

POLÍTICA DO SISTEMA DE GESTÃO

A liderança da Maccaferri nos vários setores da engenharia civil em que atua é proveniente da dedicação, compromisso de seus funcionários e o respeito aos seus clientes ao longo de vários anos de existência.

Compromissos da Política do Sistema de Gestão:

- M** Desenvolver e fortalecer relações duradouras com nossos clientes e fornecedores, fundamentadas em mútua confiança e inovação tecnológica;
- M** Disponibilizar aos nossos clientes, soluções eficazes e tecnologicamente avançadas para as engenharias: civil, ambiental e industrial;
- M** Assegurar o cumprimento das diretrizes definidas no código de ética e conduta, valorizando assim nosso capital humano;
- M** Conscientizar nossos colaboradores com relação a proteção do meio ambiente, incluindo a prevenção da poluição;
- M** Promover ambiente de trabalho saudável e seguro com o objetivo de eliminar os perigos e reduzir os riscos;
- M** Monitorar a melhoria contínua dos sistemas de gestão, através dos indicadores de desempenho;
- M** Atender aos requisitos legais, normativos, de clientes e outros aplicáveis;
- M** Assegurar a consulta e participação dos colaboradores nas questões de Qualidade, Meio Ambiente, Segurança e Saúde Ocupacional, através dos nossos canais de comunicação.

Alexandre Marcos Texeira
CEO – Chief Executive Officer



BUREAU
VERITAS

Bureau Veritas Certification

MACCAFERRI DO BRASIL LTDA. MACSERVICE SERVIÇOS DE ENGENHARIA
LTDA. MACCAFERRI DE MÉXICO, S.A. DE C.V. MACCAFERRI CONSTRUCTION
S.A.C. MACCAFERRI DE BOLÍVIA LTDA. MACCAFERRI DE PERU S.A.C.

Avenida José Benassi, 2601, Ala 1, Distrito Industrial Fazgran - 13201-970 -
Jundiaí/SP - Brasil

*Bureau Veritas Certification certifica que o Sistema de Gestão da organização acima foi
avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.*

Norma

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO E COMERCIALIZAÇÃO DE: ARAMES: TREFILADOS, COM
REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS POLIMÉRICOS;
FIBRAS METÁLICAS E SINTÉTICAS; TELAS SIMPLES TORÇÃO; PRODUTOS
EM MALHA DUPLA TORÇÃO; PRODUTOS PARA CONTROLE DE CAÍDA DE
PEDRAS; PRODUTOS GEOSSINTÉTICOS; COMERCIALIZAÇÃO DE
BARREIRA DINÂMICA. CONSULTORIA E ASSISTÊNCIA TÉCNICA;
ADMINISTRAÇÃO DE OBRAS E SERVIÇOS; EXECUÇÃO DE OBRAS E
SERVIÇOS PARA: CONTENÇÕES, SOLO GRAMPEADO, SOLO REFORÇADO,
INSTALAÇÃO DE BARREIRAS DINÂMICAS E DRENAGEM.

Data de Início do Ciclo de Certificação: 17-08-2021

Sujeito à operação satisfatória contínua do sistema de gestão da organização, este
certificado é válido até:

13-09-2024

Validade do certificado anterior: 14-09-2021

Data da auditoria de recertificação/certificação: 28-07-2021

Data de Aprovação Original: 17-01-2013

Certificado N°: BR036522 Versão: 1 Data da Revisão: 17-08-2021

Bruno Bomtorim Moreira
Gerente Técnico



Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo - SP
- Brasil

Esclarecimentos adicionais a respeito do escopo deste certificado e à aplicabilidade dos requisitos do Sistema de
Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para
+551126559001.





BUREAU
VERITAS

Bureau Veritas Certification

MACCAFERRI DA ARGENTINA S/A.

Calle Gumes, 320, Benavidez, Co. Postal 1621 - CP:1621 - Buenos Aires/- - Argentina

Bureau Veritas Certification certifica que o Sistema de Gestão da organização acima foi avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.

Norma

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO DE PRODUTOS DE MALHA DE DUPLA TORÇÃO E VENDAS DE ARAMES COM REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS POLIMÉRICOS; AÇO E SINTÉTICO, FIBRAS; MALHA DE SIMPLES TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSINTÉTICOS.

Data de Início do Ciclo de Certificação: 17-08-2021
Sujeito à operação satisfatória contínua do sistema de gestão da organização, este certificado é válido até: 13-09-2024
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Data da auditoria de recertificação/certificação: 28-07-2021
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Certificado N°: BR036522 Versão: 1 Data da Revisão: 17-08-2021

Bruno Bomtorim Moreira
Gerente Técnico



A existência e validade deste certificado está vinculada ao certificado principal N°:

BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo - SP - Brasil

Esclarecimentos adicionais a respeito do escopo deste certificado e à aplicabilidade dos requisitos do Sistema de Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para +551126559001.





BUREAU
VERITAS

Bureau Veritas Certification

MACSERVICE SERVIÇOS DE ENGENHARIA LTDA.

Avenida José Benassi, 2601, Ala 1, Distrito Industrial Fazgran - 13201-970 - Jundiaí/SP -
Brasil

*Bureau Veritas Certification certifica que o Sistema de Gestão da organização acima foi
avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.*

Norma

ISO 9001:2015

Escopo de Certificação

CONSULTORIA E ASSISTÊNCIA TÉCNICA; ADMINISTRAÇÃO DE OBRAS E
SERVIÇOS; EXECUÇÃO DE OBRAS E SERVIÇOS PARA: CONTENÇÕES,
SOLO GRAMPEADO, SOLO REFORÇADO, INSTALAÇÃO DE BARREIRAS
DINÂMICAS E DRENAGEM.

Data de Início do Ciclo de Certificação: 17-08-2021
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Bruno Bomtorim Moreira
Gerente Técnico



A existência e validade deste certificado está vinculada ao certificado principal N°:

BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo
- SP - Brasil

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Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para
+551126559001.





BUREAU
VERITAS

Bureau Veritas Certification

MACCAFERRI DE PERU S.A.C.

Km 33 De La Nueva Panamericana Sur - Lurin 15823 - Lima/- - Peru

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Norma

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO DE PRODUTOS DE MALHA DE DUPLA TORÇÃO E ARAME DE TORÇÃO COM REVESTIMENTOS POLIMÉRICOS; FIBRAS DE AÇO; VENDA DE REVESTIMENTOS METÁLICOS DE ARAME; FIBRAS SINTÉTICAS; MALHA DE SIMPLES TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSSINTÉTICOS.

Data de Início do Ciclo de Certificação:	17-08-2021	
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Certificado N°: BR036522	Versão: 1	Data da Revisão: 17-08-2021

Bruno Bomtorim Moreira
Gerente Técnico



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BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo - SP - Brasil

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BUREAU
VERITAS

Bureau Veritas Certification

MACCAFERRI DE BOLÍVIA LTDA.

Carretera a Pailón, S/Nº, Barrio Campanero - CP:3040 - Santa Cruz de La Sierra/- -
Bolivia

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avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.*

Norma

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO DE PRODUTOS DE MALHA DE DUPLA TORÇÃO E VENDA DE
ARAME DE TORÇÃO COM REVESTIMENTOS METÁLICOS, COM
REVESTIMENTOS POLIMÉRICOS; AÇO E FIBRAS SINTÉTICAS; MALHA
DE SIMPLES TORÇÃO PRODUTOS DE ROCKFALL; PRODUTOS
GEOSSINTÉTICOS

Data de Início do Ciclo de Certificação:	17-08-2021	
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Data de Aprovação Original:	17-01-2013	
Certificado N°: BR036522	Versão: 1	Data da Revisão: 17-08-2021

Bruno Bomtorim Moreira
Gerente Técnico



A existência e validade deste certificado está vinculada ao certificado principal N°:

BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo
- SP - Brasil

Esclarecimentos adicionais a respeito do escopo deste certificado e à aplicabilidade dos requisitos do Sistema de
Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para
+551126559001.





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Bureau Veritas Certification

MACCAFERRI DE CENTRO AMÉRICA LTDA.

De la Iglesia de Santa Rosa de Santo Domingo de Heredia, 100m, Oeste, 100m Sur, 1KM
Oeste, Calle Rinconada, Barrio San Martin 670-1007 - San Jose/- - Costa Rica

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avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.*

Norma

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO DE PRODUTOS DE MALHA DE DUPLA TORÇÃO E VENDAS
DE ARAMES COM REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS
POLIMÉRICOS; AÇO E SINTÉTICO, FIBRAS; MALHA DE SIMPLES
TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSINTÉTICOS.

Data de Início do Ciclo de Certificação: 17-08-2021
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Certificado N°: BR036522 Versão: 1 Data da Revisão: 17-08-2021

Bruno Bomtorim Moreira
Gerente Técnico



A existência e validade deste certificado está vinculada ao certificado principal N°:

BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo
- SP - Brasil

Esclarecimentos adicionais a respeito do escopo deste certificado e à aplicabilidade dos requisitos do Sistema de
Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para
+551126559001.





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VERITAS

Bureau Veritas Certification

MACCAFERRI DE MÉXICO, S.A. DE C.V.

Av. San Pedrito, 119, Parque Industrial C.P.76220. Sata Rosa - C.P.76220 - Querétaro/- - Mexico

Bureau Veritas Certification certifica que o Sistema de Gestão da organização acima foi avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.

Norma

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO E COMERCIALIZAÇÃO DE PRODUTOS EM DUPLA TORÇÃO E
COMERCIALIZAÇÃO DE PRODUTOS GEOSSINTÉTICOS PARA A
INDÚSTRIA DA CONSTRUÇÃO.

Data de Início do Ciclo de Certificação: 17-08-2021
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Bruno Bomtorim Moreira
Gerente Técnico



A existência e validade deste certificado está vinculada ao certificado principal N°:

BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo - SP - Brasil

Esclarecimentos adicionais a respeito do escopo deste certificado e à aplicabilidade dos requisitos do Sistema de Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para +551126559001.





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VERITAS

Bureau Veritas Certification

MACCAFERRI DO BRASIL LTDA.

Avenida José Benassi, 2601, Ala 1, Distrito Industrial Fazgran - 13201-970 - Jundiaí/SP -
Brasil

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avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.*

Norma

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO E COMERCIALIZAÇÃO DE: ARAMES: TREFILADOS, COM
REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS POLIMÉRICOS;
FIBRAS METÁLICAS E SINTÉTICAS; TELAS SIMPLES TORÇÃO;
PRODUTOS EM MALHA DUPLA TORÇÃO; PRODUTOS PARA CONTROLE
DE CAÍDA DE PEDRAS; PRODUTOS GEOSSINTÉTICOS;
COMERCIALIZAÇÃO DE BARREIRA DINÂMICA.

Data de Início do Ciclo de Certificação:	17-08-2021	
Sujeito à operação satisfatória contínua do sistema de gestão da organização, este certificado é válido até:	13-09-2024	
Validade do certificado anterior:	14-09-2021	
Data da auditoria de recertificação/certificação:	28-07-2021	
Data de Aprovação Original:	17-01-2013	
Certificado N°: BR036522	Versão: 1	Data da Revisão: 17-08-2021

Bruno Bomtorim Moreira
Gerente Técnico



A existência e validade deste certificado está vinculada ao certificado principal N°:

BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo
- SP - Brasil

Esclarecimentos adicionais a respeito do escopo deste certificado e à aplicabilidade dos requisitos do Sistema de
Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para
+551126559001.





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VERITAS

Bureau Veritas Certification

MACCAFERRI CONSTRUCTION S.A.C.

Av. Benavides, 1944 - Oficina 801 - Miraflores 15074 - Lima/PER - Peru

Bureau Veritas Certification certifica que o Sistema de Gestão da organização acima foi avaliado e encontrado em conformidade com os requisitos da Norma detalhada abaixo.

