSA where foamed glass bodies or aggregate are in a thin ceramic or structural matrix, etc. *See* Ex. 1001, 6:43–51.

“[T]he claims define the invention. . . . [L]imitations from the specification are not to be read into the claims.” *Sjolund v. Musland*, 847 F.2d 1573, 1582 (Fed. Cir. 1988). We will not read a limitation from the Specification into the claims where the claim language is not so narrow and the Specification does not clearly require it.

¹⁴ Patent Owner filed a Motion to Amend (Paper 22, “MTA”) in this proceeding, but later expressly withdrew it, without objection from Petitioner. Paper 48. Although we no longer consider Patent Owner’s proposed substitute claims, the parties’ briefing and evidence regarding the MTA remains a part of the record to the extent it is considered relevant to this Decision.

In conclusion, all claim language has its ordinary meaning as would have been understood by the person of skill in the art at the time of the invention.

C. APPLICABLE LEGAL STANDARDS

“In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to Patent Owner. See *Dynamic Drinkware*, 800 F.3d at 1378 (discussing the burden of proof in *inter partes* review).

Regarding obviousness, the Supreme Court in *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398 (2007), reaffirmed the framework for determining obviousness as set forth in *Graham v. John Deere Co.*, 383 U.S. 1 (1966). The *KSR* Court summarized the four factual inquiries set forth in *Graham* (383 U.S. at 17–18) that are applied in determining whether a claim is unpatentable as obvious under 35 U.S.C. § 103(a) as follows:

(1) determining the scope and content of the prior art; (2) ascertaining the differences between the prior art and the claims at issue; (3) resolving the level of ordinary skill in the pertinent art;¹⁵ and (4) considering objective

¹⁵ The ordinary level of skill in the art is not in dispute and it is resolved *supra* at Section II.A.

evidence indicating obviousness or non-obviousness.¹⁶ *KSR*, 550 U.S. at 406.

“The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.” *Id.* at 416. “[W]hen the question is whether a patent claiming the combination of elements of prior art is obvious,” the answer depends on “whether the improvement is more than the predictable use of prior art elements according to their established functions.” *Id.* at 417.

With these standards in mind, and in view of the definition of the skilled artisan and claim interpretation discussed above, we address Petitioner’s challenges below.

D. OBVIOUSNESS OF CLAIMS 1–16 OVER SCHIRTZINGER, ANGLEY, AND HOJAJI

Petitioner asserts (under its Ground 6) that claims 1–16 (all claims) would have been obvious over Angley, Hojaji, and Schirtzinger. Pet. 60–61; *see also id.* at 46–60 (Petitioner’s Ground 5 addressing the teachings of Angley and Hojaji). Petitioner bases its assertions under Ground 6, at least in part, on the facts alleged under Ground 5, stating:

As supported by Dr. Zupan’s declaration (and as set forth above in Section VII.G), independent claims 1 and 10, and claims 2–9 and 11–16 depending therefrom, are obvious in view of *Angley* and *Hojaji*. (Ex. 1002, ¶¶113–115). However, in the event the Board is not persuaded that *Angley* and *Hojaji* would be properly combined, *Schirtzinger* confirms the propriety of using foamed glass in runway arrestor beds. (Ex. 1009, 9:16–47). *Schirtzinger*’s disclosures, as set forth in Section VII.B.6, confirm that a POSA would have understood foamed glass to be

¹⁶ Patent Owner has not presented any arguments or evidence regarding objective indicia of non-obviousness. Therefore, we will not address the issue further.

a viable alternative to other foamed materials in the runway arrestor bed context and that the claimed crush strength were well known to a POSA. (Ex. 1009, 9:16–47; Ex. 1002, ¶113).

In this regard, Ground 6 is the same as Ground 5 above, which petitioner incorporates herein, with the additional understanding provided by *Schirtzinger* that a POSA would have recognized the combinability of the foamed glass of *Hojaji* into the arrestor bed of *Angle* and that such a combination would be made with an expectation of success, as in fact such a combination had already been proposed and articulated. (Ex. 1009, 9:16–47; Ex. 1002, ¶¶45, 114–115). Additionally, *Schirtzinger* [*sic*] confirms that the claimed crush strength of dependent claims 4 and 13 (e.g., 100 PSI (Ex. 1009, 9:40)) and the claimed density and crush strength of dependent claims 5 and 14 (100 PSI and 80 to 160 kg/m³ (Ex. 1009, 9:39–40)) would have been known to a POSA. (Ex. 1002, ¶¶45, 114–115). The disclosures of *Angle* and *Hojaji*, as set forth above in Section VII.G, and the addition of these disclosures of *Schirtzinger* [*sic*] demonstrate that the Challenged Claims would have been obvious to a POSA. (Ex. 1002, ¶¶45, 114–115).

Pet. 60–61. Therefore, Petitioner’s Ground 6 incorporates the allegations of Ground 5.

Because we find, for the reasons discussed below, that Petitioner proves by a preponderance of the evidence that, under Ground 6, the prior art combination of *Angle*, *Hojaji*, and *Schirtzinger* would have rendered the ’671 patent’s claims 1–11 and 13–16 obvious, because Patent Owner does not contest the propriety of this prior art combination, and because we conclude Ground 6 is superior to Ground 5 because it includes *Schirtzinger*, we address Ground 5 only to the extent it’s allegations are subsumed within Ground 6.

I. COMBINING AND MODIFYING THE PRIOR ART

We first address the propriety of Petitioner's asserted combination of Angley, Hojaji, and Schirtzinger.

Petitioner asserts that the skilled artisan would have been motivated to combine Angley, Hojaji, and Schirtzinger because Schirtzinger confirms the obviousness of using foamed glass in aircraft runway arrestor beds and the skilled artisan would have understood the materials for the Schirtzinger (foamed glass) and Angley (foamed concrete) arrestor beds were viable alternatives to one another, i.e., functionally interchangeable and known substitutes. Pet. 1, 21–22, 46–47, 60 (citing Ex. 1002 ¶¶ 90–94, 113–115; Ex. 1009, 9:16–48; Ex. 1016, Abstract). Petitioner also asserts that the skilled artisan would have recognized that Hojaji's disclosed foamed glass, a long and well known material in the building industry, would have been an obvious alternative material for Angley's foamed concrete because it is also foamed, is lightweight, and porous. *Id.* at 47 (citing Ex. 1002 ¶¶ 90–94; Ex. 1014, 1:36–38) (Petitioner also asserts that Sachs shows that it would have been obvious to replace cellular concrete with foamed glass because the materials have similar properties (citing Ex. 1020, 1:41–47, 2:51–53; Ex. 1002 ¶ 93)).

Petitioner asserts that Schirtzinger discloses an aircraft arrestor system including a basin structure containing high kinetic energy absorbing material, which is yieldable to aircraft landing gear wheels. *Id.* at 21–22 (citing Ex. 1009, 2:30–36, 5:56–62, 6:1, 6:13–22). Petitioner asserts that Schirtzinger teaches blocks of depressible, crushable material, such as foamed glass with closed cell structure, e.g., Foamsil, can be used as such high kinetic energy absorbing material. *Id.* at 22 (citing Ex. 1009, 9:32–38).

Petitioner asserts that Schirtzinger teaches that such foamed glass can have a density of approximately 5–10 lbs./ft.³, a crush strength of approximately 100–125 psi, and a sheer strength of approximately 60–80 psi, but that each of these can be varied as necessary. *Id.* at 22 (citing Ex. 1009, 9:38–47; Ex. 1002 ¶ 45). Further, Petitioner asserts that Schirtzinger (like Angley) teaches it is advantageous to provide a cover over such crushable material, but that the cover may be destroyed during the aircraft arresting process. *Id.* at 22 (citing Ex. 1009, 9:25–28).

In relation to these assertions, Petitioner’s witness, Dr. Zupan, states:

In my opinion, a person of ordinary skill in the art would have been motivated to combine these references [Angley, Hojaji, and Schirtzinger] and would have been readily able to combine them with an expectation of success. It is my opinion that a person of skill in the art would be motivated to combine *Angley* and *Hojaji* (as *Schirtzinger* confirms the idea of this combination) to develop a runway arrestor bed system relying on foamed glass.

Ex. 1002 ¶ 113. Dr. Zupan further states:

As set forth in *Schirtzinger*, a POSA would have recognized the combinability of the foamed glass of *Hojaji* into the arrestor bed of *Angley* and that such a combination would be made with an expectation of success, as the combination had already been proposed and articulated.

Id. ¶ 115 (citing Ex. 1009, 9:16–47).

We find that, for the reasons set forth above, Petitioner has established that the teachings of Angley, Hojaji, and Schirtzinger would have been combined by the skilled artisan, that there would have been motivation to make the combination, and that such a combination would have been reasonably expected to succeed. “[W]hen a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a

predictable result.” *KSR*, 550 U.S. at 416 (citing *United States v. Adams*, 383 U.S. 39, 50-51 (1966)). Here, well-known materials are proposed to be substituted in a well-known structure for materials that are their functional equivalents and used for the same purposes.

Patent Owner does not contest Petitioner’s assertions and evidence directed to the propriety of combining Anglely, Hojaji, and Schirtzinger, and makes no argument that these prior art references would not have been combined, and expected to be successfully so, by the skilled artisan. Resp. 17–19. In circumstances such as this, where Patent Owner has chosen not to address or dispute Petitioner’s arguments and evidence, we view Patent Owner’s arguments as waived. *See In re Nuvasive, Inc.*, 841 F.3d 966, 974 (Fed. Cir. 2016) (“Although the Board did not make findings as to whether any of the other claim limitations (such as fusion apertures or anti-migration teeth) are disclosed in the prior art, it did not have to: Nuvasive did not present arguments about those limitations to the Board. . . . The Board, having found the only disputed limitations together in one reference, was not required to address undisputed matters.”); Paper 18, 7 (emphasizing that “any arguments for patentability not raised in the response may be deemed waived”).

Having found it would have been obvious to the skilled artisan to combine the references, we turn to Petitioner’s assertions as to how the combination of Anglely, Hojaji, and Schirtzinger teaches or suggests the elements of each claim of the ’671 patent.

2. *INDEPENDENT CLAIM 1*

Regarding independent claim 1, Petitioner notes that the preamble of claim 1 is directed to “[a] method of slowing an aircraft overrunning a

runway,” asserts that Angley is likewise directed to such a method, and also asserts that “*Schirtzinger* confirms the propriety of using foamed glass in runway arrestor beds.” Pet. 47–48, 60 (citing Ex. 1001, 10:56–57 (claim 1); Ex. 1016, 3:2–4, 6:41–42, 11:56–63 (claim 1); Ex. 1009, 9:16–47; Ex. 1002 ¶¶ 98, 113). Patent Owner does not contest this. “Generally, the preamble does not limit the claims.” *Allen Eng’g Corp. v. Bartell Indus., Inc.*, 299 F.3d 1336, 1346 (Fed. Cir. 2002). Regardless of whether the preamble is limiting here, Petitioner sufficiently shows that the recitation in the preamble is satisfied by the prior art, as both *Schirtzinger* and Angley are directed to this same method recited in the preamble. Ex. 1009, 1:10–14; Ex. 1016, Abstract; *see also* Ex 1002 ¶¶ 18, 43, 45, 90, 114.

Petitioner notes that claim 1 recites “a) paving an area with foamed glass bodies to define a bed.” Pet. 48 (citing Ex. 1001, 10:59 (claim 1)). Petitioner asserts that Angley teaches such a bed having cellular concrete (as blocks or aggregate) and that it would have been obvious to the skilled artisan to replace this cellular concrete with foamed glass (of Hojaji) because the two materials had long been known in the building industry as alternatives. *Id.* (citing Ex. 1002 ¶¶ 98–99; Ex. 1016, Abstract, 3:31–33, 10:1–28, Figs. 2A, 2B, 6; Ex. 1014, 1:36–38). As noted above, Petitioner also asserts that “*Schirtzinger* confirms the propriety of using foamed glass in runway arrestor beds” and that Hojaji confirms that foamed glass was a well-known building material. *Id.* at 47, 60 (citing Ex. 1014, 1:36–38; Ex. 1009, 9:16–47; Ex. 1002 ¶¶ 45, 93, 113–115).

Patent Owner argues that, when considering Angley and Hojaji, there is no suggestion to substitute Hojaji’s foamed glass for Angley’s cellular concrete material in an arrestor bed. Resp. 17–18. Although this may be a

reasonable point in view of the fact that Hojaji is not explicit regarding the use of its foamed glass in an arrestor bed, it is not persuasive because it overlooks Schirtzinger's teaching of using such foamed glass in an aircraft arrestor bed (like Angley's aircraft arrestor bed); Patent Owner acknowledges that Schirtzinger teaches forming an arrestor bed of Foamsil, which Patent Owner concedes "is a foamed, closed-celled silica that is 99 percent or more chemically pure," i.e., it is foamed glass. Resp. 18; *see also* Ex. 2011, 12 (Patent Owner's exhibit identifying Foamsil as foamed glass); and *see also* Pet. 22 (discussing Schirtzinger's disclosure of Foamsil); Ex. 1002 ¶¶ 18, 45 (Dr. Zupan testimony: Schirtzinger confirms foamed glass was known for use in arrestor beds). Schirtzinger discloses a paved bed of foamed glass bodies in the form of foam glass bricks in a basin on a runway. Ex. 1009, 5:12–22, 9:16–22, 9:32–43.

Furthermore, Angley teaches its foamed material, e.g., cellular concrete, can be provided in an aircraft arrestor bed in the form of an aggregate, that is, as discrete bodies, and Schirtzinger confirms that foamed glass material, like Foamsil or the foamed glass taught by Hojaji, is useful for this same aircraft arrestor bed purpose. *See* Pet. 20–21, 48 (discussing Angley); Ex. 1002 ¶¶ 109–110, 113–115. "The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *KSR*, 550 U.S. at 416. The materials at issue here were well-known and their disclosure in the cited prior art for aircraft arrestor beds indicates predictable results. It is obvious to those skilled in the art to substitute one known equivalent for another, as here, where foamed glass bodies were a known equivalent of foamed cellular concrete aggregate for use in aircraft arrestor beds. *See In re*

Omeprazole Patent Litigation, 483 F.3d 1364, 1374 (Fed. Cir. 2007). Thus, as argued by Petitioner, the skilled artisan would have been motivated to use Schirtzinger's (or Hojaji's) foamed glass as aggregate for an aircraft arrestor bed, as taught by Angley. Therefore, we find that the combination of Angley, Hojaji, and Schirtzinger teaches forming an aircraft arrestor bed by paving an area with foamed glass bodies to define a bed, as claimed.

Petitioner identifies that claim 1 further recites “b) covering the bed with a layer of cementitious material to define a composite bed.” Pet. 49 (citing Ex. 1001, 10:60–61 (claim 1)). Petitioner asserts that Angley discloses the advantages of a hardcoat layer of cementitious material overlaying its arrestor bed, such a hardcoat layer having a thickness not exceeding 10% of the average thickness of the bed and being strong enough to support a pedestrian (or even large vehicles). *Id.* (citing Ex. 1016, 11:56–63 (claim 1), 4:51–53, 9:22–26; Ex. 1002 ¶ 100); *see also id.* 20–21 (discussing Angley's disclosure). Petitioner asserts that this hardcoat layer of Angley teaches the claimed layer of cementitious material over and defining the composite bed. *Id.*

Patent Owner does not specifically argue against Petitioner's assertions or evidence concerning this claim element. Resp. 17–19. However, Patent Owner does argue that Schirtzinger does not teach making a composite bed, which relates to this claim limitation because the claim requires that the covering of the claimed bed of foamed glass bodies with a layer of cementitious material *defines a composite bed*. *Id.* at 18. Patent Owner's argument is not persuasive.

As discussed above, we find that it would have been obvious to combine the teachings of Angley and Schirtzinger, thus, it would have been

obvious to use foamed glass bodies as aggregate in an aircraft arrestor bed. Ex. 1002 ¶¶ 113–115. Schirtzinger teaches that it is advantageous to provide a cover layer for its aircraft decelerating runway, e.g., the foam glass basin, and Angley teaches that it is advantageous to use a thin, cured-in-place, cellular concrete layer as a hardcoat top cover for arrestor beds. Ex. 1009, 6:13–22, 9:22–28, Fig. 15; Ex. 1016, 3:55–4:14, 8:60–64, 9:7–13, 10:1–65, Figs. 1B, 2B; Ex. 1002 ¶ 100. Angley discusses the advantages of pouring and curing-in-place (i.e., pouring as a fluid) cellular concrete over its aircraft arrestor bed material (e.g., aggregate of cellular concrete and glass spheres) to form a hardcoat thereover. Ex. 1016, Abstract, Fig. 2B, 4:10–14, 5:12–20, 8:60–9:16, 10:1–65, 11:55–63, 12:8–12, 12:24–33, 12:61–64, 13:6–19, 13:26–33; Ex. 1002 ¶¶ 43, 100–102.

Patent Owner’s assertions and evidence in this proceeding confirm that pouring- and curing-in-place, fluid cellular concrete (a cementitious material) over foamed glass bodies forms a composite, as claimed. *See* Resp. 11; *see also* MTA 12 (the MTA relied on the assertion that “pouring cement over the foamed glass bodies to infiltrate the foamed glass bodies with the cement such that the cement sets to form a cement matrix around the foamed glass bodies;” and “infiltrating foamed glass bodies with cementitious fluid to create a composite consisting of foamed glass bodies suspended in a continuous foamed glass matrix material”); *see also* Hr’g Tr. 24:7–16 (“JUDGE FLAX: So in the situation where you’re pouring in place as that [(Angley or ACRP)] is describing, wouldn’t some of that infiltrate down into the foamed glass body area below it? DR. BRANNON: If you pour the cement in place yes, it should.”), 31:2–18 (any degree of infiltration by cementitious material poured over foamed glass bodies is within the

scope of the claims); *see also* Ex. 2007 ¶¶ 10, 12 (Mr. Helgeland: “In the ‘671 patent specification and claims, it is the act of infiltration of the cement into the aggregate, and its consequent curing in place, which constitutes a composite.”); *see also* Reply 3 (discussing Patent Owner’s understanding of the results of covering a bed of foamed glass with liquid cement). Patent Owner and each of Patent Owner’s primary witnesses each confirmed that pouring fluid cementitious material, e.g., cement or concrete, over a bed of foamed glass bodies creates a composite bed. Ex. 1038, 72:14–21, 73:10–13; 117:18–19; Ex. 1039, 24:1–25:11, 27:17–28:6, 44:9–45:12, 51:9–52:6.

Thus, as Petitioner asserts and Patent Owner confirms, the combination of Angley and Schirtzinger teaches forming an aircraft arrestor bed of foamed glass bodies and covering this bed of foamed glass bodies with pour-in-place cementitious material in the form of cement or concrete.¹⁷ This would result in infiltration of the cementitious material into the foamed glass bodies so as to define a composite bed and provide a cementitious surface thereover, thus, meeting the respective claim limitation.

Petitioner identifies that claim 1 also recites “c) crushing at least a portion of the composite bed with an oncoming aircraft.” Pet. 49 (citing Ex. 1001, 10:63–64 (claim 1)). Petitioner asserts that Angley teaches this as its invention’s purpose. *Id.* at 49–50 (citing Ex. 1016, 1:57–64, 11:12–15, 11:32–47; Ex. 1002 ¶ 102).

¹⁷ We also note that Hojaji explicitly discloses that its foamed glass material, which is an exemplary material for use when combining Schirtzinger’s foamed glass with Angley’s arrestor bed and hardcoat cover, “can be used for ‘composite concrete-foam glass.’” Ex. 1014, 25:55–60. This further supports the expectation of success combining Angley and Schirtzinger. *See, e.g.*, Ex. 1002 ¶ 41 (discussing Hojaji).

Patent Owner makes no argument directed to this claim limitation or Petitioner's assertions thereto. *See generally* Resp. We agree with Petitioner's assertions. Angley teaches crushing a composite bed with an aircraft; this is the primary purpose of its arrestor bed. Ex. 1002 ¶¶ 43, 102; Ex. 1016, Abstract (arrestor beds are composed of compressible material to safely decelerate aircraft), 1:50–2:13 (cellular concrete offers the advantage, like foam, of being crushed when contacted by an aircraft). Moreover, Schirtzinger, which Petitioner asserts to be combined with Angley, teaches that an object of its invention is to provide material that “will be crushed by the landing gear wheels . . . of an aircraft to bring the aircraft to a safe stop during a short run,” and teaches that foamed glass is such a crushable material. Ex. 1009, 3:57–61, 5:12–22, 9:15–52; Ex. 1002 ¶¶ 18, 45.

Petitioner identifies that claim 1 also recites “wherein the composite bed is at least 85 percent foamed glass bodies.” Pet. 50 (citing Ex. 1001, 10:65–66 (claim 1)). As noted above, Petitioner asserts Angley would have been modified to replace its cellular concrete with foamed glass bodies, such as taught by Hojaji, and asserts that in Angley's aircraft arrestor bed, even if other filler materials are used along with this primary crushable material, they serve only a minor role and it would be desirable to maximize the percentage of foamed glass bodies used to replace Angley's crushable cellular concrete and, further, that the cement hardcoat of Angley is taught to be 10% or less of the arrestor bed. *Id.* at 51 (citing Ex. 1016, 10:57–65; Ex. 1002 ¶¶ 101, 103).

Patent Owner makes no argument directed to this claim limitation or Petitioner's assertions thereto. *See generally* Resp. We agree with Petitioner's assertions. Angley teaches an aircraft arrestor bed that is almost

entirely made of the primary crushable material, e.g., cellular concrete. *See* Ex. 1016, 3:55–4:14, 8:60–64, 9:7–13, 10:1–17, Figs. 1B, 2B. As we conclude above, it would have been obvious to substitute Angley’s cellular concrete with foamed glass bodies. Moreover, Schirtzinger does not indicate that anything other than its disclosed crushable material, e.g., foamed glass, fills its disclosed arrestor beds. Ex. 1009, 9:15–46, Fig. 15. Thus, the prior art supports that it would have been obvious to have a composite bed composed essentially entirely of or, as claimed, at least 85% of foamed glass bodies. Ex. 1002 ¶ 101 (Angley teaches at least 85% limitation, and achieving this specific volume of crushable material, e.g., foamed glass, would require mere routine optimization), ¶ 103 (Angley teaches using, but minimizing materials other than the primary crushable material).

Petitioner further identifies that claim 1 recites “wherein the composite bed has a cementitious surface.” Pet. (citing Ex. 1001, 10:67 (claim 1)). Petitioner asserts that Angley’s hardcoat meets this limitation. *Id.* at 51–52 (citing Ex. 1016, 4:51–53, 9:1–3, 9:13–16, 9:22–26; Ex. 1002 ¶ 100).

Patent Owner makes no argument directed to this claim limitation or Petitioner’s assertions thereto. *See generally* Resp. As discussed above, we agree with Petitioner’s assertions that, upon using Schirtzinger’s foamed glass in place of Angley’s cellular concrete aggregate materials in an arrestor bed, and then pouring-in-place fluid concrete thereover, a cementitious surface would be formed. *See* Ex. 1002 ¶ 100.