Norma

ISO 9001:2015

Escopo de Certificação

VENDA DE REVESTIMENTOS METÁLICOS DE ARAME; FIBRAS SINTÉTICAS; MALHA DE SIMPLES TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSSINTÉTICOS.

Data de Início do Ciclo de Certificação: 17-08-2021
Sujeito à operação satisfatória contínua do sistema de gestão da organização, este certificado é válido até: 13-09-2024
Validade do certificado anterior: 14-09-2021
Data da auditoria de recertificação/certificação: 28-07-2021
Data de Aprovação Original: 17-01-2013
Certificado N°: BR036522 Versão: 1 Data da Revisão: 17-08-2021

Bruno Bomtorim Moreira
Gerente Técnico



A existência e validade deste certificado está vinculada ao certificado principal N°:

BR036522

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo - SP - Brasil

Esclarecimentos adicionais a respeito do escopo deste certificado e à aplicabilidade dos requisitos do Sistema de Gerenciamento podem ser obtidos consultando a Organização. Para verificar a validade deste certificado, telefone para +551126559001.





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VERITAS

Bureau Veritas Certification

MACCAFERRI DO BRASIL LTDA.

Avenida José Benassi, 2601, Ala 1, Distrito Industrial Fazgran - 13201-970 - Jundiaí / SP - Brasil

Este é um certificado multi-site, as informações das demais unidades estão disponíveis na(s) próxima(s) página(s).

Bureau Veritas Certification Holding SAS - UK Branch certifica que o Sistema de Gestão da organização acima foi avaliado e encontrado em conformidade com os requisitos da norma detalhada abaixo

ISO 9001:2015

Escopo de Certificação

PRODUÇÃO E COMERCIALIZAÇÃO DE: ARAMES: TREFILADOS, COM REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS POLIMÉRICOS; FIBRAS METÁLICAS E SINTÉTICAS; TELAS SIMPLES TORÇÃO; PRODUTOS EM MALHA DUPLA TORÇÃO; PRODUTOS PARA CONTROLE DE CAÍDA DE PEDRAS; PRODUTOS GEOSSINTÉTICOS; COMERCIALIZAÇÃO DE BARREIRA DINÂMICA. CONSULTORIA E ASSISTÊNCIA TÉCNICA; ADMINISTRAÇÃO DE OBRAS E SERVIÇOS; EXECUÇÃO DE OBRAS E SERVIÇOS PARA: CONTENÇÕES, SOLO GRAMPEADO, SOLO REFORÇADO, INSTALAÇÃO DE BARREIRAS DINÂMICAS E DRENAGEM.

Data de início do ciclo original:	05-12-1995
Validade do certificado anterior:	14-09-2021
Data da auditoria de recertificação/certificação:	28-07-2021
Data de início do ciclo de certificação / recertificação:	17-08-2021
Sujeito à operação satisfatória contínua do sistema de gestão da organização, este certificado é válido até:	13-09-2024

Certificado N°: **BR036523**

Versão: **1** Data de emissão: **17-08-2021**



0008

Endereço do corpo de certificação: 5th Floor, 66 Prescott Street, London, E1 8HG, United Kingdom

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo/SP - Brasil

Para esclarecimentos adicionais em relação ao escopo e validade deste certificado, e a aplicabilidade dos requisitos do sistema de gestão, ligar para: +551126559001.





BUREAU
VERITAS

Bureau Veritas Certification

MACCAFERRI DO BRASIL LTDA.

ISO 9001:2015

Escopo de Certificação

Site	Endereço	Âmbito do site
MATRIZ	Avenida José Benassi, 2601, Ala 1, Distrito Industrial Fazgran - 13201-970 - Jundiaí / SP - Brasil	PRODUÇÃO E COMERCIALIZAÇÃO DE: ARAMES: TREFILADOS, COM REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS POLIMÉRICOS; FIBRAS METÁLICAS E SINTÉTICAS; TELAS SIMPLES TORÇÃO; PRODUTOS EM MALHA DUPLA TORÇÃO; PRODUTOS PARA CONTROLE DE CAÍDA DE PEDRAS; PRODUTOS GEOSSINTÉTICOS; COMERCIALIZAÇÃO DE BARREIRA DINÂMICA.
SITE 1 - MACSERVICE SERVIÇOS DE ENGENHARIA LTDA	Avenida José Benassi, 2601, Ala 1, Distrito Industrial Fazgran - 13201-970 - Jundiaí / SP - Brasil	CONSULTORIA E ASSISTÊNCIA TÉCNICA; ADMINISTRAÇÃO DE OBRAS E SERVIÇOS; EXECUÇÃO DE OBRAS E SERVIÇOS PARA: CONTENÇÕES, SOLO GRAMPEADO, SOLO REFORÇADO, INSTALAÇÃO DE BARREIRAS DINÂMICAS E DRENAGEM.
SITE 2 - MACCAFERRI DE MÉXICO, S.A. DE C.V	Av. San Pedrito, 119, Parque Industrial C.P.76220. Sata Rosa - C.P.76220 - Querétaro / - - Mexico	PRODUÇÃO E COMERCIALIZAÇÃO DE PRODUTOS EM DUPLA TORÇÃO E COMERCIALIZAÇÃO DE PRODUTOS GEOSSINTÉTICOS PARA A INDÚSTRIA DA CONSTRUÇÃO.

Certificado N°: **BR036523**

Versão: **1**

Data de emissão: **17-08-2021**



0008

Endereço do corpo de certificação: 5th Floor, 66 Prescot Street, London, E1 8HG, United Kingdom

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo/SP - Brasil

Para esclarecimentos adicionais em relação ao escopo e validade deste certificado, e a aplicabilidade dos requisitos do sistema de gestão, ligar para: +551126559001.





ISO 9001:2015

Escopo de Certificação

Site	Endereço	Âmbito do site
SITE 3 - MACCAFERRI CONSTRUCTION S.A.C	Av. Benavides, 1944, Oficina 801, Miraflores, Lima/Peru - 13213-085 - Lima / PER - Brasil	VENDA DE REVESTIMENTOS METÁLICOS DE ARAME; FIBRAS SINTÉTICAS; MALHA DE SIMPLES TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSSINTÉTICOS
SITE 4 - MACCAFERRI DE BOLÍVIA LTDA	Carretera a Pailón, S/Nº, Barrio Campanero - CP:3040 - Santa Cruz de La Sierra / - - Bolívia	PRODUÇÃO DE PRODUTOS DE MALHA DE DUPLA TORÇÃO E VENDA DE ARAME DE TORÇÃO COM REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS POLIMÉRICOS; AÇO E FIBRAS SINTÉTICAS; MALHA DE SIMPLES TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSSINTÉTICOS.
SITE 5 - MACCAFERRI DE PERU S.A.C	Prédio Las Salinas, Lúrin - Lote C12-1 - Lima / - - Peru	PRODUÇÃO DE PRODUTOS DE MALHA DE DUPLA TORÇÃO E ARAME DE TORÇÃO COM REVESTIMENTOS POLIMÉRICOS; FIBRAS DE AÇO; VENDA DE REVESTIMENTOS METÁLICOS DE ARAME; FIBRAS SINTÉTICAS; MALHA DE SIMPLES TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSSINTÉTICOS.

Certificado N°: **BR036523**Versão: **1**Data de emissão: **17-08-2021**


0008

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Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo/SP - Brasil

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VERITAS

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MACCAFERRI DO BRASIL LTDA.

ISO 9001:2015

Escopo de Certificação

Site	Endereço	Âmbito do site
SITE 6 - MACCAFERRI DA ARGENTINA S/A	Calle Gumes, 320, Benavidez, Co. Postal 1621 - CP:1621 - Buenos Aires / - - Argentina	PRODUÇÃO DE PRODUTOS DE MALHA DE DUPLA TORÇÃO E VENDAS DE ARAMES COM REVESTIMENTOS METÁLICOS, COM REVESTIMENTOS POLIMÉRICOS; AÇO E SINTÉTICO, FIBRAS; MALHA DE SIMPLES TORÇÃO; PRODUTOS DE ROCKFALL; PRODUTOS GEOSSINTÉTICOS.
SITE 7 - MACCAFERRI DE CENTRO AMÉRICA LTDA	De la Iglesia de Santa Rosa de Santo Domingo de Heredia, 100m, Oeste, 100m Sur, 1KM Oeste, Calle Rinconada, Barrio San Martin 670- 1007 - San Jose / - - Costa Rica	

Certificado N°: **BR036523**

Versão: 1

Data de emissão: 17-08-2021



0008

Endereço do corpo de certificação: 5th Floor, 66 Prescot Street, London, E1 8HG, United Kingdom

Escritório local: Av. Alfredo Egídio de Souza Aranha, 100, Torre C, 4º Andar Vila Cruzeiro, 04726-170 - São Paulo/SP - Brasil

Para esclarecimentos adicionais em relação ao escopo e validade deste certificado, e a aplicabilidade dos requisitos do sistema de gestão, ligar para: +551126559001.





EL INSTITUTO BOLIVIANO DE NORMALIZACIÓN Y CALIDAD

Respaldo por los Decretos Supremos N° 23489 y N° 24498 y concluido el proceso de Certificación de Productos que se sustenta en el Esquema 5 de la NB/ISO/IEC 17067, reglamentos y procedimientos internos, otorga el:

CERTIFICADO DE USO DEL "SELLO IBNORCA" DE CONFORMIDAD CON NORMA EN 10223 - 3:2013

Al Producto:

Malla hexagonal de acero para aplicaciones en ingeniería civil del tipo 6x8, 8x10 y 10x12; para:

- a) gaviones, colchones, gaviones saco y rollos; con alambre de acero con revestimiento metálico de Zinc
- b) gaviones, colchones, gaviones saco y rollos; con alambre de acero con revestimiento metálico de aleación Zn90%/Al10%
- c) gaviones, colchones, gaviones saco y rollos; con alambre de acero con revestimiento metálico de Zinc o de aleación Zn90%/Al10%, adicionalmente recubiertos con una capa de polivinilo de cloruro (PVC)
- d) gaviones, colchones, gaviones saco y rollos; con alambre de acero de aleación Zn90%/Al10%, adicionalmente recubiertos con una capa de polietileno (PE).

Marca Comercial:

MACCAFERRI

De la Empresa:

MACCAFERRI DO BRASIL LTDA.

Lugar de Fabricación:

Av. José Benassi, N° 2601 - Medeiros, Jundiá - SP, 13213-085 - Brasil



El presente certificado autoriza al Titular para hacer uso del Sello IBNORCA por el periodo de vigencia, estando condicionado al contrato suscrito con IBNORCA y a la especificación complementaria o reglamento particular correspondiente, debiendo además someterse a los procedimientos internos establecidos para el efecto. Esto supone los seguimientos anuales del Sistema de la Calidad implementado en las instalaciones del Titular y la toma de muestras en la fábrica y/o mercado, las mismas que son sometidas a ensayos.

Vigencia del Certificado: 2022-10-20 al 2025-09-16

REG-IT-EC-01-02B

José Durán Guillén
Director Ejecutivo

Daniel Sánchez Soliz
Presidente



N° 19175/121



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HAPAS

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HAPAS Certificate

16/H247

Product Sheet 2

MACCAFERRI CIVIL ENGINEERING PRODUCTS

MACCAFERRI TERRAMESH SYSTEM

This HAPAS Certificate Product Sheet⁽¹⁾ is issued by the British Board of Agrément (BBA), supported by Highways England (HE) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Government and the Department for Infrastructure, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies. HAPAS Certificates are normally each subject to a review every three years.

(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to the Maccaferri Terramesh System, hexagonal, polymer-coated, galvanized or zinc/aluminium alloy steel mesh units, for use as a reinforcement structure to embankments with slope angles of up to 70° or in the construction of reinforced soil walls with slope angles above 70° and less than 90°.

CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- factors relating to compliance with Regulations where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.



KEY FACTORS ASSESSED

Mechanical properties — the system will have adequate lateral restraint through interaction and interlocking of soil particles, when used correctly in fully designed applications based on specified cohesive or frictional soils (see section 6).