For the reasons discussed above, we conclude that Petitioner has met its burden to show by a preponderance of the evidence that independent claim 1 would have been obvious over Angley, Hojaji, and Schirtzinger.

3. *DEPENDENT CLAIMS 2–9*

Petitioner also discusses how the combination of Angley, Hojaji, and Schirtzinger teaches or suggests each element of claims 2–9, which depend from independent claim 1. Pet. 52–56 (citing Ex. 1016, 2:50–64, 3:47–50, 8:21–46, 10:1–45, 10:57–65, Figs. 2A, 2B, 6; Ex. 1014, 27:1–14, 3:40, 6:3–11, 18:60–66, 23:8–15; Ex. 1002 ¶¶ 101–110). We address these challenges below.

Claim 2 further requires “the composite bed is at least about 90 volume percent foamed glass bodies,” and Petitioner asserts that this is taught by Angley (and Hojaji and Schirtzinger) for the same reasons asserted for the similar 85% limitation of claim 1. Pet. 52 (citing Ex. 1016, 2:50–64, 10:57–65; Ex. 1002 ¶¶ 101,103); Ex. 1001, 11:1–2. Patent Owner does not expressly contest this. *See* Resp. 17–19. We agree with Petitioner. For the same reasons Angley and Schirtzinger teaches or suggests an arrestor bed having essentially entirely, but at least 85%, foamed glass bodies as recited by claim 1, the prior art also teaches that 90% of such volume would be foamed glass bodies. Ex. 1009, 9:16–38, Fig. 15; Ex. 1016, 3:55–4:14, 9:7–13, Figs. 1B, 2B; *see also* Ex. 1002 ¶¶ 101–102 (selecting the volume of the bed material and cementitious material would require only routine optimization, where the amount of cementitious material would depend on what was intended to be supported by the cover layer).

Claim 3 further requires “the foamed glass bodies have a closed cell structure.” Ex. 1001, 11:3–4. Petitioner asserts that “*Hojaji* discloses

foamed glass with a ‘closed pore structure.’ (Ex. 1014, 27:1–14). A POSA reading *Hojaji* would understand that foamed glass has a closed pore structure. The combination of *Anglely* and *Hojaji* render obvious this limitation. (Ex. 1002, ¶104).” Pet. 52. Patent Owner does not expressly contest this. *See* Resp. 17–19. We agree with Petitioner. *Hojaji* discloses that foamed glass bodies have a closed pore structure. Ex. 1002 ¶¶ 104, 111; Ex. 1014, 27:1–12. Moreover, Schirtzinger also teaches its foamed glass is cellular with closed cells, which further supports Petitioner’s assertions. Ex. 1009, 9:33–35.

Claim 4 further requires “the foamed glass bodies have a crush strength of between about 50 PSI and about 100 PSI.” Ex. 1001, 6–8. Petitioner asserts that “*Anglely* discloses that for a foamed arrestor bed, the crush strength of the material should be between 60 PSI and 90 PSI (60/80 and 80/100 CGS). (Ex. 1016, 8:21–46). A POSA modifying *Anglely* to include the foamed glass of *Hojaji* would understand that this range of crush strength is suitable and desirable for aircraft arrestor beds. (Ex. 1002, ¶¶ 105–106). The combination of *Anglely* and *Hojaji* render obvious this limitation. (Ex. 1002, ¶¶105–106).” Pet. 52–53. Petitioner also asserts that this crush strength is confirmed as well-known by Schirtzinger, which teaches its foamed glass bodies have a field strength of 100–125 PSI. *Id.* at 60–62; Ex. 1009, 9:40–41. Patent Owner does not expressly contest this. *See* Resp. 17–19. We agree with Petitioner. The prior art, as cited by Petitioner, teaches the claimed crush strength in its crushable material for aircraft arrestor beds. *See* Ex. 1002 ¶¶ 105–106, 114; *E.I. DuPont de Nemours & Co., v. Synvina C.V.*, 904 F.3d 996, 1010 (2018) (claimed range abutting range(s) disclosed in prior art was obvious).

Claim 5 further requires “the foamed glass bodies have a crush strength of at least about 100 PSI, and wherein the foamed glass bodies have densities of between about 100 kg/m³ and 180 kg/m³.” Ex. 1001, 11:9–12. Petitioner asserts that “*Angle* discloses the use of foam with densities in the lower portion in the range of 12 to 22 pcf. (Ex. 1016, 3:47–50). 12 pcf corresponds to approximately 190 k[g]/m³ and 22 pcf corresponds to approximately 350 kg/m³. (Ex. 1002, ¶106). Additionally, *Angle* discloses arrestor foams having a crush strength of 90 PSI. (Ex. 1016, 8:21–46).” Pet. 53. Petitioner also asserts that Schirtzinger confirms the obviousness of the claimed crush strength and densities in that it teaches a field strength of 100 PSI and that its foamed glass can have a density of approximately 5–10 lbs./ft.³, which converts to 80–160 kg/m³. *Id.* at 60–61 (citing Ex. 1009, 9:39–40; Ex. 1002 ¶¶ 45, 114–115). Again, Patent Owner does not expressly contest this. *See* Resp. 17–19. We agree with Petitioner and find no fault in its assertions. *Iron Grip Barbell Co. v. USA Sports, Inc.*, 392 F.3d 1317, 1322 (Fed. Cir. 2004) (“[W]here there is a range disclosed in the prior art, and the claimed invention falls within that range, there is a presumption of obviousness.”).

Claim 6 further requires “the foamed glass bodies have compositions in the range around 70 weight percent SiO₂, around 13 weight percent Na₂O and around 10 weight percent CaO with the remainder being other metal oxides.” Ex. 1001, 11:14–17. Petitioner cites Hojaji as teaching this. *See* Pet. 54 (citing Ex. 1014, 3:40, 6:3–11, 18:60–66, 23:8–15). Petitioner also asserts that “[a] A POSA would have known that foamed glass would include a combination of SiO₂, Na₂O, CaO and other metal oxides.

(Ex. 1002, ¶¶107–108). The exact composition would have been attained through routine optimization. (Ex. 1002, ¶¶107–108).” *Id.*

Because we indicated some uncertainty over Petitioner’s evidence regarding this claim in our Institution Decision (at 42), Petitioner further explained that the glass composition defined by claim 6 was “nothing more than . . . then-existing recycled glass—the same glass that has been unchanged for hundreds of years,” which would have been an obvious choice for the skilled artisan. Reply 15–16 (citing Ex. 1038, 41:14–25, 42:10–44:13, 45:2–12; Ex. 1037 ¶¶ 26–30). Petitioner inquired at deposition of Patent Owner’s expert witness, Mr. Helgeland, who confirmed that the claimed glass composition (which provides for some variances in components in reciting “around”) was mere “soda lime glass,” which was traditional glass and well-known. *Id.* at 16 (citing Ex. 1038, 28:23–30:5; Ex. 1002 ¶¶ 19, 39, 87; Ex. 1037 ¶¶ 26–30). Petitioner also asserts that the glass disclosed by Hojaji was such “**traditional** soda lime glass,” e.g., window glass. *Id.* at 17 (citing Ex. 1002 ¶¶ 41, 107–108; Ex. 1035 2:66–72; Ex. 1037 ¶¶ 26, 28, 30; Ex. 1038, 20:17–25; Ex. 1014, 1:46–51 (using soda lime glass, e.g., window type glass, was “the most common technique for making foam glass”)).

Dr. Zupan indicates that the ’671 patent discloses “traditional soda-lime-silica glass” as the glass used in its invention. Ex. 1037 ¶ 26 (citing Ex. 1001, 2:60–62 (“typically, the vitreous starting material will have a traditional soda-lime-silica glass composition”)). Dr. Zupan states that such glass “makes up almost 90% of consumer glassware today . . . and has not varied significantly in over 100 years.” *Id.* (citing Ex. 1034, 72). Dr. Zupan states that a common textbook (Baker) establishes that soda-lime glass, i.e.,

modern glass, has a composition of approximately 74% silica (SiO_2), 13% soda (Na_2O), and 10% lime (CaO), and that Patent Owner's witness, Mr. Helgeland, explained that varying the percentages of these components was known for the purpose of altering the glass's melting point. *Id.* ¶ 27 (citing Ex. 1034); *see also* Ex. 1037 ¶ 28 (Dr. Zupan discussing Mr. Helgeland's testimony that "soda-lime glass" is approximately 70% SiO_2 , 13% Na_2O , 10% CaO — the claimed composition).

Thus, when Hojaji (Ex. 1014, 1:35–51) states that the most common way to make foamed glass is using window glass, we agree with Petitioner that it is referring to traditional soda-lime glass, which would have the claimed composition. We are satisfied by Petitioner's explanation of its position on claim 6. This is not contested by Patent Owner.

Claim 7 expands on claim 1's method as "further comprising d) before step a), mixing the foamed glass bodies with a cementitious material to define a paving mixture." Ex. 1001, 11:19–21. Petitioner asserts that "*Angley* also discloses the incorporation of crushable pieces into cement[*it*]itious material. (Ex. 1016, 10:55–57; Fig. 6). A POSA would understand that this limitation is obvious in view of *Angley* and *Hojaji*. (Ex. 1002, ¶¶ 109–110)." Pet. 54–55. Patent Owner does not contest this. We agree with Petitioner. *Angley* teaches that glass bodies (per Schirtzinger or Hojaji) and concrete (a cementitious material) can be mixed in its embodiment having an aggregate structure. Ex. 1016, 10:9–17, Fig. 2B; Ex. 1002 ¶¶ 109–110. Hojaji supports such a position in confirming that its disclosed foamed glass materials "can be used for 'composite concrete-foam glass' structures, e.g., walls. Ex. 1014, 25:58–60.

Claim 8 further requires “the bed is comprised entirely of foamed glass bodies.” Ex. 1001, 11:22–23. Petitioner asserts that such a bed would have been obvious for the same reasons discussed above regarding the 85% foamed glass bodies limitation of claim 1 and the 90% foamed glass bodies limitation of claim 2. Pet. 55. Patent Owner does not expressly contest this. We agree with Petitioner. We note that this claim refers to “the bed” being entirely foamed glass bodies and we understand this as referring back to “a bed” recited by claim 1’s step “a,” which is the paved area of foamed glass bodies. Ex. 1001, 10:59. Thus, according to claim 8, when an area is paved with foamed glass bodies to define a bed, as recited by claim 1, according to claim 8, this bed is entirely foamed glass bodies. Schirtzinger teaches an embodiment with a bed (basin) completely filled with foamed glass bodies (blocks). Ex. 1009, Fig. 15. We explained above that it would have been obvious to use Schirtzinger’s and Hojaji’s foamed glass material as Angley’s aggregate crushable material for an aircraft arrestor bed. In such a circumstance, the bed would be entirely foamed glass bodies before a top coat of cementitious material (e.g., Angley’s cellular concrete) is poured in place over the bed and infiltrates into the foamed glass bodies to some degree. *See* Ex. 1002 ¶ 103 (maximizing the foamed glass material in an arrestor bed would have been desirable and obvious); *see also* Resp. 11 (it is the act of pouring fluid cementitious material over a bed of foamed glass bodies that creates a composite, i.e., a mixture).

Claim 9 further requires “the bed includes a cementitious matrix material in which the foamed glass bodies are distributed.” Ex. 1001, 11:25–27. Petitioner asserts that “this limitation would have been obvious in view of *Angley* and *Hojaji*. (Ex. 1016, 10:1–45, 10:55–57; Figs. 2A, 2B,

and [*sic*]; Ex. 1002, ¶¶109–110).” Pet. 55–56. Patent Owner does not contest this. As noted above, Angley teaches that glass bodies and concrete (a cementitious material) can be mixed in its embodiment having an aggregate structure and Hojaji is clear that its foamed glass bodies are suitable for a composite concrete-foam glass structure. Ex. 1016, 10:9–17, Fig. 2B; Ex. 1014 25:59–60; Ex. 1001 ¶¶ 109–110. Under such circumstances, a cementitious material/foamed glass aggregate would be present when an aircraft arrestor bed is formed, prior to the overlaying of a cementitious material topcoat, which would provide the claimed structure.

4. *INDEPENDENT CLAIM 10*

Claim 10 is the other independent claim of the ’671 patent, from which claims 11–16 depend. Regarding independent claim 10, Petitioner asserts that its limitations would have been obvious over Angley, Hojaji, and Schirtzinger for the same reasons the similar limitations of claim 1 would have been obvious over the prior art combination. Pet. 56–57, 60–61 (citing, *inter alia*, Ex. 1002 ¶¶ 45, 98–103, 113–115). We note that claim 10 is generally similar to, if somewhat broader than, claim 1 in most respects, but includes the following limitation that claim 1 does not: “d) slowing the oncoming aircraft; wherein the arrestor bed is has a crushing failure mode.” *Compare* Ex. 1001, 10:56–67, *with id.* at 12:1–10. Petitioner asserts that this would have been obvious over Angley, Hojaji, and Schirtzinger because this prior art combination teaches aircraft arrestor beds for slowing an aircraft and the claimed crush strength (e.g., 100 PSI, per claims 4 and 5) was well-known to the skilled artisan. Ex. 57–61 (citing, *inter alia*, Ex. 1002 ¶¶ 102–106, 113–115).

Patent Owner's response to Petitioner's assertions is substantially the same for claim 10 as for claim 1. Resp. 17–19. Those arguments are not persuasive. We have addressed the propriety and obviousness of combining the teachings of Angley, Hojaji, and Schirtzinger above and Petitioner's rationale is as valid for claim 10 as for claim 1. We agree with Petitioner's assertions that this prior art combination teaches the limitations of claim 10, just as it teaches the similar limitations of claim 1 discussed above. Further, the prior art teaches the claimed crush strength of claim 10 just as it does the specifically recited crush strengths of dependent claims 4 and 5, discussed above.

5. *DEPENDENT CLAIMS 11–16*

Regarding claims 11–16 that depend from claim 10, Petitioner also discusses how the combination of Angley, Hojaji, and Schirtzinger teaches or suggests the elements thereof. Pet. 58–61 (citing Ex. 1009, 9:16–47; Ex. 1016, 2:50–64, 3:47–50, 7:34–50, 8:21–46, 10:1–14, 10:57–65, Figs. 1B, 1C, 2A, 2B, 6; Ex. 1002 ¶¶ 45, 101, 103, 105–106, 109–115); *see also* Ex. 1014, 27:1–14.

Claim 11 is substantially the same as claim 2 (“... at least about 90 volume percent foamed glass aggregate bodies” (Ex. 1001, 12:11–13)), claim 13 is substantially the same as claim 4 (“... a crush strength of between about 50 PSI and about 100 PSI” (Ex. 1001, 12:16–18)), claim 14 is substantially the same as claim 5 (“... a crush strength of at least about 100 PSI, and wherein the respective foamed glass bodies have densities of between about 100 kg/m³ and 180 kg/m³” (Ex. 1001, 12:19–22)), and claim 15 recites the concluding limitation of claim 1 regarding a “cementitious surface” (Ex. 1001, 12:23–24). Ex. 1001, 11:1–12:15. Being so similar,

Petitioner's asserted evidence for the obviousness of claims 11, 13, 14, and 15 is the same as discussed above for their respective counterpart claims depending from claim 1. *See* Pet. 58–59; *see also* Ex. 1009, 9:16–41, Fig. 15; Ex. 1016, 3:55–4:14, 8:60–64, 9:7–13, Figs. 1B, 2B; *see also* *DuPont*, 904 F.3d at 1010. Claims 12 and 16 are significantly different from any other claim and are discussed below. Patent Owner makes no specific arguments against Petitioner's assertions regarding claims 11–16 under Ground 6. Therefore, for the reasons discussed above regarding claims 1, 2, 4, and 5, we find Petitioner has met its burden of showing that claims 11, 13, 14, and 15 would have been obvious.

Claim 12 further requires “the foamed glass aggregate bodies have an interconnected open porosity.” Ex. 1001, 12:14–15. Petitioner asserts only that “[a] POSA would have recognized that the claimed interconnected open porosity would result. (Ex. 1002, ¶111),” without any further discussion (regarding the Angley and Hojaji combination, and the combination including Schirtzinger). Pet. 58; *see also id.* at 38–39 (similar arguments challenging claim 12 under Ground 1 over ACRP and citing Ex. 1002 ¶ 75). Petitioner cites Dr. Zupan, who, at the cited portion of his declaration, states:

A POSA would understand that foamed glass would generally have a closed-cell structure. For example, Hojaji discloses foamed glass with a “closed pore structure.” (Ex. 1014, 27:1–14). However, the outermost pores would be exposed to the elements and would be open. As the glass of Hojaji was exposed to freeze thaw cycles, these pores may be cracked and expanded, providing a greater percentage of interconnected-ness between pores. This suggests that at least some pores of foamed glass may include an open pore structure.

Ex. 1002 ¶ 111. This constitutes the entirety of Petitioner's position, at least initially, on claim 12's obviousness over Angley, Hojaji, and Schirtzinger.

As we stated in the Institution Decision, this argument is an allegation of inherency because Petitioner and its witness assert that it is the exposure to the environment and “freeze thaw cycles” that provides for cracking and expansion in foamed glass so as to eventually create the claimed interconnected open pore structure. DI 43–44. Our reviewing court has “held that ‘the use of inherency in the context of obviousness must be carefully circumscribed because ‘[t]hat which may be inherent is not necessarily known’ and that which is unknown cannot be obvious.’” *Southwire Co. v. Cerro Wire LLC*, 870 F.3d 1306, 1310–11 (Fed. Cir. 2017) (quoting *Honeywell Int’l v. Mexichem Amanco Holding S.A.*, 865 F.3d 1348, 1354 (Fed. Cir. 2017), which quotes *In re Rijckaert*, 9 F.3d 1531, 1534 (Fed. Cir. 1993)). “To establish that a prior art reference inherently—rather than expressly—discloses a claim limitation, ‘the limitation at issue *necessarily* must be present, or [be] the natural result of the combination of elements explicitly disclosed by the prior art.’” *Endo Pharm. Solutions, Inc. v. Custopharm Inc.*, 894 F.3d 1374, 1381 (Fed. Cir. 2018) (quoting *Par Pharm., Inc. v. TWI Pharm., Inc.*, 773 F.3d 1186, 1196 (Fed. Cir. 2014)). “[I]nherency ‘may not be established by probabilities or possibilities.’” *Id.* (quoting *Par Pharm.*, 773 F.3d at 1195). We noted in our Institution Decision that Petitioner neither alleges nor offers evidence that the foamed glass bodies of the prior art would necessarily have the claimed open pore structure, under any conditions. DI 43–44.

Patent Owner’s Response does not present any arguments specific to claim 12 as patentable over Anglely, Hojaji, and Schirtzinger. *See* Resp. 17–19. Patent Owner’s Response does not even mention the claim or its “interconnected open porosity” limitation specifically in view of the Anglely-

Hojaji-Schirtzinger prior art combination. *Id.* Thus, Patent Owner waives any such arguments. However, the Board questioned Petitioner's assertions on this claim and Petitioner responded. *See* Pet. Reply 19–21.

Petitioner further asserts in its Reply that it “never alleged the prior art foamed glass inherently would have had ‘an interconnected open porosity,’” but, rather, that “a POSA would have understood that the use of foamed glass with open pores would have been obvious” because the cited prior art discussed varying glass density, which could increase the internal pockets in the glass bodies so that they would eventually interconnect. *Id.* (citing Pet. 38–39, 58; Ex. 1037 ¶ 31; Ex. 1002 ¶¶ 75, 111; Ex. 1038, 35:22–36:6; Ex. 1009, 9:39–43; Ex. 1008, 96). Petitioner summarized its revised position at oral argument, stating that “what it basically boils down to is there’s only two different ways that you can have this porosity. You either have open cell porosity or closed cell porosity. So under the *KSR* framework when you’re selecting from a finite number of known instances, that type of selection cannot be” patentable. Hr’g Tr. 20:19–23 (*italics added*).

Petitioner’s revised position is an obviousness argument based on *KSR*’s obvious to try rationale. Under such an obviousness theory, picking one of a finite number of known solutions to a known problem is obvious. *KSR*, 550 U.S. at 421. *KSR* specifically states that

When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that

instance the fact that a combination was obvious to try might show that it was obvious under § 103.

Id. Even if this argument could in some way be considered to be based upon the original assertions of the Petition, which it does not appear to be, we are unpersuaded.

“The mere fact that the prior art may be modified in the manner suggested . . . does not make the modification obvious unless the prior art suggested the desirability of the modification.” *In re Fritch*, 972 F.2d 1260, 1266 (Fed. Cir. 1992). Petitioner presents no evidence illuminating why a skilled artisan would have fabricated foamed glass bodies having an interconnected open porosity, but only that it was technically possible to do so.

Petitioner identifies no advantage to an interconnected open pore structure and the cited prior art suggests that closed cells are preferred and open cells are not. *See* Ex. 1014 *passim* (discussing porosity); *see, e.g., id.* at 4:10–39 (discussing sealed pores), 9:1–19 (discussing completely sealed, semi-closed, and completely closed pores), 18:25–28:29 (Examples discussing closed pores and open pores, where the latter appears undesirable because of its water permeability and high thermal conductivity). Although it appears that producing an interconnected open porosity would have been within the skilled artisan’s technical grasp, Petitioner presents no evidence that a person of ordinary skill in the art would have had any reason to pursue the claimed interconnected open porosity, no evidence of a design need for such a structure, and no evidence of market pressure to solve any problem relating to foamed glass porosity. *KSR*, 550 U.S. at 421. Therefore, we conclude Petitioner has not carried its burden of proving claim 12 would have been obvious over Angle, Hojaji, and Schirtzinger.

Claim 16 further requires “the arrestor bed has a contoured surface.” Ex. 1001, 12:25–26. Because such a limitation is not presented by any other claim, we address claim 16 separately. Petitioner asserts that “*Angley* discloses an arrestor bed with a contoured surface. (Ex. 1016, Fig. 1B, 1C, 2A, and 2B). There is an ‘incremental height difference’ between rows. (Ex. 1016, 7:34–50).” Pet. 59 (citing Ex. 1002 ¶ 112). Patent Owner presents no arguments contesting Petitioner’s position. *See* Resp. 17–19. We agree with Petitioner’s position. *Angley* teaches embodiments where its arrestor bed’s surface is contoured. *See* Ex. 1016, Figs. 1B, 1C, 2B (the hardcoat is shown in a stair-step contour over the underlying blocks or, alternatively, is shown to be sloped up to a planar top section in a different stair-step fashion). Also, several embodiments disclosed by Schirtzinger have arrestor beds with contoured surfaces. *See* Ex. 1009, Figs. 5, 13, 14.