Resistance to weathering — the system will have adequate resistance to weathering (see section 7).

Durability — when used in accordance with the requirements of this Certificate, and based on available evidence from installations and tests, the system may be considered to have a service life expectancy of 120 years (see section 9).



The BBA has awarded this Certificate to the company named above for the system described herein. This system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of Second issue: 11 March 2019

Originally certificated on 11 July 2016

Paul Valentine
Technical Excellence Director

Claire Curtis-Thomas
Chief Executive

The BBA is a UKAS accredited certification body – Number 113.

The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk
Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

British Board of Agrément

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Requirements

The Highways Technical Advisory Committee has agreed with the BBA the aspects of performance to be used by the BBA in assessing the Maccaferri Terramesh System.

In the opinion of the BBA, the Maccaferri Terramesh System, when manufactured and installed in accordance with the provisions of this Certificate and the Department of the Environment, Transport and the Regions, Highways England (DETR, HE) Standard HD22 *Ground Investigations and Earthworks Procedure for Geotechnical Certification*, is suitable for use in embankments with an effective slope angle of up to 70°. It may, at the discretion of the Technical Approval Authority (TAA), be used for the construction of reinforced soil walls (slope angle up to 90°) where the Departmental Standard BD2 Design Manual for Roads and Bridges (DMRB)⁽¹⁾ Volume 1, Section 1 is appropriate.

The design, materials specification and construction methods adopted must be in accordance with DETR, HE Advice Note HA 68/94 and/or BS 8006-1 : 2010, IAN 124/11 and the *Manual of Contract Documents for Highway Works* (MCHW)⁽²⁾, Volume 1 *Specification for Highway Works* (SHW).

- (1) The DMRB is operated by the Overseeing Organisations: Highways England (HE), Transport Scotland, the Welsh Government and the Department for Infrastructure (Northern Ireland).
- (2) The MCHW is operated by the Overseeing Organisations: Highways England (HE), Transport Scotland, the Welsh Government and the Department for Infrastructure (Northern Ireland).

Regulations

Construction (Design and Management) Regulations 2015

Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See section: 3 *Delivery and site handling* (3.1, 3.3 and 3.5) of this Certificate.

Additional Information

CE marking

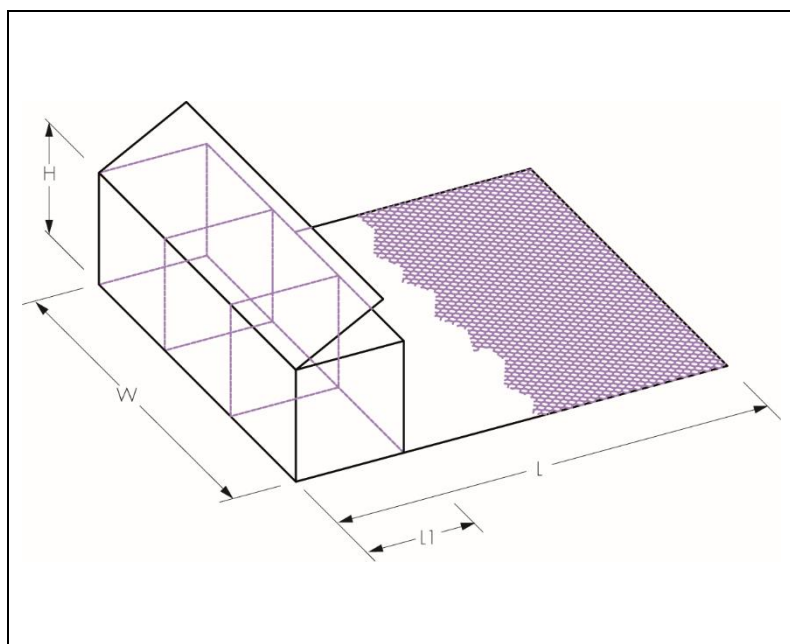
The Certificate holder has taken the responsibility of CE marking the system in accordance with ETA 16/0767. An asterisk (*) appearing in this Certificate indicates that data shown are given in the manufacturer's Declaration of Performance.

Technical Specification

1 Description

1.1 The Maccaferri Terramesh System consists of polymer-coated, double-twisted, galvanized or zinc/aluminium alloy steel mesh, fabricated into a horizontal soil reinforcement panel faced at one end with a gabion box section. The front and top sections of the gabion are folded from the reinforcement mesh panel. The back and ends are formed separately, and fixed and folded to the horizontal panel during manufacture. Additional separate diaphragm (partition) panels can be fixed on site to the gabion box facing, as required by the design (see Figure 1).

Figure 1 Maccaferri Terramesh composition



1.2 The hexagonal double twisted mesh wire is protected with PVC⁽¹⁾, PA6⁽²⁾ or PoliMac⁽³⁾⁽⁴⁾ polymer-coating onto galvanized or Zn/Al alloy galvanized wire.

- (1) PVC coating in accordance with BS EN 10245-2 : 2011.
- (2) Maccaferri PA6 is an environmentally safe, extruded polyamide coating applied to galvanized mild steel wire to provide increased resistance against mechanical damage, low friction coefficients, long term strength and elasticity, improved adhesion to wire, low liquid penetration for corrosion process, and improved performance in cold temperature.
- (3) Maccaferri PoliMac is an environmentally safe extruded polymer specifically developed with an additional masterbatch, to provide increased resistance to abrasion and to mechanical damage, an improved performance in cold and hot temperatures, and a better performance to UV radiation. The properties of the Polimac coating are in accordance with BS EN 10245- 1 : 2011.
- (4) Polimac is a registered trademark.

1.3 Nominal dimensions of standard panels are given in Table 1.

Table 1 Standard sizes of the Maccaferri Terramesh System units

L = length (m)	W = width (m)	L1 = stone filled front section depth (m)	H = height (m)
3	2 or 3 ⁽¹⁾	1.0, 0.8	0.5, 0.8, 1.0
4	2 or 3 ⁽¹⁾	1.0, 0.8	0.5, 0.8, 1.0
5	2 or 3 ⁽¹⁾	1.0, 0.8	0.5, 0.8, 1.0
6	2 or 3 ⁽¹⁾	1.0, 0.8	0.5, 0.8, 1.0

(1) Provided with 2 diaphragms.

1.4 An ancillary item used with the system is the Maccaferri Pneumatic Tool.

Wire mesh

1.5 The hexagonal mesh is manufactured from steel wire in accordance with BS EN 10218-1 : 2012 and BS EN 10218-2 : 2012.

1.6 The wire has a tensile strength in the range of 350 to 550 N·mm², with a minimum elongation at rupture of 8% in accordance with BS EN 10223-3 : 2013, and is drawn from rods complying with BS EN ISO 16120-1 : 2017 and BS EN ISO 16120-2 : 2017.

1.7 The base steel wire is coated with zinc or zinc-aluminium alloy in accordance with BS EN 10244-2 : 2009. The metallic coating is classified Class A, for PVC and Polimac coated wire with nominal thickness of 0.5 mm, and minimum Class E for PA6 coated wire with nominal thickness of 0.4 mm. Wire specifications are given in Table 2.

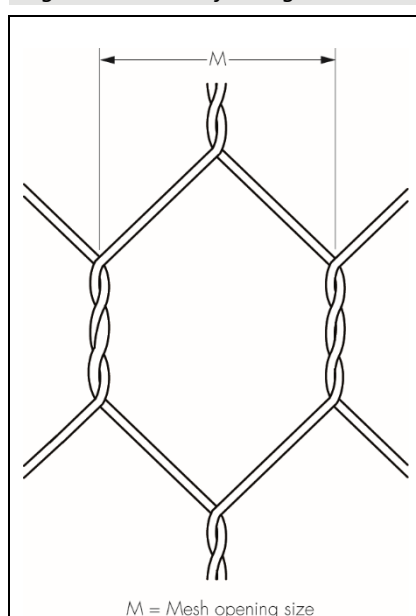
Table 2 Wire specification

Wire type	Nominal diameter			Core tolerance \pm (mm)	Mesh opening size M ⁽¹⁾ (mm)	Minimum Zn or Zn-Al coating Class A (g·m ²)	Minimum Zn-Al coating Class E (g·m ²)
	Overall diameter PVC or PoliMac coated wire (mm)	Overall diameter PA6 coated wire (mm)	Core diameter (mm)				
Mesh wire	3.7	3.5	2.7 ⁽¹⁾	0.06	80	245	60
Edge and selvedge	4.4	4.2	3.4	0.07	80	265	60
Lacing	3.2	3.0	2.2	0.06	80	230	60

(1) Manufacturing reference: 8 x 10 mesh type.

1.8 The wire is woven into a hexagonal pattern mesh (see Figure 2) with double-twist joints; larger diameter wire is introduced along the edge and selvedge.

Figure 2 Details of hexagonal mesh



1.9 To form the individual unit panels the mesh is cut, during manufacture, to the required dimensions and the selvedge wire is positioned and mechanically fixed to the panel. The rear panel is fixed to the main panel. Diaphragm panels are provided loose, packed with the folded unit for delivery.

1.10 Site assembly of the Maccaferri Terramesh units is carried out using either lacing wire (see Table 2) or stainless-steel rings (see section 13.5). Stainless steel rings are manufactured from 3 mm diameter stainless steel wire with a minimum tensile strength of 1550 MPa. The pull-apart strength of the lacing rings is a minimum of 2.0 kN.

2 Manufacture

2.1 The system units are manufactured, controlled and delivered to an agreed specification that includes requirements for incoming raw materials, method of production and process control, inspection and testing of the finished product, and packaging and delivery to site.

2.2 Galvanized or zinc/aluminium alloy PVC, PoliMac or PA6 coated steel wires are manufactured by the Certificate holder or bought in to the specification defined by the Certificate holder. Certificates of conformity and/or mill certificates are supplied with each batch of bought-in wire.

2.3 As part of the assessment and ongoing surveillance of the product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.4 The management system of Maccaferri Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by CERTICOM/Slovak Republic (Certificate CM5620718/1). The management system of Maccaferri Ltd has also been certified by SGS UK for geotechnical design and supplying of retaining structures, erosion protection works, highway and bio-engineering systems (Certificate GB01/52789).

3 Delivery and site handling

3.1 The system units are delivered to site in bundles weighing from 600 to 700 kg, depending on unit size and mesh specification.

3.2 A label bearing the BBA logo incorporating the number of this Certificate, the Certificate holder's name, batch number and product code is attached to each bundle.

3.3 All bundles must be handled with due care to avoid damage to the polymer coating. Individual panels can be manhandled, but the weight of individual units varies between 20 and 75 kg, and therefore the appropriate number of people required to lift the units must be assessed to satisfy manual lifting requirements.

3.4 The flat-pack units may be stored outdoors, but away from site traffic to avoid the risk of accidental damage, and should remain packaged until required.

3.5 Lacing wire is supplied in 25 kg coils.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the Maccaferri Terramesh System.

Design Considerations

4 Use

4.1 The Maccaferri Terramesh System is satisfactory for use as a reinforcement structure to embankments with slope angles up to 70°. The system is also satisfactory for use in the construction of reinforced soil walls with slope angle above 70° and less than 90°, at the discretion of the TAA, where the Departmental Standard BD2 (DMRB 1.1) is appropriate.

4.2 For reinforced embankment projects in the UK, when designs are carried out by, or on behalf of, the Certificate holder, they must be in accordance with the procedures given in HA 68/94 (DMRB 4.1.4) or BS 8006-1 : 2010.

4.3 Structural stability is achieved through frictional interaction and mechanical interlocking of soil particles with the system.

4.4 The system may be used in combination with soil types having an effective angle of shearing resistance in the range of 25° to 50°, and where the design is in accordance with the procedures given in DMRB 4.1.4 and/or BS 8006-1 : 2010.