6. *SUMMARY*

For the reasons above, we are persuaded that Petitioner has carried its burden and shown by a preponderance of the evidence, under Ground 6, that claims 1–11 and 13–16 of the ’671 patent would have been obvious over *Angley*, *Hojaji*, and *Schirtzinger*. We are persuaded that these prior art references would have been combined by the person of ordinary skill in the art and that such a skilled artisan would have had a reasonable expectation of success in doing so. Patent Owner either has not contested Petitioner’s arguments and evidence, or has unpersuasively done so with little or no citation to its own supporting evidence. Thus, we conclude claims 1–11 and 13–16 of the ’671 patent would have been obvious over *Angley*, *Hojaji*, and *Schirtzinger*. We also conclude that Petitioner has not established by a

preponderance of the evidence that claim 12 would have been obvious over this prior art combination.

E. OBVIOUSNESS OF CLAIMS 1–16 OVER ACRP, ACRP AND NARMO, ACRP AND HOJAJI, AND ACRP AND RAMSEY

We next address Grounds 1–4, which assert the unpatentability of claims 1–16 of the '671 patent over ACRP individually or, alternatively for certain dependent claims, ACRP in combination with Narmo, or Hojaji, or Ramsey. Petitioner asserts that each of claims 1–16 would have been obvious over ACRP, individually. Pet. 22–40. Petitioner alternatively asserts that claims 5 and 14 would have been obvious over ACRP combined with Narmo. *Id.* at 40–42. Further, Petitioner alternatively asserts that claim 6 would have been obvious over ACRP combined with Hojaji. *Id.* at 42–43. Finally, Petitioner alternatively asserts that claims 6, 7, and 9 would have been obvious over ACRP combined with Ramsey. *Id.* at 43–46. Because each of these challenges primarily relies on ACRP we discuss them together.

1. *COMBINING AND MODIFYING THE PRIOR ART*

Although the majority of Petitioner's challenges here rely on the disclosure of ACRP alone, we first address the propriety of Petitioner's combining ACRP with Narmo, Hojaji, or Ramsey. "The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *KSR*, 550 U.S. at 416. Moreover, it is obvious "to substitute one well-known . . . agent for another." *Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC*, 683 F.3d 1356, 1364 (Fed. Cir. 2012); *see also KSR*, 550 U.S. at 416 ("[W]hen a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result."). Here, each proposed

combination of prior art is merely asserted to utilize a known foamed glass material in a known structure comprising foamed glass.

Petitioner asserts that ACRP and Narmo are “from the same field of endeavor,” i.e., each is directed to arresting beds for deceleration aircraft and using foamed glass as the main component to do so, and that Narmo describes the composition of foamed glass while ACRP merely discusses it generally so it would be obvious to look to Narmo when considering ACRP. *See* Pet. 40–41; Ex. 1008, 7; Ex. 1012, Abstract; *see also* Ex. 1002 ¶ 78. Similarly, Petitioner asserts that Hojaji discloses methods for producing foamed glass as used in ACRP’s structures. Pet. 42; Ex. 1014, Abstract; Ex. 1002 ¶ 81. Finally, Petitioner asserts that ACRP’s silence on the composition of its foamed glass would lead the skilled artisan to Ramsey, which teaches the composition of foamed glass and its manufacture, as well as its use with cement. Pet. 44; Ex. 1011, Abstract; Ex. 1002 ¶¶ 84–86.

Patent Owner does not contest the propriety of combining ACRP with any of Narmo, Hojaji, and Ramsey. Resp. 8, 16–17. On this record, we conclude it would have been obvious to the person of ordinary skill in the art to combine the teachings of ACRP and Narmo, Hojaji, or Ramsey, as asserted by Petitioner. Moreover, we also conclude such combinations merely use specific foamed glass compositions in structures already using foamed glass compositions and that the skilled artisan would have reasonably expected to successfully do so. *See* Ex. 1002 ¶¶ 78, 81, 84. The simplicity of the technology and the reasonably high level of skill in the art support such a conclusion.

We next turn to Petitioner evidence of obviousness under Grounds 1–4, and Patent Owner’s defenses, to the extent any are presented. Petitioner

addresses each step/element of independent claims 1–16 as taught by ACRP and, alternatively, for certain claims, by ACRP and Narmo, ACRP and Hojaji, or ACRP and Ramsey. Pet. 26–46.

2. *INDEPENDENT CLAIM 1*

Regarding claim 1’s preamble, Petitioner asserts that ACRP teaches Engineered Material Arresting Systems (EMAS), which are systems/methods for slowing aircraft on runways. *Id.* at 26 (citing Ex. 1008, 11, 14; Ex. 1002 ¶ 62). Patent Owner does not present any counter arguments. Resp. 14–16. We agree with Petitioner that, if this preamble is considered a limitation, it is taught by ACRP by the portions of the reference cited by Petitioner if not throughout. *See* Ex. 1002 ¶¶ 19, 31–34, 59–60 (Dr. Zupan discussing how ACRP teaches aircraft arrestor beds for slowing aircraft overrunning a runway).

Regarding claim 1’s recitation of “a) paving an area with foamed glass bodies to define a bed,” Petitioner asserts that ACRP teaches an aggregate foamed glass bed as a part of a runway, where the bed is a basin filed with foamed glass aggregate or foamed glass blocks or monolithic structure. Pet. 27–28 (citing Ex. 1008, 15–18, 120, Figs. S-3, S-5; Ex. 1002 ¶ 63). Petitioner points, as an example, to ACRP’s figure S-5, which illustrates a bed of aggregate foam for an arrestor basin. *Id.* at 27. We note, Petitioner also asserts, regarding dependent claim 7’s and dependent claim 9’s more specific requirements for the claimed bed of foamed glass bodies, that ACRP teaches a bed of ceramic glass aggregate, which is a crushable aggregate with binder of cement, and that it would have been obvious to pave such a bed. *Id.* at 35–36 (citing Ex. 1002 ¶ 74; Ex. 1008, 60). Patent

Owner does not argue that ACRP fails to teach paving an area with foamed glass bodies to define a bed, as claimed. *See generally* Resp.

We agree with Petitioner that ACRP teaches this limitation. In agreement with Petitioner, we find ACRP is focused on using a bed paved with foamed glass bodies as an aircraft arrestor bed. Ex. 1008, 1 (cover indicating ACRP is focused on developing aircraft arresting systems), 7 (identifying that cellular glass foam and aggregate foam are of focus for this use), 16–18 (identifying that such aggregate foam is made from recycled glass, which is provided in a paved basin), 24 (discussing using glass foam aggregates, e.g., hard spherical pellets, covered and sealed), 60 (discussing loose crushable fill and crushable aggregates with binder of foamed glass bodies); *see also* Ex. 1002 ¶¶ 19–20, 31–34, 58–63, 68, 70, 74 (discussing ACRP’s disclosure of foamed glass runway arrestor beds).

Regarding claim 1’s recited “b) covering the bed with a layer of cementitious material to define a composite bed,” Petitioner asserts that ACRP teaches covering the foamed glass bed with a layer of cementitious material because ACRP recognizes the need to cover and seal the arrestor bed material and because ACRP discloses various ways to do so, including providing a “painted cement board top.” Pet. 28–29 (citing Ex. 1008, 12, 24, 30, 33, 58, 63; Ex. 1002 ¶ 64), *see also id.* at 24–26 (arguing motivation to make “minor modifications” to arrive at “cement tops atop an arrestor bed”). Petitioner asserts that an advantage of providing a cementitious top for a foamed glass bed, as opposed to using a thin plastic layer, would be to make it sturdier so as to support work trucks and other airport vehicles (but not an aircraft). *Id.* at 29 (citing Ex. 1002 ¶ 64).

In our Institution Decision, we questioned ACRP (whether or not combined with Narmo, Hojaji, or Ramsey) as teaching of this claim limitation, which kept us from then endorsing Petitioner's challenge as to claim 1 and its independent claims under Grounds 1–4. DI 50–51. Our skepticism focused on ACRP's disclosure that covering arrestor beds with cement boards was not the newest or most preferred way of covering such structures and that there was some industry concern over such structures regarding their durability. *Id.* We questioned whether such industry concerns might teach away from such a feature. *Id.* at 50.

Patent Owner, adopting our preliminary concerns, argues that ACRP teaches away from this claim limitation and, further, that ACRP fails to teach defining a composite when a bed of foamed glass bodies is covered by cementitious material because mere covering, as in placing a cement board, is not sufficient because there must be some intermingling to yield a composite. Resp. 14–15 (Patent Owner cites only Ex. 2007, “6:12” as evidence; it is unclear to exactly what this citation refers); *see also supra* Section II.B (claim construction analysis regarding the meaning and scope of composite bed).

Based on the evidence advanced in the briefs, we are persuaded by Petitioner's assertions in the Petition that ACRP teaches this claim limitation. When considering § 103, the prior art must be considered for all of its teachings, including unpreferred embodiments. *Merck & Co. v. Biocraft Labs., Inc.*, 874 F.2d 804, 807 (Fed. Cir. 1989) (citation omitted). In rendering our Institution Decision, we focused on the cement boards disclosed by ACRP as being the only proposed cementitious covering.

Upon considering the Petition more fully, we note that Petitioner and its witness, Dr. Zupan, also point to the fact that

ACRP describes crushable aggregates with binders that are suitable for use in aircraft arrestor systems. (Ex. 1008, 60). One type of aggregate includes ceramic glass aggregate that includes a cement binder. (Ex. 1008, 60). Such an example would “offer[] the possibility of a pour-in-place crushable material, which would reduce cost compared with prefabricated block installation.” (Ex. 1008, 60).

Pet. 35–36 (citing Ex. 1002 ¶ 74). We have discussed the cited portion of ACRP above as teaching paving an aircraft arrestor bed using foamed glass bodies, as well as the cementitious material covering such a bed. This portion of ACRP discloses using crushable aggregate foam composed of recycled glass, of varied density as desired by the user, which can be mixed to some degree with a phosphate cement binder, which may be poured-in-place. Ex. 1008, 60. This discloses a composite material, even under Patent Owner’s proposed understanding of the term, because the foamed glass bodies are intermingled with cement binder, at least to some degree, so as to form a composite therewith. Thus, ACRP teaches that a bed of foamed glass bodies can be provided with cement (a cementitious material) as a composite and that such a bed can also be covered with and defined by the cement or by cement boards (a cementitious material), which teaches the claim limitation, even under Patent Owner’s proposed narrow construction.¹⁸

Regarding the next limitation of claim 1, which states “c) crushing at least a portion of the composite bed with an oncoming aircraft,” Petitioner

¹⁸ Because we do not adopt Patent Owner’s proposed interpretation of “composite bed,” the ordinary meaning would also cover cement boards laid over foamed glass. *See supra* Section II.B.

asserts that ACRP teaches crushing (as computer modeled) a bed of foamed glass bodies by aircraft wheels. *Id.* at 29–30 (citing Ex. 1008, 73–96; Ex. 1002 ¶ 67). Patent Owner does not contest this assertion. Resp. 14–15. We agree with Petitioner’s assertion. As just one example, of many, immediately following its disclosure of a bed of foamed glass bodies intermingled with cement binder, ACRP illustrates crushing such material with an aircraft wheel, as follows:

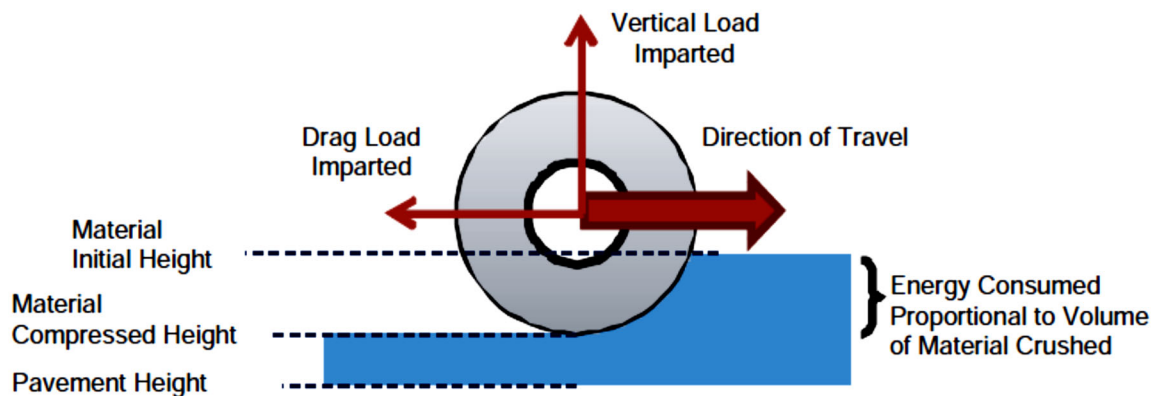


Figure 7-1. Physical performance of crushable materials.

Ex. 1008, 52. Figure 7-1 of ACRP, above, shows a wheel crushing a path through a “volume of material crushed” (in blue) and illustrates the forces on such a wheel (red arrows) and the response of the crushed material (energy consumed proportional to volume of material crushed). *Id.* As we noted above at Section I.E, ACRP teaches such foamed-glass-crushing elsewhere throughout its disclosure. *See, e.g., id.* at 86 (Fig. 9-21), 131 (Fig. 11-16). The disclosure of ACRP is focused on providing material, e.g., foamed glass bodies, to be crushed by an aircraft and thereby slow it. *See* Ex. 1002 ¶¶ 19, 31–34, 62, 67.

Regarding the next limitation of claim 1, which reads “wherein the composite bed is at least 85 percent foamed glass bodies,” Petitioner asserts

that ACRP teaches that its beds (in simulations) can be 100% foamed glass or foamed glass aggregate. *Id.* at 30–31 (citing Ex. 1008, 86, 90, 120, 131–132, 143; Ex. 1002 ¶¶ 64–66, 68–69). Petitioner asserts that, even when using a cement topper, the skilled artisan would keep it sufficiently thin to be less than 10% of the overall volume of the bed, keeping the amount of foamed glass over 90%. *Id.* at 31 (citing Ex. 1002 ¶¶ 65–66). Patent Owner does not contest this assertion. Resp. 14–15. We agree with Petitioner’s assertion. Dr. Zupan states that “[i]t is advantageous to ensure that the bed has as homogenous of a composition as possible to ensure that consistent forces are imparted upon the landing gear to predictably slow the aircraft” and Petitioner makes the point that “[b]y minimizing the percentage of other components in the arrestor bed, the greatest degree of consistency can be achieved throughout the bed of materials. (Ex. 1002, ¶¶ 64–66, 68–69).” Ex. 1002 ¶ 68; Pet. 31. Dr. Zupan further testified, in view of claim 1’s requirement of 85% or more foamed glass bodies, that in some instances, as taught by ACRP, it would be useful to also include a cement binder to hold the system together and reduce aircraft ingestion hazards from wayward foamed glass bodies. Ex. 1002 ¶ 74.

Regarding the final limitation of claim 1, which states “wherein the composite bed has a cementitious surface,” Petitioner asserts that the ACRP cement topper would provide a cementitious surface for the bed. *Id.* at 32–33 (citing Ex. 1008, 12, 23, 30, 33, 42, 58, 63; Ex. 1002 ¶ 64). Patent Owner does not contest this assertion. Resp. 14–15. We agree with Petitioner. ACRP states that “[c]overing layers are often used to preserve the crushable or displaceable materials from the environment, jet blast, and so on. The current EMAS design uses such a ‘covering layer.’ The latest

generation uses thin plastic tops, while the prior generation used cement board tops.” Ex. 1008, 58. Dr. Zupan also testifies that a cement surface/topper of 10% or less of the total volume of the arrestor bed provides the advantages of sealing and protecting the bed and providing structural performance to permit personnel and vehicles to travel across the bed, yet still allow an aircraft to crush the bed, which is evidence that the skilled artisan would provide such a cementitious surface, as claimed. Ex. 1002 ¶¶ 64–65, 74.

3. *DEPENDENT CLAIMS 2–9*

Regarding claim 2, which recites “the composite bed is at least about 90 volume percent foamed glass bodies,” Petitioner asserts that this 90% limitation is taught by ACRP for the same reasons claim 1’s 85% limitation is taught by the reference. Ex. 1001, 11:1–2; Pet. 33 (citing Ex. 1008, 16, 32, 86, 90, 110, 120, 131–132, 143, Figs. S-3, S-5; Ex. 1002 ¶¶ 64–69). Patent Owner does not dispute Petitioner’s assertion here, or as to ACRP’s teaching of claim 1’s 85% limitation. *See* Pet. 14–16. We agree with Petitioner’s position here for the same reasons discussed above regarding claim 1’s 85% limitation. *See supra* discussion of claim 1 as obvious over ACRP.

Regarding claim 3, which recites “the foamed glass bodies have a closed cell structure,” Petitioner asserts “*ACRP* explains that “[t]he chemical make-up and closed-cell properties of glass foam suggested . . .” confirming that the foamed glass of *ACRP* has a closed-cell structure. (Ex. 1008, 64). [Thus,] *ACRP* discloses this limitation. (Ex. 1002, ¶75).” Ex. 1001, 11:3–4; Pet. 33. Patent Owner does not dispute Petitioner’s assertion. *See* Pet. 14–16. We agree with Petitioner’s position; *ACRP* teaches foamed glass bodies

having a closed-cell structure, as claimed. *See, e.g.*, Ex. 1008, 24 (“From a materials standpoint, the glass foam and aggregate foam concepts both use closed-cell glass foams that inherently resist water penetration.”); Ex. 1002 ¶ 75.

Regarding claim 4, which recites “the foamed glass bodies have a crush strength of between about 50 PSI and about 100 PSI,” Petitioner asserts that ACRP discloses its foamed glass was tested to have a nominal strength of 55 PSI and that, traditionally, EMAS (aircraft arrestor bed) materials had a crush strength of 60–80 PSI, which would have been a target for the skilled artisan. Ex. 1001, 11:6–8; Pet. 33–43 (citing Ex. 1008, 63, 80, Fig. 9-16; Ex. 1002 ¶ 70). Patent Owner does not dispute Petitioner’s assertion. *See* Pet. 14–16. We agree with Petitioner. ACRP teaches the claimed crush strength for its foamed glass bodies. *See, e.g.*, Ex. 1008, 53 (Table 7-4), 70 (nominal 55 psi strength of foamed glass material); Ex. 1002 ¶ 72 (density and crush strength are optimizable variables, which the prior art teaches may be optimized to be within the claimed range).

Regarding claim 5, which recites “the foamed glass bodies have a crush strength of at least about 100 PSI, and wherein the foamed glass bodies have densities of between about 100 kg/m³ and 180 kg/m³,” Petitioner asserts that ACRP teaches foamed glass having a punch test strength of 140 PSI, which represents an actual implementation where an aircraft wheel does the crushing, and that foamed glass crush strength is an optimizable variable related to density. Ex. 1001, 11:9–12; Pet. 34 (citing Ex. 1008, 79–81, 96; Ex. 1002 ¶¶ 71–72). Petitioner alternatively argues (under Ground 2) that the combination of ACRP and Narmo would have rendered the claimed subject matter (100+ PSI crush strength) obvious

because Narmo teaches crush strength and density of foamed glass for aircraft arrestor beds as claimed. Pet. 40–41 (citing Ex. 1012, cover, Table 1; Ex. 1013, 148; Ex. 1002 ¶¶ 78–80). At its Table 1, Narmo discloses compression resistances for foamed glass aggregate of 0.46–1.7 MPa, which we understand converts to ~66.7–246.5 PSI, related to a disclosed density range of 135–180 kg/m³. Ex. 1012 ¶ 60 (Table 1, spanning pages 5–6). Petitioner’s witness, Dr. Zupan, testifies that the person of ordinary skill in the art would have been motivated to combine ACRP and Narmo because Narmo discloses how to develop certain, specific properties of the foamed glass of ACRP, and that the skilled artisan would have had an expectation of success doing so. Ex. 1002 ¶ 78.

Patent Owner does not dispute Petitioner’s assertions except to argue that Narmo does not disclose the claimed cementitious cover or composite element of claim 1; however, for reasons explained above, Petitioner has established by a preponderance of the evidence that was taught by ACRP. *See* Pet. 14–16; Resp. 16. We agree with Petitioner’s position. ACRP teaches the claimed crush strength (at least 100 PSI) and that density for its foamed glass bodies is optimizable. *See, e.g.*, Ex. 1008, 66 (“Several densities of the glass foam material were examined. The higher density samples had higher compressive strengths.”), 70 (punch strength of 140 psi); Ex. 1002 ¶¶ 70–72. Also, we agree with Petitioner that it would have been obvious to the skilled artisan to combine ACRP and Narmo and that this combination teaches a range of crush strengths and densities for foamed glass bodies, and the obviousness of optimizing these variables, as claimed. *See, e.g.*, Ex. 1012, Table 1; Ex. 1002 ¶¶ 78–80. “[I]t is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re*

Aller, 220 F.2d 454, 456 (CCPA 1955). Only if the ‘results of optimizing a variable’ are ‘unexpectedly good’ can a patent be obtained for the claimed critical range. *In re Antonie*, 559 F.2d 618, 620 (CCPA 1977).” *In re Geisler*, 116 F.3d 1465, 1469 (Fed. Cir. 1997).

Regarding claim 6, which recites “the foamed glass bodies have compositions in the range around 70 weight percent SiO₂, around 13 weight percent Na₂O and around 10 weight percent CaO with the remainder being other metal oxides,” Petitioner asserts, in view of ACRP, that “A POSA would have known that foamed glass would include a combination of SiO₂, Na₂O, CaO and other metal oxides. (Ex. 1002, ¶73; Ex. 1019, 1:21–45). A POSA would have known the exact composition would have been attained through routine optimization. (Ex. 1002, ¶73; Ex. 1019 at 1:21-45).” Ex. 1001, 11:14–17; Pet. 35. Alternatively, Petitioner also asserts under Ground 3 that, as teaching a method for producing ACRP’s foamed glass, Hojaji would have been combined with ACRP by the skilled artisan, and in so doing the combination teaches that the claimed materials are used for foamed glass and the claimed amounts are mere soda-lime-silica glass of antiquity. Pet. 42–43 (citing Ex. 1002 ¶¶ 81–83; Ex. 1014, 3:40, 18:60–66, 23:8–15; 6:3–11; Ex. 1019, 1:21–45). Furthermore, Petitioner again alternatively asserts under Ground 4 that, similar to Hojaji under Ground 3, Ramsey also teaches how to produce foamed glass as in ACRP and would be combined therewith by the skilled artisan for that reason and that Ramsey teaches that such glass is “traditional Soda-lime-silica glass,” which is the claimed composition. Pet. 43–45 (citing Ex. 1001, 6:56–59; Ex. 1002 ¶¶ 84–88; Ex. 1003, 172; Ex. 1008, 12, 30; Ex. 1011 ¶¶ 11; Ex. 1019, 1:21–45).