4.5 The system may also be used in combination with Linear Composites Paragrid, Paradrain or Paralink reinforcement geogrids (the subject of BBA Certificates 16/H249, 03/4065 and 14/H213) or other types of Maccaferri reinforcement geogrids, but this was not assessed by the BBA and is outside the scope of this Certificate.

4.6 The system may also be used in combination with soil nailing or other ground anchor system. This combination was not assessed by the BBA and it is outside the scope of this Certificate.

4.7 The designer should specify the relevant properties of a fill material deemed 'acceptable' for the purpose of the design. 'Acceptable' materials must meet the requirements of the MCHW, Volume 1 [supplemented by HA 68/94 (DMRB 4.1.4) and/or BS 8006-1 : 2010 as appropriate].

5 Practicability of installation

The system is designed to be installed by trained ground engineering contractors, experienced in both gabion and reinforced soil construction techniques, and in accordance with the specifications given in this Certificate.

6 Mechanical properties

Tensile strength

6.1 The short-term tensile strength (T_B)⁽¹⁾ of the system is:

$$T_B = 50.0 \text{ kN} \cdot \text{m}^{-1}$$

(1) Tensile strength determined according to the procedures of BS EN 10223-3 : 2013.

Design load (T_D)

6.2 The maximum design load (T_D) that the reinforcement can be relied upon to deliver at the end of the design life and at the design temperature can be calculated from the equation:

$$T_D = \frac{T_B}{f_m}$$

where f_m is the partial factor for the reinforcement.

Partial Material factor (f_m)

6.3 In establishing the design tensile strength of the system and ensuring that during the life of the embankment the reinforcement will not fail in tension, the BBA recommends that, in line with the method given in HA 68/94 and BS 8006-1 : 2010, a set of partial safety factors should be applied to the base strength (T_B) value:

$$f_m = f_{m11} \times f_{m12} \times f_{m21} \times f_{m22}$$

Manufacture (f_{m11}) and extrapolation (f_{m12}) of data — partial safety factor (f_m)

6.4 To allow for variation in manufacture and product dimensions and to account for extrapolation of data, the value for the factor f_m is given in Table 3:

$$f_{m11} = 1.04 \text{ and } f_{m12} = 1.0$$

Table 3 Partial material safety factor — manufacture and extrapolation of data	
Design life (years)	Safety factor (f_m)
120	1.04

Installation damage — partial safety factor (f_{m21})

6.5 To allow for loss of strength owing to mechanical damage that may be sustained during installation, the appropriate value for f_{m21} may be selected from Table 4. The partial safety factors given for site damage assume that well-graded material is used (coefficient of uniformity >5) and with a minimum compacted depth of 150 mm. For soils not covered by Table 4, appropriate values of f_{m21} may be determined from site specific trials.

Table 4 Partial material safety factor — mechanical installation damage (f_{m21})

Fill material	Maximum particle size (mm)	Safety factor (f_{m21})
Silts and clays	<0.06	1.00
Sands	<2	1.00
Sandy gravels	<9.5	1.05
Coarse gravels	<38	1.15
Crushed stones	<200	1.22

Environmental effects — partial safety factor (f_{m22})

6.6 To account for environmental conditions, the appropriate value for f_{m22} may be selected from Table 5. For soils with pH values outside the range quoted, consideration should be given to an increased value for f_{m22} .

Table 5 Partial material safety factor — environmental effects

Soil pH level (pH)	Safety factor (f_{m22})
3-13	1.05

Fill/Maccaferri Terramesh System interaction

Bond strength

6.7 The pull-out resistance in granular soils, ignoring cohesion, can be determined from the equation:

$$F_{po} = 2\sigma_v\mu LB / f_p f_n$$

where:

- F_{po} is the ultimate pull-out resistance
- σ_v is the total ultimate vertical applied pressure
- μ is the coefficient of soil/reinforcement friction
- L is the length of the reinforcement in the resistant zone
- B is the width of the reinforcement
- f_p is the partial factor for pull-out resistance (see BS 8006-1 : 2010, Table 11)
- f_n is the partial factor for economic ramification of failure (see BS 8006-1 : 2010, Table 9).

Note:

$$\mu = a' \times \tan \phi'$$

where:

- a' is the interaction coefficient relating soil/reinforcement bond angle with $\tan \phi'$
- ϕ' is the internal friction angle of the structural soil.

Pull-out resistance has been verified for a range of materials by tests in accordance with BS EN 13738 : 2004. The results of the tests were analysed and used to establish the coefficients shown in Table 6.

Table 6 Typical values of coefficients relating to pull-out resistance

Fill material	ϕ [°]	$a'^{(1)}$	μ $= a' \tan \phi$
Silty sand	25	0.5	0.233
Sand	34	0.65	0.438
Gravel	38	0.9	0.703

(1) Average a' value of interaction factor determined from tests.

Note:

These values may be used in the equation above to establish the pull-out resistance for a particular situation but the resistances generated may deviate by $\pm 30\%$ of the value established by testing.

The characteristics of the fill materials used for determination of the interaction factors shown in Table 6 are given in Table 7.

Table 7 Characteristics of tested fill materials

Fill material	Bulk unit weight (kN·m ³)	Moisture content (%)	Sieve analysis (mm) (D50)
Silty sand	14.5	8	0.14
Sand	16.7	2	0.56
Gravel	16.9	<1	3.22

For soils not covered by Table 6, appropriate values of a' may be determined from site-specific tests to BS EN 13738 : 2004.

6.8 For routine design purposes, the coefficient of skin friction, a' , of the system may be assumed to be 0.6 for compacted frictional fill ($\phi \geq 30^\circ$). This is a conservative value. Where more precise values are required, for use in design, tests to BS EN 13738 : 2004 may be carried out using the appropriate soil and Maccaferri Terramesh System reinforcement mesh.

Direct sliding

6.9 When used in steep slopes, defined as from 45° to 70° from the horizontal, designed to HA 68/94 (permitted within BS 8006-1 : 2010, Clause 7.4.4.2), the direct sliding resistance of the system may be established from the value $f_{ds} \tan \phi'$ where f_{ds} is a direct sliding coefficient and determined as follows:

$$f_{ds} = \alpha_s a' + (1 - \alpha_s)$$

where:

- α_s is the proportion of plane sliding area that is solid, 0.091 for the Maccaferri Terramesh System reinforcement mesh
- a' is taken from Table 6 or established from site specific tests to BS EN 13738 : 2004. (Note: a' is referred to as f_{sf} in HA 68/94).

6.10 The designer should specify the relevant properties of the fill material for the reinforced soil structure deemed acceptable for the purposes of the design. Acceptable materials should meet the requirements of BS 8006-1 : 2010 and the MCHW, Volume 1, Series 600.

7 Resistance to weathering

7.1 Some localised damage may occur to the polymer coating during installation, and in exposed areas this may lead to corrosion of the mesh. Site evidence and test data indicate that such damage will not spread and will not cause sequential corrosion underneath the intact adjacent area of mesh. The design of the wire mesh and the fact that the strength of the external facing mesh is not used in the design of the structure as a whole indicate that this local damage will not affect the integrity of the structure.

7.2 The system will permit the growth of vegetation which will contribute to the integrity of the structure and to maintaining a natural appearance.

7.3 The polymer protection and galvanized or zinc/aluminium alloy coated steel wire will not be affected by the chemicals normally encountered in earth-retaining structures.

8 Maintenance and repair

Routine maintenance is not normally required, however, should the exposed mesh be damaged, additional or replacement panels can readily be fixed to the structure.

9 Durability

9.1 The system may be used in soils normally encountered in civil engineering practice.

9.2 Evidence from tests show that the polymer-coated wire has good resistance to chemical corrosion, bio-degradation, temperature effects and ultraviolet exposure.

9.3 In the opinion of the BBA, when used and installed in accordance with this Certificate the system units may be considered to have a design life of 120 years.

10 Reuse and recyclability

The polymer-coated galvanized or zinc/aluminium coated steel wire can be recycled.

Installation

11 General

11.1 Installation of the Maccaferri Terramesh System must be carried out in accordance with this Certificate and the Certificate holder's installation instructions.

11.2 Provided the appropriate reduction factor for mechanical damage has been included at the design stage to allow for the installation methods employed and the type of fill permitted, the system can be readily installed following appropriate construction drawings.

11.3 Prior to and during installation, particular care must be taken to ensure that:

- site preparation and embankment construction are as detailed in sections 12 and 13
- fill properties satisfy the design specification
- drainage is adequate at all stages of construction, as required by the contract documents
- the system is protected against damage from site traffic and installation equipment
- the stability of existing structures is not affected.

11.4 Care must be exercised to ensure that the system is laid with the longitudinal direction of the reinforcement mesh panel, parallel to the direction of principal stress.

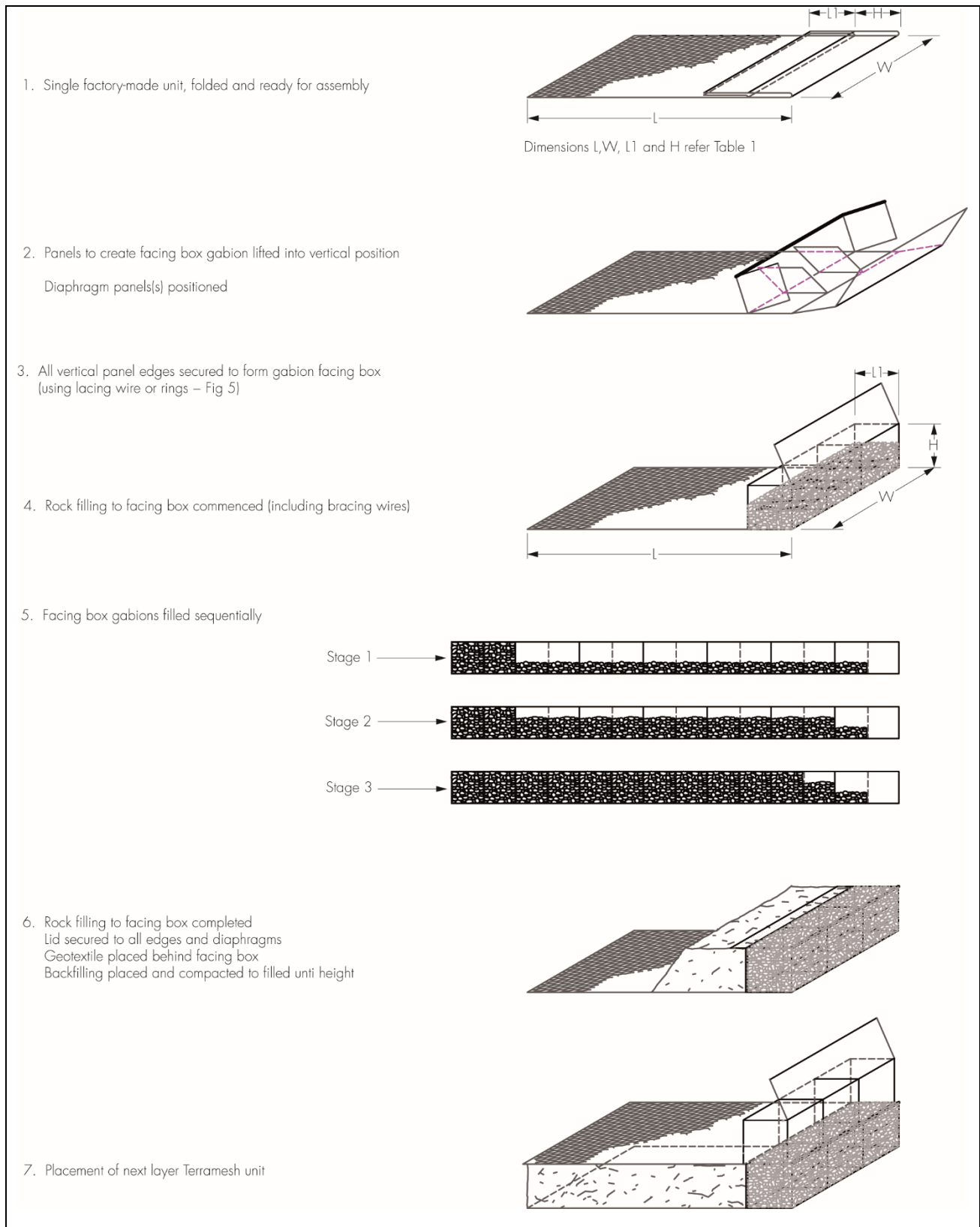
12 Preparation

The gabion formation is prepared by levelling and compacting the subgrade in accordance with MCHW, Volume 1. The surface must be free of surface irregularities, loose material, organic or frozen matter and any other obstacles that may damage the polymer-coated wire mesh.