Patent Owner does not specifically argue against Petitioner's assertions over claim 6's claimed glass composition as taught by ACRP, ACRP and Hojaji, or ACRP and Ramsey. Resp. 14–17. For the reasons asserted by Petitioner, and for the same reasons discussed above in relation to Petitioner's Ground 6 and the obviousness of using soda-lime-glass as a resource for foamed glass bodies as in Patent Owner's claims, we are similarly persuaded that the foamed glass of ACRP's aircraft arrestor beds would have obviously been composed of soda-lime-glass, which is or renders obvious the claimed composition of claim 6. *See supra* Section II.D.3 discussion of claim 6 in view of Angley, Hojaji, and Schirtzinger; *see also* Ex. 1038, 42:10–25 (Mr. Helgeland conceding that the '671 patent's claimed glass composition is the same as soda-lime glass as found in windows and bottles); Ex. 1037 ¶¶ 26–30 (Dr. Zupan explaining his opinion that claim 6's glass composition is mere traditional soda-lime-glass, the most common glass in use and optimizable to modify its melting point).

Regarding claim 7, which recites “further comprising d) before step a), mixing the foamed glass bodies with a cementitious material to define a paving mixture,” Petitioner asserts (under Ground 1) that “ACRP describes crushable aggregates with binders that are suitable for use in aircraft arrestor systems. (Ex. 1008, 60). One type of aggregate includes ceramic glass aggregate that includes a cement binder. (Ex. 1008, 60). Such an example would ‘offer[] the possibility of a pour-in-place crushable material, which would reduce cost compared with prefabricated block installation.’ (Ex. 1008, 60).” Ex. 1001, 11:19–21; Pet. 35–36 (further citing Ex. 1002 ¶ 74). Alternatively, under Ground 4 Petitioner again combines ACRP with Ramsey and asserts that Ramsey teaches mixing foam bodies with Portland

cement and water to form a composite material suitable for structural applications, such as ACRP's aircraft arrestor beds, which already utilize foamed glass bodies and can be pour-in-place aggregates with cement binder. Pet. 44–45 (citing Ex. 1011, Abstract, ¶ 9; Ex. 1002 ¶ 88).

Patent Owner does not make any arguments specifically against Petitioner's assertions regarding claim 7 as taught by ACRP or ACRP and Ramsey. Resp. 14–15, 17. We are persuaded by Petitioner's assertions and evidence. ACRP discloses using a foamed glass bodies and cement aggregate to pour-in-place an aircraft arrestor bed (Ex. 1008, 60) and Ramsey teaches several ways of preparing such a composite (Ex. 1011, Abstract, Fig. 1, ¶ 9). *See* Ex. 1002 ¶¶ 74, 88. Using such a composition and providing the foamed glass bodies in such a way for an aircraft arrestor bed, as claimed, would have been obvious.

Regarding claim 8, which recites “the bed is comprised entirely of foamed glass bodies,” Petitioner asserts that this limitation would have been obvious over ACRP for the same reasons as for claim 1's limitation relating to the composite bed being at least 85% foamed glass bodies. Ex. 1001, 22–23; Pet. 30–32, 36 (citing, *inter alia*, Ex. 1002 ¶¶ 64–69).

Patent Owner does not make any arguments specifically against Petitioner's assertions regarding claim 8 as taught by ACRP. Resp. 14–15, 17. We are persuaded by Petitioner's assertions and evidence. As we discussed above (*see supra* Section II.B), the *composite bed* of the claims encompasses a scope including both pre-mixing foamed glass bodies and cementitious material before the mixture's application and also pouring fluid cementitious material over a bed of foamed glass bodies and allowing its infiltration to provide a composite. ACRP renders either scenario obvious.

See Ex. 1002 ¶¶ 74; Ex. 1008, 60 (disclosing dry crushable glass foam, loose crushable aggregate foam, and using cement binder with crushable ceramic glass foam aggregate as alternative techniques).

Regarding claim 9, which recites “the bed includes a cementitious matrix material in which the foamed glass bodies are distributed,” Petitioner asserts that this claim limitation would have been obvious for the same reasons asserted for claim 7’s recitation of pre-mixing the foamed glass and cementitious material. Ex. 1001, 11:25–27; Pet. 35–36 (citing, *inter alia*, Ex. 1002 ¶ 74). Alternatively, under Ground 4, Petitioner asserts that the ACRP-Ramsey combination also teaches this claim limitation for the same reasons this combination taught the limitation of claim 6, which is that Ramsey teaches various methods of producing a foamed glass and cement mixture for structural applications. Pet. 43–46 (citing, *inter alia*, Ex. 1002 ¶ 87). Patent Owner does not make any arguments specifically against Petitioner’s assertions regarding claim 9 as taught by ACRP, or ACRP and Ramsey combined. Resp. 14–15, 17. We are persuaded by Petitioner’s assertions and evidence, for the reasons discussed above.

4. INDEPENDENT CLAIM 10

As noted above, independent claim 10 is similar to, but not identical to claim 1. Petitioner addresses each limitation/step of claim 10 as taught by ACRP. Pet. 36–38. Petitioner asserts that claim 10 is unpatentable as obvious because its limitations/steps were taught by ACRP for the same reasons ACRP taught the similar limitations/steps of claim 1, as discussed above. *Id.* (citing Ex. 1008, 11, 12, 15–18, 24, 30, 32, 33, 42, 58, 63, 73–96, 110, 120, 131–132, 143, Figs. S-5, S-3; Ex. 1002 ¶¶ 62–69). Similar to claim 1, Patent Owner offers no real argument against Petitioner’s assertions

as to the obviousness of claim 10 in view of ACRP, except that its witness, Mr. Helgeland, offered a construction of the claim language “arrestor bed is formed from a plurality of foamed glass aggregate bodies covered by a paving layer” as meaning *the aggregate bodies are each covered by paving layer matrix material to yield a matrix composite*, and that this was not addressed in the Petition. Resp. 15. However, Patent Owner offers no citation to evidence in support of this argument. *Id.* As discussed above, we have not adopted Patent Owner’s claim construction position. *See supra* Section II.B.

Claim 10 is directed to “[a] method of slowing an aircraft overrunning a runway.” Ex. 1001, 12:1–2. Petitioner asserts that ACRP is also directed to method of slowing aircraft on runways, which it is. Pet. 36; Ex. 1008, 7 (introducing the concept of EMAS). If the preamble of claim 10 is a limitation, we agree with Petitioner that ACRP teaches it.

Claim 10 requires “establishing an aircraft arrestor bed adjacent a runway, wherein the aircraft arrestor bed is formed from a plurality of foamed glass aggregate bodies covered by a paving layer.” Ex. 1001, 12:3–5. Petitioner asserts that this is taught by ACRP. Pet. 37 (citing, *inter alia*, Ex. 1008, 12, 15–18, 24, 30, 32, 33, 42, 58, 63, 73, 86, 90, 110, 120, 132–132, 143, Figs. S-5, S-3; Ex. 1002 ¶¶ 63, 64–69). We agree with Petitioner, as ACRP discloses EMAS provided on a runway, the EMAS being an arrestor bed, which can be formed of foamed glass aggregate bodies covered by a paving layer(s) of cement binder, cement boards, plastic, or engineered turf. *See, e.g.*, Ex. 1008, 16–19, 24, 30, 60, 120–22, 145; Ex. 1002 ¶¶ 63, 64–69.

Claim 10 requires “moving an aircraft over the aircraft arrestor bed; . . . crushing at least a portion of the arrestor bed with the aircraft; and [] slowing the oncoming aircraft.” Ex. 1001, 12:6–9. Again, Petitioner asserts this is taught by ACRP. Pet. 37–38 (citing, *inter alia*, Ex. 1008, 73–96; Ex. 1002 ¶ 67). We agree with Petitioner that such an act is the main focus of the disclosure of ACRP and ACRP discloses computer modeling this scenario (“tire and arrestor simulations”). Ex. 1008, 130–37; Ex. 1002 ¶ 67.

Finally, claim 10 requires “the arrestor bed is [*sic*] has a crushing failure mode.” Ex. 1001, 12:10. Petitioner asserts that this is also taught by ACRP. Pet. 38 (citing, *inter alia*, Ex. 1008, 73–96; Ex. 1002 ¶ 67). We agree with Petitioner that such a failure mode is taught by ACRP, which discloses a variety of foamed glass aggregate material characteristics relating to compression and crushability, and uses these characteristics in its reported computer modeling regarding the failure modes of arrestor beds under the wheels of aircraft. Ex. 1008, 124–37; *see also id.* at 76–83 (similar disclosure relating to foamed glass blocks); Ex. 1002 ¶ 67.

5. *DEPENDENT CLAIMS 11–16*

Petitioner also addresses each of claims 11–16, which depend directly from claim 10. As already noted, claim 11 is substantially the same as claim 2 (“. . . at least about 90 volume percent foamed glass aggregate bodies” (Ex. 1001, 12:11–13)), claim 13 is substantially the same as claim 4 (“. . . a crush strength of between about 50 PSI and about 100 PSI” (Ex. 1001, 12:16–18)), claim 14 is substantially the same as claim 5 (“. . . a crush strength of at least about 100 PSI, and wherein the respective foamed glass bodies have densities of between about 100 kg/m³ and 180 kg/m³” (Ex. 1001, 12:19–22)), and claim 15 recites the concluding limitation of

claim 1 regarding a “cementitious surface” (Ex. 1001, 12:23–24). Ex. 1001, 11:1–12:15. Being so similar, again, Petitioner’s asserted evidence for the obviousness of claims 11, 13, 14, and 15 is essentially the same as discussed above for their respective counterpart claims depending from claim 1. Pet. 38–42 (citing Ex. 1008, 12, 16, 24, 30, 32, 33, 42, 58, 63, 79–81, 82, 86, 90, 96, 110, 120, 131–132, 143, Figs. 9-16, S-3, S-5; Ex. 1002, ¶¶ 64–69, 70–72, 75). For claim 14, alternatively under Ground 2, Petitioner asserts it would have been obvious over ACRP combined with Narmo because Narmo’s Table 1 teaches foamed glass bodies having this claimed crush strength and density. *Id.* at 40–42 (citing Ex. 1013, 148, 171; Ex. 1012, Table 1; Ex. 1002 ¶¶ 79–80).

Regarding claim 11, we agree with Petitioner that ACRP teaches arrestor beds composed of up to 100% foamed glass aggregate, which meets this limitation; further, where a cover layer is used, ACRP shows it to be very thin compared to the basin filled with foamed glass aggregate. Ex. 1008, 18, 121, 131–34; Ex. 1002 ¶ 68 (“It is advantageous to ensure that the bed has as homogenous of a composition as possible to ensure that consistent forces are imparted upon the landing gear to predictably slow the aircraft”).

Claim 12 further requires “the foamed glass aggregate bodies have an interconnected open porosity.” Ex. 1001, 12:14–15. Petitioner asserts that ACRP teaches the claimed interconnected open porosity in the foamed glass aggregate bodies because “the foamed glass may have an open porosity formed over the course of several freeze thaw cycles, ‘permitting progressively deeper penetration into the specimen’” and so “[a] POSA

would have recognized that the claimed interconnected open porosity would result.” Pet. 38–39 (citing Ex. 1008, 82; Ex. 1002 ¶ 75).

Regarding claim 12, Patent Owner argues that the open, interconnected porosity is not disclosed or suggested by ACRP. Resp. 15. Patent Owner goes further, arguing that ACRP, in fact, cautions against the use of such a material, as it would result in “water infiltration and thermal cycling” that may cause damage that is undesirable. *Id.* However, Patent Owner offers no citation to any evidence in support of this argument, which we reject as conclusory. *Id.*

As with Ground 6, discussed above, Petitioner’s argument that ACRP disclosed foamed glass aggregate bodies to have an “interconnected open porosity” is based on an allegation of inherency, where the open porosity forms because of weathering. *See* Pet. 38–39 (citing Ex. 1002 ¶ 75). Similar to our conclusion regarding Ground 6, we also find that Petitioner has not demonstrated that the subject matter of claim 12 would have been obvious over ACRP. We are directed to no evidence of record that the interconnected open porosity limitation would necessarily be present or would be the natural result of weathering, as asserted by Petitioner. *See Endo Pharm.*, 894 F.3d at 1381. To the extent that Petitioner’s argument is premised on a *KSR* “obvious to try” rationale, as with Ground 6, we find Petitioner presents no evidence that a person of ordinary skill in the art would have had any reason to pursue the claimed interconnected open porosity, no evidence of a design need for such a structure, and no evidence of market pressure to solve any problem relating to foamed glass porosity. *KSR*, 550 U.S. at 421. Indeed, Petitioner failed to clearly articulate any obvious to try rationale in the Petition.

Regarding claim 13, we agree with Petitioner that ACRP teaches that EMAS material having a strength of 60–80 psi provides high efficiency in arresting commercial aircraft. Ex. 1008, 63 (Table 7-4). It, therefore, would have been obvious at the time of the invention to use foamed glass bodies having the claimed crush strength.

Regarding claim 14, Patent Owner argues its limitation is not taught by ACRP or Narmo, without any elaboration or citation to supporting evidence. *See* Resp. 15–16. On this claim, we agree with Petitioner that ACRP teaches foam glass with a crush strength of 140 psi (in a punch test), which Petitioner asserts is the claimed at least 100 psi, as claimed. Ex. 1008, 79–80; *see also* Ex. 1002 ¶ 71. Regarding the claimed density, ACRP is not explicit; the reference states that to transition to field testing foam densities would have to be finalized, but how this would be accomplished and what densities would be obvious is not explained. Ex. 1008, 96. ACRP discloses that “[s]everal densities of the glass foam were examined,” where “higher density samples had higher compressive strengths,” and with the lowest density being 6 pcf, which was the “most promising.” *Id.* at 76. Six pcf converts to 96.12 kg/m³. As 96.12 kg/m³ is close to the bottom of the claimed density range and ACRP states that this was the lowest density tested, the reference reasonably supports a finding that densities within the claimed range may have also been tested. Petitioner asserts that both the claimed crush strength and density variable would be optimized by the skilled artisan, and would have been obvious. *See* Ex. 1002 ¶ 72. We agree with this assertion, as ACRP indicates density is an optimizable, result effective variable. *See, e.g.*, Ex. 1008, 78 (for example, foam glass density affects compressive strength). We also agree

with Petitioner that it would have been obvious to the skilled artisan to combine ACRP and Narmo and that this combination teaches a range of crush strengths and densities for foamed glass bodies, and the obviousness of optimizing these variables, as claimed. *See, e.g.*, Ex. 1012, Table 1; Ex. 1002 ¶¶ 78–80.

Regarding claim 15, we agree with Petitioner that ACRP teaches the use of cement boards as a paving layer over a bed of foamed glass aggregate bodies, and also teaches a bed composed of a pour-in-place aggregate of foamed glass bodies with a cement binder, either of which (or both together) would obviously provide a cementitious surface. *See* Ex. 1002 ¶¶ 59, 61, 64, 66, 74; *see also* Ex. 1008, 12, 17, 24, 30, 58, 60 (disclosing covering foamed glass, for example, with cement boards or cement binder).

Regarding claim 16, we agree with Petitioner that, as shown at Figures S-3 and 9-2, ACRP teaches an arrestor bed with a contoured surface. Ex. 1008, 16–17, 73–74; *see also* Ex. 1002 ¶ 76. When the arrestor bed's lower surface is considered, ACRP also teaches a contoured bed having an inclined bottom surface of an arrestor basin at its Figure 11-3. *Id.* at 121.

6. SUMMARY

For the reasons stated above, we are persuaded that Petitioner has carried its burden and shown by preponderance of the evidence, under Grounds 1–4, that claims 1–11 and 13–16 of the '671 patent would have been obvious over ACRP individually or, alternatively for certain dependent claims, over ACRP in combination with Narmo, or Hojaji, or Ramsey. We are persuaded that ACRP would have been combined by the person of ordinary skill in the art with these other prior art references and that such a skilled artisan would have has a reasonable expectation of success in doing

so. Patent Owner either has not contested Petitioner's arguments and evidence, or has unpersuasively done so with little or no citation to supporting evidence. We also conclude that Petitioner has not established by a preponderance of the evidence that claim 12 would have been obvious over this prior art combination.

III. PARTIES' MOTIONS TO STRIKE OR EXCLUDE

Petitioner filed a Motion to Strike Patent Owner's Sur-Reply for inappropriately raising new arguments. Pet. Mot. Strike. Patent Owner opposes this Motion. PO Opp. Mot. Strike. Patent Owner filed a Motion to Exclude Petitioner's evidence. PO Mot. Exclude. Petitioner opposes this motion. Pet. Opp. Mot. Exclude. Patent Owner also filed a Reply to Petitioner's Opposition to Patent Owner's Motion to Exclude. PO Reply Pet. Opp.

A. PETITIONER'S MOTION TO STRIKE

Petitioner moves to strike portions of Patent Owner's Sur-Reply. Pet. Mot. Strike 1–3. Petitioner's position is summarized as follows:

Patent Owner's ("PO") Sur-Reply (Paper 37) raises, for the first time, the argument that "Petitioner's arguments are not based on expert opinion but entirely on attorney argument." (Paper 37, 1, "Introduction"; *see also* Page 5). Nowhere in the Patent Owner Response ("POR") (Paper 24), does PO make the argument that the arguments in the Petition are based "entirely on attorney argument." (*See e.g.*, Paper 1 at Pages 23–26, 40–41, 42–43, 44, 46–47, 60 (Petitioner's obviousness arguments based on both the prior art of record and the technical analysis provided by Dr. Zupan not specific to any claim construction)).

Id. at 1. We deny Petitioner's Motion.

The Board has broad discretion to assign weight to be accorded expert testimony, including Dr. Zupan's declaration. *Yorkey v. Diab*, 601 F.3d

1279, 1284 (Fed. Cir. 2010). Petitioner’s objections do not support striking any portion of Patent Owner’s Sur-Reply. The nature of our proceedings, in which the same panel that decides admissibility also serves as the fact-finder, disfavors exclusion, or striking, in these circumstances. *See Corning Inc. v. DSM IP Assets B.V.*, IPR2013-00053, Paper 66, 19 (PTAB May 1, 2014) (sitting as a non-jury tribunal, the Board may assign appropriate weight to evidence presented) (citing *Donnelly Garment Co. v. NLRB*, 123 F.2d 215, 224 (8th Cir. 1941)). As the *Donnelly* court observed, “[o]ne who is capable of ruling accurately upon the admissibility of evidence is equally capable of sifting it accurately after it has been received” 123 F.2d at 224.

In most cases, the Board is capable of identifying new issues or belatedly presented evidence when weighing the evidence at the close of trial, and disregarding any new issues or belatedly presented evidence that exceeds the proper scope of reply or sur-reply. As such, striking the entirety or a portion of a party’s brief is an exceptional remedy that the Board expects will be granted rarely.

Patent Trial and Appeal Board Consolidated Trial Practice Guide 80 (Nov. 2019), <https://www.uspto.gov/TrialPracticeGuideConsolidated> (combining the Trial Practice Guide and updates).

To the extent that any particular argument asserted in Patent Owner’s Sur-Reply improperly introduces a new theory or position regarding Dr. Zupan’s testimony or the Petition’s reliance thereon, we are capable of distinguishing and disregarding such argument. Similar to a district court in a bench trial, the Board, sitting as a non-jury tribunal with administrative expertise, is well positioned to determine and assign appropriate weight to evidence presented, including not relying on it or giving it no weight when

improperly raised in a reply. *See, e.g., Donnelly*, 123 F.2d at 224. As illustrated above in our discussion of Petitioner’s challenges and Patent Owner’s responses thereto, our conclusions on obviousness are based on the evidence cited in the Petition. Thus, in this *inter partes* review, the better course is to have a complete record of the evidence to facilitate public access as well as appellate review and we deny the motion.

B. PATENT OWNER’S MOTION TO EXCLUDE

Patent Owner’s Motion states that “Patent Owner moves to exclude portions of the declaration of Dr. Marc Zupan (Ex. 1002) which are based on incorrect constructions of the claim term “composite bed” as irrelevant and inadmissible under FRE 401 and 402.” PO Mot. Exclude 1. The party moving to exclude evidence bears the burden of proving that it is entitled to the relief requested—namely, that the material sought to be excluded is inadmissible under the Federal Rules of Evidence (“FRE”). *See* 37 C.F.R. §§ 42.20(c), 42.62(a) (2019). Thus, for this motion, Patent Owner must show it is entitled to the requested relief. It has not done so.

Patent Owner states that “Patent Owner first raised this issue with respect to Dr. Zupan’s declaration in their Sur-Reply filed on October 14, 2020. (IPR 2019-01490, Paper No. 37).” PO Mot. Exclude 1. This was not timely because Dr. Zupan’s first declaration (Ex. 1002) was submitted August 23, 2019, and the Institution Decision, wherein the Board first indicated it would not interpret the claims as proposed by Petitioner, was entered February 20, 2020. Thus, any objections to Dr. Zupan’s declaration, i.e., Exhibit 1002, must have been made by Patent Owner “within ten business days of the institution of the trial” as required by 37 C.F.R. § 42.64(b)(1). Patent Owner waived its evidence objection. *See* Pet. Opp.

PO Mot. Exclude 1. Because Patent Owner waived its respective objection, we deny Patent Owner's motion.

IV. CONCLUSION

On the record in the proceeding, Petitioner has shown by a preponderance of the evidence that claims 1–11 and 13–16 of the '671 patent would have been obvious and unpatentable, but has not shown under this standard that claim 12 would have been unpatentable.¹⁹ In summary:

Claims	35 U.S.C. §	References	Claims Shown Unpatentable	Claims <u>Not</u> Shown Unpatentable
1–16	103	ACRP	1–11, 13–16	12
5, 14	103	ACRP, Narmo	5, 14	-
6	103	ACRP, Hojaji	6	-
6, 7, 9	103	ACRP, Ramsey	6, 7, 9	-
1–16 ²⁰	103	Angley, Hojaji	-	-

¹⁹ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

²⁰ Ground 5 is not reached as it is subsumed within Ground 6, which asserts Angley, Hojaji, and Schirtzinger, and challenges the same claims. For example, we need not address whether Angley and Hojaji render claims 1–

Claims	35 U.S.C. §	References	Claims Shown Unpatentable	Claims <u>Not</u> Shown Unpatenable
1–16	103	Anglely, Hojaji, Schirtzinger	1–11, 13–16	12
Overall Outcome			1–11, 13–16	12

Further, we deny Petitioner’s Motion to Strike and Patent Owner’s Motion to Exclude.

ORDER

Accordingly, it is hereby:

ORDERED that Petitioner has demonstrated by a preponderance of the evidence that claims 1–11 and 13–16 of the ’671 patent are *unpatentable*;

FURTHER ORDERED that Petitioner has not demonstrated by a preponderance of the evidence that claim 12 of the ’671 patent is *unpatentable*;

FURTHER ORDERED that, because this is a Final Written Decision, parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2;

FURTHER ORDERED that Petitioner’s Motion to Strike is *denied*; and

FURTHER ORDERED that Patent Owner’s Motion to Exclude is *denied*.

11 and 13–16 obvious because those claims are obvious over Anglely, Hojaji, and Schirtzinger, and Petitioner has not established that claim 12 would have been obvious based on Anglely and Hojaji, with or without Schirtzinger.

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