13 Procedure

13.1 The system units are unfolded and the base mesh section is placed over the hard flat surface. Any creases not required for forming the box are pressed out and the installation procedure is commenced (see Figure 3).

Figure 3 Installation sequence



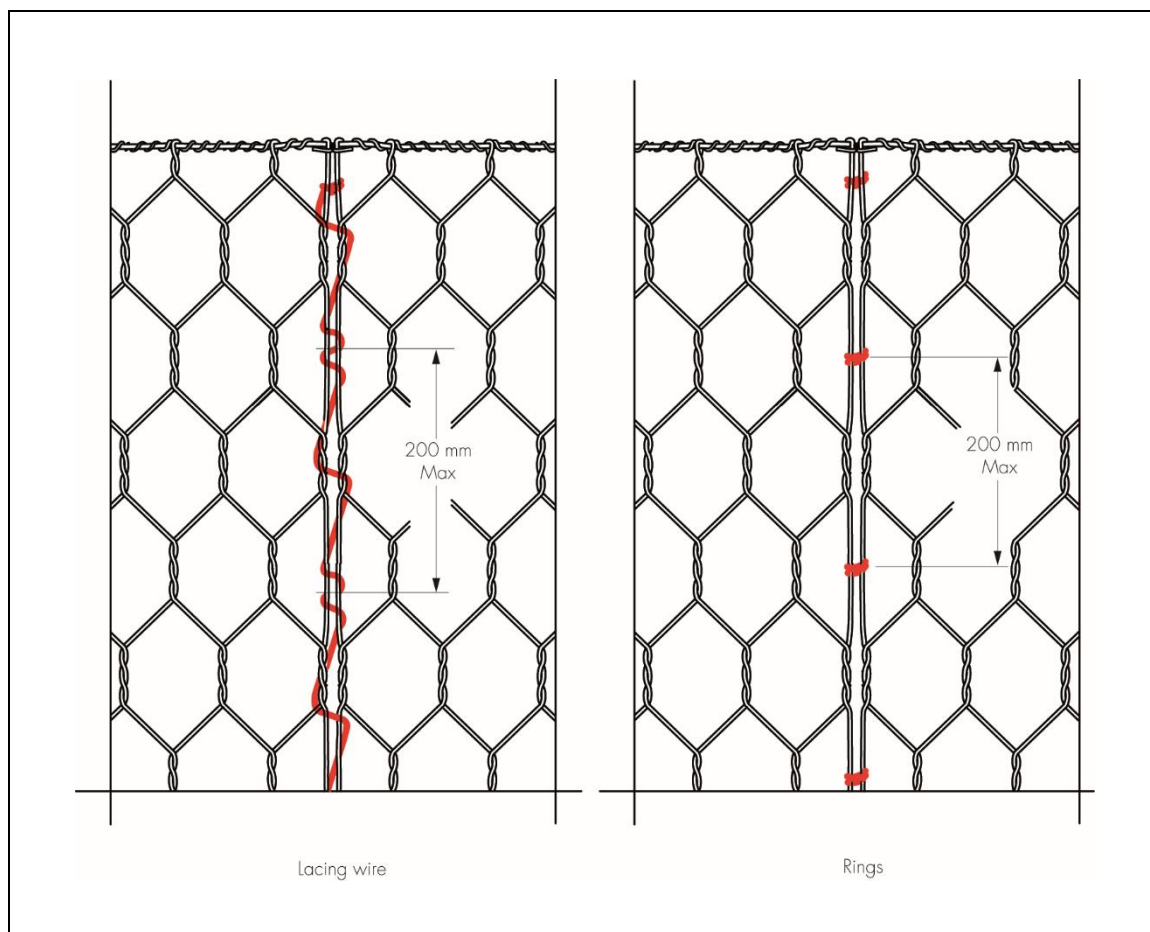
13.2 The front and rear sides, ends and diaphragm are lifted into position to form the shape of the facing box gabion.

13.3 The top corners are secured with the thick selvedge wire.

13.4 The external-facing gabion cage is assembled by wiring up the vertical faces of the front, rear, sides and diaphragm.

13.5 Vertical panel edges are joined together, either using the appropriate lacing wire starting from the top edge in a continuous operation using alternate single and double twists, or using rings applied using the Maccaferri Pneumatic Tool (see Figure 4). Individual ties of lacing wire must not be used.

Figure 4 Typical Mesh joint lacing pattern



13.6 The initial layer of pre-assembled units are placed empty on the flat, prepared formation surface (see section 12) and wired or fastened to adjacent units along all the containing edges, in order to form a continuously connected, monolithic structural unit. The horizontal reinforcement panels (behind the gabion facing box) do not need to be joined together.

13.7 The gabion box facing is lightly tensioned (parallel to the wall alignment) using a cable winch/tirfor or similar, to hold the faces taut during the filling operation and assist in alignment. The units are laced to the course below (if present).

13.8 The gabion box facing is filled in the identical manner to standard gabions.

13.9 The stone infill to the gabion facing section is normally sized between 100 and 200 mm. The fill must comprise hard, durable stone as quarried or naturally occurring rounded stone (class 6G in accordance with the MCHW, Volume 1, Table 6/1).

13.10 One-metre high gabion facing cages are filled to one-third height, braced, filled to two-thirds height and braced again. A half-metre high unit requires only one row of bracing at 250 mm height. The gabion is overfilled by approximately 30 to 50 mm to allow for natural settlement of the infill.

13.11 After filling, the cage mesh lid is folded down, stretched into position and laced to the front and side panels and the top of the diaphragm panel(s).

13.12 The full length of gabion facing must be filled sequentially (as shown in Figure 3), and the lids laced down. A strip of non-woven geotextile is placed against the rear side of the gabion facing cages, before the reinforced block backfill is commenced, to provide a separation layer.

13.13 Placement and compaction of the backfill must be carried out in accordance with BS EN 14475 : 2006, Section 8.5.4, and the MCHW, Volume 1 SHW, Series 600.

13.14 The design-specified fill is initially placed to a minimum depth of 150 mm, with particular care being taken to ensure that the polymer-coated reinforcing mesh panels are adequately covered before compaction or trafficking.

13.15 The fill must be fully compacted, in layers, to satisfy the design specification requirements. Thickness of compaction layers depends on the type of fill and compaction equipment employed, which must be determined according to the MCHW, Volume 1 SHW, Series 600, Clause 612.

Technical Investigations

14 Investigations

14.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

14.2 An assessment of data was made to determine:

- dimensional accuracy
- tensile strength
- quality of galvanized and zinc/aluminium alloy coatings
- performance of wire, mesh and filled gabions
- quality of PVC, PoliMac and PA6 coating
- ease of assembly
- durability.

14.3 Site visits were carried out to assess the practicability, ease of handling and installation under various site conditions.

14.4 An assessment was made of data pertaining to site case studies where the system has been in use for a number of years.

Bibliography

BS 8006-1 : 2010 + A1 : 2016 *Code of practice for strengthened/reinforced soils and other fills*

BS EN 10218-1 : 2012 *Steel wire and wire products — General — Test methods*

BS EN 10218-2 : 2012 *Steel wire and wire products — General — Wire dimensions and tolerances*

BS EN 10223-3 : 2013 *Steel wire and wire products for fences — Hexagonal steel wire mesh products for civil engineering purposes*

BS EN 10244-2 : 2009 *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Zinc or zinc alloy coatings*

BS EN 10245-2 : 2011 *Steel wire and wire products — Organic coatings of steel wire — PVC finished wire*

BS EN 13738 : 2004 *Geotextiles and geotextile-related products — Determination of pull-out resistance in soil*

BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*

BS EN ISO 9001 : 2015 *Quality management systems — Requirements*

BS EN ISO 16120-1 : 2017 *Non-alloy steel wire rod for conversion to wire — General requirements*

BS EN ISO 16120-2 : 2017 *Non-alloy steel wire rod for conversion to wire — Specific requirements for general-purpose wire rod*

BD 2/12 *Design Manual for Roads and Bridges Volume 1 : Highway Structures: Approval Procedures and General Design, Section 1 : Approval Procedures, Part 1 : Technical Approval of Highway Structures*

HA 68/94 *Design Manual for Roads and Bridges Volume 4 : Geotechnics and Drainage, Section 1 : Earthworks, Part 4 : Design Methods for the Reinforcement of Highway Slopes by Reinforced Soil and Soil Nailing Techniques*

IAN 124/11 *Use of Eurocodes for the design of highway structures*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works, Series 600 Earthworks*

15 Conditions

15.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

15.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/ or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

15.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

15.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

15.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

15.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

HAPAS

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HAPAS Certificate

16/H247

Product Sheet 3

MACCAFERRI CIVIL ENGINEERING PRODUCTS

MACCAFERRI GREEN TERRAMESH SYSTEM

This HAPAS Certificate Product Sheet⁽¹⁾ is issued by the British Board of Agrément (BBA), supported by Highways England (HE) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Government and the Department for Infrastructure, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies. HAPAS Certificates are normally each subject to a review every three years.

(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to the Maccaferri Green Terramesh System, hexagonal, polymer-coated, galvanized or zinc/aluminium alloy steel mesh units for use as soil reinforcement in combination with slope face restraint on embankments with slope angles of above 70° and up to 87°.

CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- factors relating to compliance with Regulations where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.



KEY FACTORS ASSESSED

Mechanical properties — the system will have adequate lateral restraint through interaction and interlocking of soil particles, when used correctly in fully designed applications based on specified cohesive or frictional soils (see section 6).

Resistance to weathering — the system will have adequate resistance to weathering (see section 7).

Durability — when used in accordance with the requirements of this Certificate, and based on available evidence from installations and tests, the system may be considered to have a service life expectancy of 120 years (see section 9).



The BBA has awarded this Certificate to the company named above for the system described herein. This system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Paul Valentine
Technical Excellence Director

Claire Curtis-Thomas
Chief Executive

Date of Second issue: 11 March 2019

Originally certificated on 4 November 2016

The BBA is a UKAS accredited certification body – Number 113.

The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk. Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct. Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

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Requirements

The Highways Technical Advisory Committee has agreed with the BBA the aspects of performance to be used by the BBA in assessing the Maccaferri Green Terramesh System.

In the opinion of the BBA, the Maccaferri Green Terramesh System, when manufactured and installed in accordance with the provisions of this Certificate and the Department of the Environment, Transport and the Regions, Highways England (DETR, HE) Standard HD22 *Ground Investigations and Earthworks Procedure for Geotechnical Certification*, is suitable for use in embankments with an effective slope angle of up to 70°. It may, at the discretion of the Technical Approval Authority (TAA), be used for the construction of reinforced soil walls (slope angle up to 87°) where the Departmental Standard BD2 *Design Manual for Roads and Bridges* (DMRB) Volume 1, Section 1, is appropriate.

The design, materials specification and construction methods adopted must be in accordance with DETR, HE Advice Note HA 68/94 and/or BS 8006-1 : 2010, IAN 124/11 and the *Manual of Contract Documents for Highway Works* (MCHW)⁽¹⁾ Volume 1 *Specification for Highway Works* (SHW).

(1) The MCHW is operated by the Overseeing Organisations: Highways England (HE), Transport Scotland, the Welsh Government and the Department for Infrastructure (Northern Ireland).

Regulations

Construction (Design and Management) Regulations 2015

Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See section: 3 Delivery and site handling (3.1, 3.3 and 3.5) of this Certificate.

Additional Information

CE marking

The Certificate holder has taken the responsibility of CE marking the system in accordance with ETA 16/0767. An asterisk (*) appearing in this Certificate indicates that data shown are given in the manufacturer's Declaration of Performance.

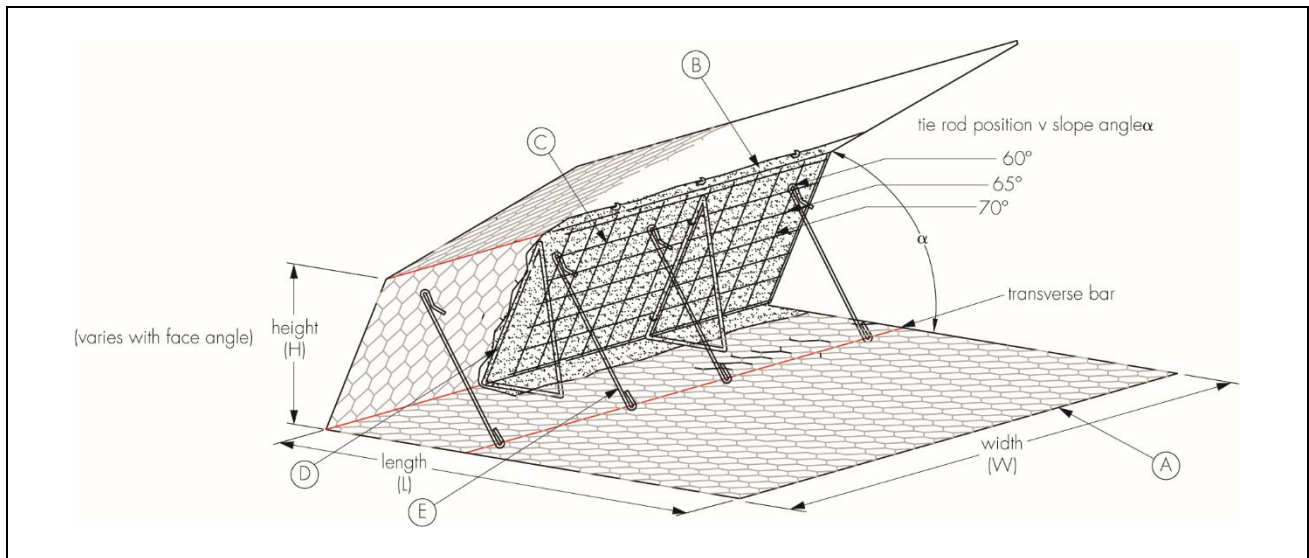
Technical Specification

1 Description

1.1 The Maccaferri Green Terramesh System is a modular system made of pre-assembled units comprising:

- a polymer-coated, double-twisted, galvanized mesh panel (A)
- an erosion control blanket (B)
- a welded mesh panel (C)
- two pre-formed steel brackets (D)
- loose steel tie rods (E) connected on site to form the unit (see Figure 1).

Figure 1 The Maccaferri Green Terramesh System — Typical composition of units



1.2 The external face, lower reinforcing panel and top return are formed from a single sheet of hexagonal double-twist mesh of polymer-coated galvanized wire. The galvanized coating is either pure zinc or zinc/aluminium alloy. The welded mesh panel, pre-formed brackets and loose tie rods create a stiff, sloping face and assist in maintaining the required face slope angle during construction.

1.3 The erosion control blanket attached to the inside face is a woven polyester fabric or bio-degradable mat (soil type) or a MacMat (water type). In case of mineral or stone face filling the erosion control blanket can be omitted.

1.4 The hexagonal double-twisted mesh wire is protected with PVC⁽¹⁾, PA6⁽²⁾ or PoliMac⁽³⁾⁽⁴⁾ polymer coating onto galvanized or Zn/Al galvanized wire.

(1) PVC coating in accordance with BS EN 10245-2 : 2011.

(2) Maccaferri PA6 is an environmentally safe, extruded polyamide coating applied to galvanized mild steel wire to provide increased resistance against mechanical damage, low friction coefficients, long term strength and elasticity, improved adhesion to wire, low liquid penetration for corrosion process, and improved performance in cold temperature.

(3) Maccaferri PoliMac is an environmentally safe extruded polymer specifically developed with an additional masterbatch, to provide increased resistance to abrasion and to mechanical damage, an improved performance in cold and hot temperatures, and a better performance to UV radiation. The properties of the Polimac coating are in accordance with BS EN 10245-1 : 2011.

(4) Polimac is a registered trademark.

1.5 The units come in two types: standard Green Terramesh, manufactured from mesh type 8 x 10 with a nominal core diameter of 2.7 mm; and a lighter version, Green Terramesh Light, manufactured from the same mesh type but with a 2.2 mm core wire diameter. Nominal dimensions of standard and Light units are given in Table 1.

Table 1 Standard sizes of Maccaferri Green Terramesh System units

L = length (m)		W = width (m)	H = height (m)/(slope angle°)	
Green Terramesh	Green Terramesh Light		Unit type a ⁽¹⁾	Unit type b ⁽²⁾
—	2.0	2.0 or 3.0	0.61 / (70°) 0.65 / (87°)	0.79 / (80°)
3.0	3.0			0.76 / (70°)
4.0	4.0			0.73 / (65°)
5.0	5.0			0.70 / (60°)
6.0	6.0			
7.0	—			
8.0	—			

(1) Type a unit can be assembled with any of the two height/face angle alternatives shown; the height is determined by the triangular brackets in position.

(2) Type b unit can be assembled with any of the four height/face angle alternatives shown; the height is determined by the tie rod position (see Figure 1).

Note : Non-standard sizes are available for special order with specific design requirements, to be checked with Certificate holder.

Wire mesh

1.6 The hexagonal mesh is manufactured from steel wire in accordance with BS EN 10218-1 : 2012 and BS EN 10218-2 : 2012.

1.7 The wire has a tensile strength in the range of 350 to 550 N·mm², with a minimum elongation at rupture of 8% and it is drawn from rods complying with BS EN ISO 16120-1 : 2017 and BS EN ISO 16120-2 : 2017.

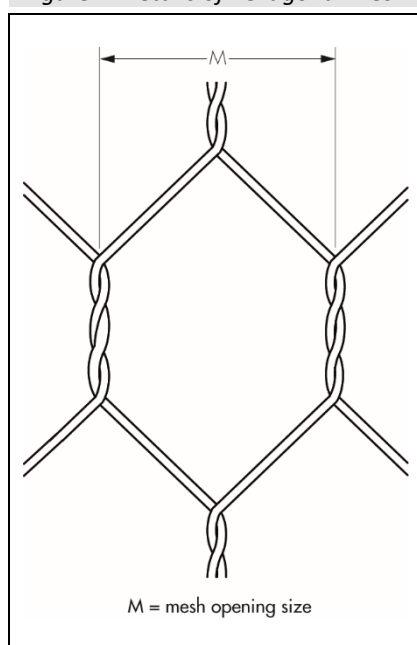
1.8 The base steel wire is coated with zinc or zinc-aluminium alloy in accordance with BS EN 10244-2 : 2011. The metallic coating is classified Class A, for PVC and PoliMac coated wire with nominal thickness of 0.5 mm, and Class E for PA6 coated wire with nominal thickness of 0.4 mm. Wire specifications are given in Table 2.

Table 2 Standard mesh wire specification

Wire type		Nominal diameter			Core tolerance (±mm)	Mesh opening size M (mm)	Min Zn or Zn-Al coating class A (g·m ²)	Min Zn or Zn-Al coating Class E (g·m ²)
		Overall diameter PVC or PoliMac coated wire (mm)	Overall diameter PA6 coated wire (mm)	Core diameter (mm)				
Mesh wire	8 x 10 (Light)	3.2	3.0	2.2	0.06	80	230	60
	8 x 10	3.7	3.5	2.7	0.06	80	245	60
Selvedge wire	8 x 10 (Light)	3.7	3.5	2.7	0.06	80	245	60
	8 x 10	4.4	4.2	3.4	0.07	80	265	60
Lacing		3.2	3.0	2.2	0.06	—	230	60

1.9 The wire is woven into a hexagonal pattern mesh (see Figure 2) with double-twist joints; larger diameter wire is introduced along the edge and selvedge.

Figure 2 Details of hexagonal mesh



1.10 Site assembly of the units is carried out using either stainless steel rings (see section 13) or lacing wire (see Table 2). Stainless steel rings are manufactured from 3 mm diameter stainless steel wire with a minimum tensile strength of 1550 MPa. The pull-apart strength of the lacing rings is a minimum of 2.0 kN.

2 Manufacture

2.1 The system units are manufactured, controlled and delivered to an agreed specification that includes requirements for incoming raw materials, method of production and process control, inspection and testing of finished product, and packaging and delivery to site.

2.2 Galvanized or zinc/aluminium alloy PVC, PoliMac or PA6 coated steel wires are manufactured by the Certificate holder or bought in to the specification defined by the Certificate holder. Certificates of conformity and/or mill certificates are supplied with each batch of bought-in wire.

2.3 As part of the assessment and ongoing surveillance of the product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.4 The management system of Maccaferri Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by CERTICOM/Slovak Republic (Certificate CM5620718/1). The management system of Maccaferri Ltd has also been certified by SGS UK for geotechnical design and supplying of retaining structures, erosion protection works, highway and bio-engineering systems (Certificate GB01/52789).

3 Delivery and site handling

3.1 The system units are delivered to site in bundles weighing from 600 to 700 kg, depending on unit size and mesh specification.

3.2 A label bearing the BBA logo incorporating the number of this Certificate, Certificate holder's name, batch number and product code is attached to each bundle.

3.3 All bundles must be handled with due care to avoid damage to the polymer coating. Individual panels can be manhandled, but the weight of individual units varies between 20 and 75 kg, and therefore the appropriate number of people required to lift the units must be assessed to satisfy manual lifting requirements.

3.4 The flat-pack units may be stored outdoors, but away from site traffic to avoid the risk of accidental damage, and should remain packaged until required.

3.5 Lacing wire is supplied in 25 kg coils.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the Maccaferri Green Terramesh System.

Design Considerations

4 Use

4.1 The Maccaferri Green Terramesh System is satisfactory for use as a lateral restraint for soil reinforcement in combination with slope face restraint on embankments with maximum slope angles of 70°. The system is also satisfactory for use in the construction of reinforced soil walls with slope angle above 70° and less than 87°, at the discretion of the TAA, where the Departmental Standard BD2 (DMRB 1.1) is appropriate.

4.2 Prior to the commencement of the work, the designer should satisfy the DETR, HE geotechnical certification requirements. For reinforced embankment projects in the UK, when designs are carried out by, or on behalf of the Certificate holder, they must be in accordance with the procedures given in HA 68/94 (DMRB 4.1.4) or BS 8006-1 : 2010.

4.3 Structural stability is achieved through frictional interaction and mechanical interlocking of soil particles with the system.

4.4 The system may be used in combination with soil types having an effective angle of shearing resistance in the range of 25° to 50° and where the design is in accordance with the procedures given in HA 68/94 (DMRB 4.1.4) and/or BS 8006-1 : 2010.

4.5 The system may also be used in combination with Linear Composites Paragrid, Paradrain or Paralink reinforcement geogrids (the subject of BBA Certificates 14/H213, 16/H249 and 03/4065) or other types of Maccaferri reinforcement geogrids. This combination was not assessed by the BBA and it is out of scope for this Certificate.

4.6 The system may also be used in combination with soil nailing or other ground anchor system. This combination was not assessed by the BBA and it is out of scope for this Certificate.

4.7 The designer should specify the relevant properties of a fill material deemed 'acceptable' for the purpose of the design. 'Acceptable' materials must meet the requirements of the MCHW, Volume 1 [supplemented by HA 68/94 (DMRB 4.1.4) and/or BS 8006-1 : 2010 as appropriate].

5 Practicability of installation

The system is designed to be installed by trained ground engineering contractors, experienced in both gabion and reinforced soil construction techniques, and in accordance with the specifications given in this Certificate.

6 Mechanical properties

Tensile strength

6.1 The short-term tensile strength (T_B)⁽¹⁾ of the system is:

$T_B = 50.0 \text{ kN}\cdot\text{m}^{-1}$ (Green Terramesh)

$T_B = 35.0 \text{ kN}\cdot\text{m}^{-1}$ (Green Terramesh Light).

(1) Tensile strength determined according to the procedures of BS EN 10223-3 : 2013.

Design load (T_D)

6.2 The maximum design load (T_D) that the reinforcement can be relied upon to deliver at the end of the design life and at the design temperature can be calculated from the equation:

$$T_D = \frac{T_B}{f_m}$$

where f_m is the partial factor for the reinforcement.

Partial Material factor (f_m)

6.3 In establishing the design tensile strength of the product and ensuring that during the life of the embankment the reinforcement will not fail in tension, the BBA recommends that, in line with the method given in HA 68/94 and BS 8006-1 : 2010, a set of partial safety factors should be applied to the base strength (T_B) value.

$$f_m = f_{m11} \times f_{m12} \times f_{m21} \times f_{m22}$$

Manufacture (f_{m11}) and extrapolation (f_{m12}) of data — partial safety factor (f_m)

6.4 To allow for variation in manufacture and product dimensions and to account for extrapolation of data, the value for the factor f_m is given in Table 3.

$$f_{m11} = 1.04 \text{ and } f_{m12} = 1.0$$

Table 3 Partial material safety factor — manufacture and extrapolation of data

Design life (years)	Safety factor (f_m)
120	1.04

Installation damage — partial safety factor (f_{m21})

6.5 To allow for loss of strength owing to mechanical damage that may be sustained during installation, the appropriate value for f_{m21} may be selected from Table 4. The partial safety factors given for site damage assume that well-graded material is used (coefficient of uniformity >5) and with a minimum compacted depth of 150 mm. For soils not covered by Table 4, appropriate values of f_{m21} may be determined from site specific trials.

Table 4 Partial material safety factor — mechanical installation damage (f_{m21})

Fill material	Maximum particle size (mm)	Safety factor f_{m21}
Silts and clays	<0.06	1.00
Sands	<2	1.00
Sandy gravels	<9.5	1.05
Coarse gravels	<38	1.15
Crushed stones	<200	1.22

Environmental effects — partial safety factor (f_{m22})

6.6 To account for environmental conditions, the appropriate value for f_{m22} may be selected from Table 5. For soils with pH values outside the range quoted, consideration should be given to an increased value for f_{m22} .

Table 5 Partial material safety factor — environmental effects

Soil pH level (pH)	Safety factor (f_{m22})
3-13	1.05

Fill/Terramesh System interaction

Bond strength

6.7 The pull-out resistance in granular soils ignoring cohesion can be determined from the equation:

$$F_{po} = 2\sigma_v\mu LB / f_p f_n$$

where:

- F_{po} is the ultimate pull-out resistance
- σ_v is the total ultimate vertical applied pressure
- μ is the coefficient of soil/reinforcement friction
- L is the length of the reinforcement in the resistant zone
- B is the width of the reinforcement
- f_p is the partial factor for pull-out resistance (see BS 8006-1 : 2010, Table 11)
- f_n is the partial factor for economic ramification of failure (see BS 8006-1 : 2010, Table 9).

Note:

$$\mu = a' \times \tan \phi'$$

where:

- a' is the interaction coefficient relating soil/reinforcement bond angle with $\tan \phi'$
- ϕ' is the internal friction angle of the structural soil.

Pull-out resistance has been verified for a range of materials by tests in accordance with BS EN 13738 : 2004. The results of the tests were analysed and used to establish the coefficients shown in Table 6.

Table 6 Typical values of coefficients relating to pull-out resistance

Fill material	ϕ (°)	$a'^{(1)}$	μ $= a' \tan \phi$
Silty sand	25	0.5	0.233
Sand	34	0.65	0.438
Gravel	38	0.9	0.703

(1) Average a' value of interaction factor determined from tests.

Note:

These values may be used in the equation above to establish the pull-out resistance for a particular situation but the resistances generated may deviate by $\pm 30\%$ of the value established by testing.

The characteristics of the fill materials used for determination of the interaction factors shown in Table 6 are given in Table 7.

Table 7 Characteristics of tested fill materials

Fill material	Bulk unit weight (kN/m ³)	Moisture content (%)	Sieve analysis (mm) (D50)
Silty sand	14.5	8	0.14
Sand	16.7	2	0.56
Gravel	16.9	<1	3.22

For soils not covered by Table 6, appropriate values of a' may be determined from site-specific tests to BS EN 13738 : 2004.

6.8 For routine design purposes, the coefficient of skin friction, a' , of the system may be assumed to be 0.6 for compacted frictional fill ($\phi \geq 30^\circ$). This is a conservative value. Where more precise values are required, for use in design, tests to BS EN 13738 : 2004 may be carried out using the appropriate soil and Maccaferri Terramesh System reinforcement mesh.

Direct sliding

6.9 When used in steep slopes, defined as from 45° to 70° from the horizontal, designed to HA 68/94 (permitted within BS 8006-1 : 2010, Clause 7.4.4.2), the direct sliding resistance of the system may be established from the value $f_{ds} \tan \phi'$ where f_{ds} is a direct sliding coefficient and determined as follows:

$$f_{ds} = \alpha_s a' + (1 - \alpha_s)$$

where:

α_s is the proportion of plane sliding area that is solid, 0.091 for the Terramesh System reinforcement mesh

a' is taken from Table 6 or established from site specific tests to BS EN 13738 : 2004. (Note: a' is referred to as f_{sf} in HA 68/94).

6.10 The designer should specify the relevant properties of the fill material for the reinforced soil structure deemed acceptable for the purposes of the design. Acceptable materials should meet the requirements of BS 8006-1 : 2010 and the MCHW, Volume 1, Series 600.

7 Resistance to weathering

7.1 Some localised damage may occur to the polymer coating during installation, and in exposed areas this may lead to corrosion of the mesh. Site evidence and test data indicate that such damage will not spread and not cause sequential corrosion underneath the intact adjacent area of mesh. The design of the wire mesh and the fact that the strength of the external facing mesh is not used in the design of the structure as a whole, indicate that this local damage will not affect the integrity of the structure.

7.2 The system will permit the growth of vegetation which will contribute to the integrity of the structure and to maintaining a natural appearance.

7.3 The polymer protection and galvanized or zinc/aluminium alloy coated steel wire will not be affected by the chemicals normally encountered in earth-retaining structures.

8 Maintenance and repair

Routine maintenance is not normally required; however, should the exposed mesh be damaged, additional or replacement panels can readily be fixed to the structure.

9 Durability

9.1 The system may be used in soils normally encountered in civil engineering practice.

9.2 Evidence from tests show that the polymer-coated wire has good resistance to chemical corrosion, bio-degradation, temperature effects and ultraviolet exposure.

9.3 In the opinion of the BBA, when used and installed in accordance with this Certificate, the system units may be considered to have a design life of 120 years.

10 Reuse and recyclability

The polymer-coated galvanized or zinc/aluminium coated steel wire can be recycled.

Installation

11 General

11.1 Installation of the Maccaferri Green Terramesh System must be carried out in accordance with this Certificate and the Certificate holder's installation instructions.

11.2 Provided the appropriate reduction factor for mechanical damage has been included at the design stage to allow for the installation methods employed and the type of fill permitted, the system can be readily installed following appropriate construction drawings.

11.3 Prior to and during installation, particular care must be taken to ensure that:

- site preparation and embankment construction are as detailed in sections 12 and 13
- fill properties satisfy the design specification
- drainage is adequate at all stages of construction, as required by the contract documents
- the system is protected against damage from site traffic and installation equipment
- the stability of existing structures is not affected.

11.4 Care must be exercised to ensure that the system is laid with the longitudinal direction of the reinforcement mesh panel, parallel to the direction of principal stress.

12 Preparation

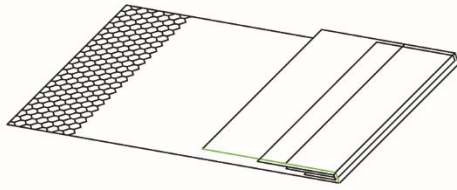
The formation is prepared by levelling and compacting the subgrade in accordance with the MCHW, Volume 1. The surface must be free of surface irregularities, loose material, organic or frozen matter and any other obstacles that may damage the polymer-coated wire mesh.

13 Procedure

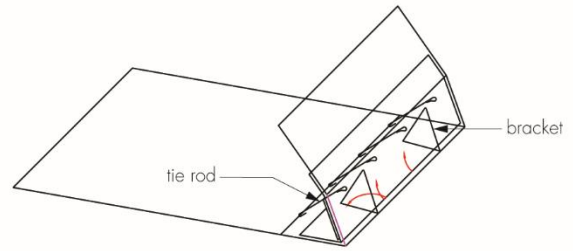
13.1 The system units are unfolded and the base mesh section is placed over the hard flat surface. Any creases not required for forming the box are pressed out and the installation procedure is commenced (see Figure 3).

Figure 3 Installation sequence

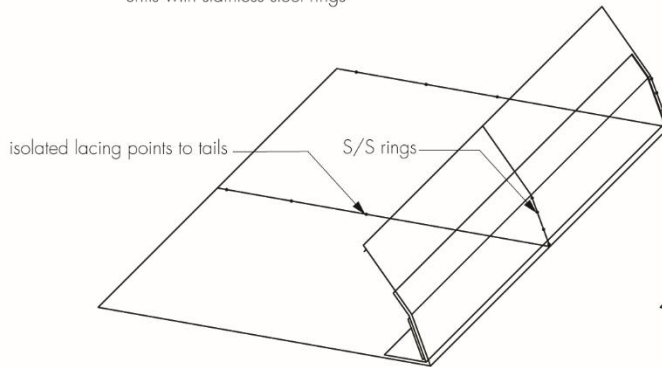
1. A single unit taken from the bundle folded ready for assembly



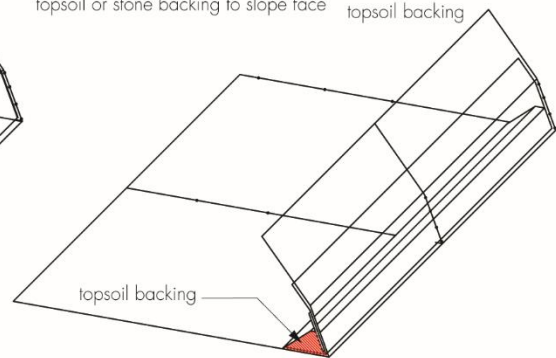
2. Placement and opening of the unit, face set to slope angle utilising integral brackets and loose tie rods



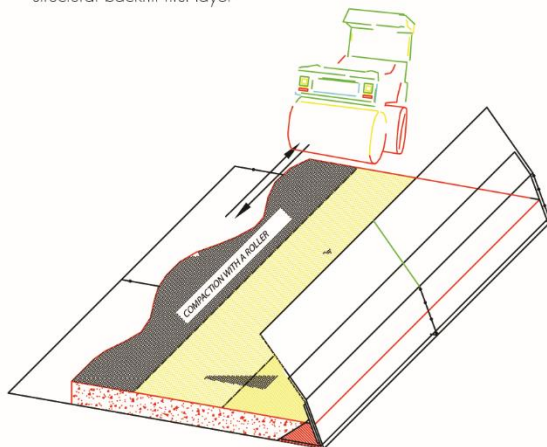
3. Connection between adjacent units with stainless steel rings



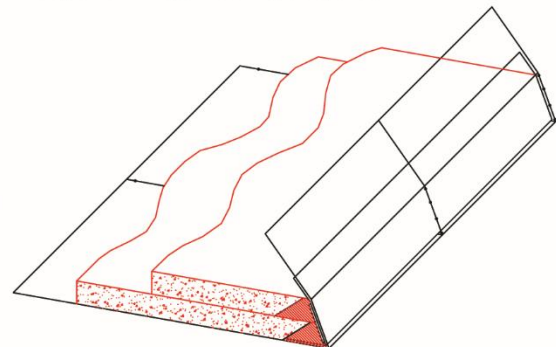
4. Commence filling with first layer of topsoil or stone backing to slope face



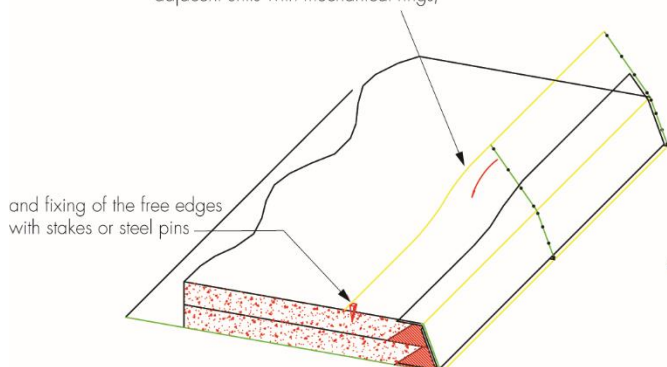
5. Backfilling and compaction of structural backfill first layer



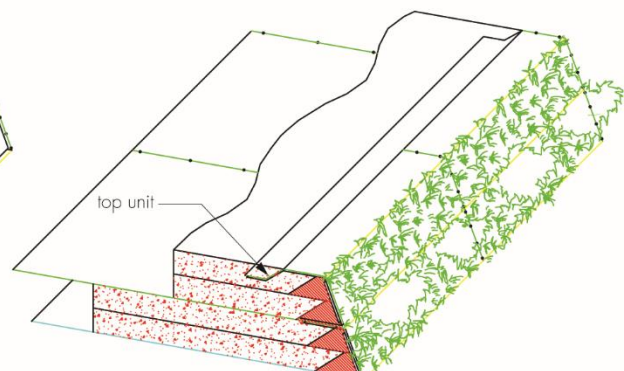
6. Structural backfilling progressed in layers sequential with topsoil backing to slope face



7. Folding of the lid (with lacing between adjacent units with mechanical rings)



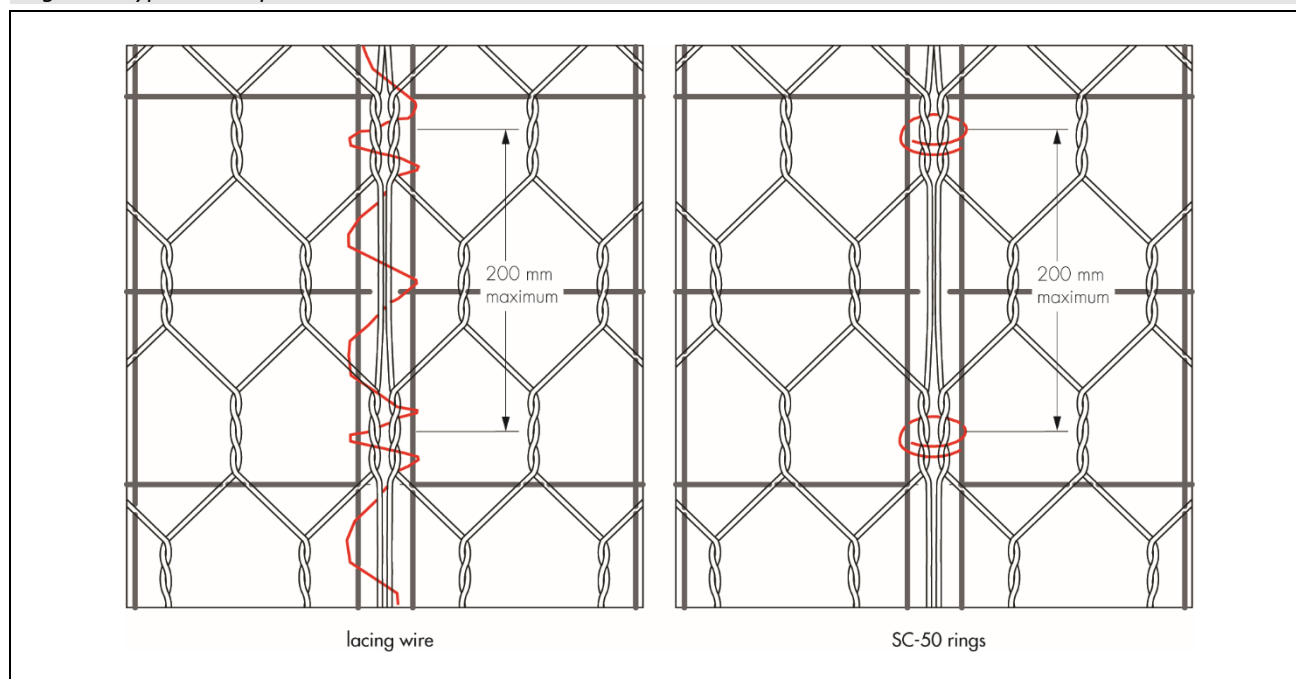
8. Lid of top unit turned down into fill



13.2 The pre-fitted triangular brackets are rotated to form the facing section of each unit and the required face angle is achieved by positioning the tie rods, connecting the welded mesh panel to the horizontal wire mesh panel.

13.3 The face panels of adjacent units are securely laced together (see Figure 4) and the reinforcing mesh 'tails' also connected to prevent displacement. Successive layers must be securely laced to the layer below.

Figure 4 Typical Face panel connection detail



13.4 Placement and compaction of the structural backfill must be carried out in accordance with BS EN 14475 : 2006 Section 8.5.4, and the MCHW, Volume 1 SHW, Series 600.

13.5 The design-specified fill is initially placed to a minimum depth of 150 mm, with particular care being taken to ensure that the polymer-coated reinforcing mesh panels are adequately covered before compaction or trafficking. Construction traffic can damage the unprotected system.

13.6 The fill must be fully compacted, in layers, to satisfy the design specification requirements. The thickness of compaction layers depends on the type of fill and compaction equipment employed, which must be determined according to the MCHW, Volume 1 SHW, Series 600, Clause 612.

13.7 For the placing of vegetative soil (topsoil) a 250 to 400 mm gap is left between the compacted fill and the facing mesh. Seeding is recommended during placement of this facing soil to promote early face vegetation establishment. Seeds should be of an appropriate mix for the local environment. The soil should be lightly compacted by foot or hand compactor. For mineral or stone facing layer, a 300 to 500 mm gap should be left between the compacted fill and the facing mesh. Stone face infill is normally sized between 100 and 200 mm and will depend on the welded panel mesh size; the minimum size will be controlled by the dimensions of the mesh. The stone fill must be of hard, durable stone as quarried or naturally occurring rounded stone.

Technical Investigations

14 Investigations

14.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

14.2 An assessment of data was made to determine:

- dimensional accuracy
- tensile strength

- quality of galvanized and zinc/aluminium alloy coatings
- performance of wire, mesh and filled gabions
- quality of PVC, PoliMac and PA6 coating
- ease of assembly
- durability.

14.3 Site visits were carried out to assess the practicability, ease of handling and installation under various site conditions.

14.4 An assessment was made of data pertaining to site case studies where the system has been in use for a number of years.

Bibliography

BS 8006-1 : 2010 + A1 :2016 *Code of practice for strengthened/reinforced soils and other fills*

BS EN 10218-1 : 2012 *Steel wire and wire products — General — Test methods*

BS EN 10218-2 : 2012 *Steel wire and wire products — General — Wire dimensions and tolerances*

BS EN 10223-3 : 2013 *Steel wire and wire products for fences — Hexagonal steel wire mesh products for civil engineering purposes*

BS EN 10244-2 : 2009 *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Zinc or zinc alloy coatings*

BS EN 10245-1 : 2011 *Steel wire and wire products — Organic coatings on steel wire— General rules*

BS EN 10245-2 : 2011 *Steel wire and wire products — Organic coatings of steel wire — PVC finished wire*

BS EN 13738 : 2004 *Geotextiles and geotextile-related products — Determination of pull-out resistance in soil*

BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*

BS EN ISO 9001 : 2015 *Quality management systems — Requirements*

BS EN ISO 16120-1 : 2017 *Non-alloy steel wire rod for conversion to wire — General requirements*

BS EN ISO 16120-2 : 2017 *Non-alloy steel wire rod for conversion to wire — Specific requirements for general-purpose wire rod*

BD 2/12 *Design Manual for Roads and Bridges Volume 1 : Highway Structures: Approval Procedures and General Design, Section 1 : Approval Procedures, Part 1 : Technical Approval of Highway Structures*

HA 68/94 *Design Manual for Roads and Bridges Volume 4 : Geotechnics and Drainage, Section 1 : Earthworks, Part 4 : Design Methods for the Reinforcement of Highway Slopes by Reinforced Soil and Soil Nailing Techniques*

IAN 124/11 *Use of Eurocodes for the design of highway structures*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works, Series 600 Earthwork.*

15 Conditions

15.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

15.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

15.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

15.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

15.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

15.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

MACCAFERRI CIVIL ENGINEERING PRODUCTS

MACCAFERRI GABIONS

This HAPAS Certificate Product Sheet⁽¹⁾ is issued by the British Board of Agrément (BBA), supported by Highways England (HE) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Government and the Department for Infrastructure, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies. HAPAS Certificates are normally each subject to a review every three years.

(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to Maccaferri Gabions, cages formed from hexagonal double-twisted mesh of polymer coated galvanized wire, used with selected fill material for retaining wall structures, river training works and erosion control, in both temporary and long-term applications.

CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- factors relating to compliance with Regulations where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Structural performance — the products, when used correctly in a fully designed application, will have adequate strength to resist the anticipated loads and the designed long-term performance (see section 6).

Resistance to weathering — the products will have adequate resistance to weathering (see section 7).

Durability — when used in accordance with the requirements of this Certificate, the polymer-coated gabions may be considered to have a life expectancy in excess of 120⁽¹⁾ years (see section 9).

(1) Excludes the effects of adverse abrasion.

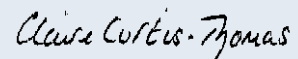


The BBA has awarded this Certificate to the company named above for the products described herein. These products have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément



Paul Valentine
Technical Excellence Director



Claire Curtis-Thomas
Chief Executive

Date of Second issue: 11 March 2019

Originally certificated on 22 June 2017

The BBA is a UKAS accredited certification body – Number 113.

The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk. Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct. Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

British Board of Agrément

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Requirements

The Highways Technical Advisory Committee has agreed with the BBA the aspects of performance to be used by the BBA in assessing Maccaferri Gabions.

In the opinion of the BBA, Maccaferri Gabions, when manufactured and installed in accordance with the provisions of this Certificate and the Department of the Environment, Transport and the Regions, Highways England (DETR, HE) Standard HD22 *Ground Investigations and Earthworks Procedure for Geotechnical Certification*, are suitable for use in short- and long-term applications including retaining wall structures, river training and erosion control.

The design, materials specification and construction methods adopted must be in accordance with the *Manual of Contract Documents for Highway Works* (MCHW)⁽¹⁾ Volume 1 *Specification for Highway Works* (SHW), BS 8002 : 2015, and BS EN 1997-1 : 2004 and its UK National Annex.

Additional site requirements may be included on particular projects.

(1) The MCHW is operated by the Overseeing Organisations: Highways England (HE), Transport Scotland, the Welsh Government and the Department for Infrastructure (Northern Ireland).

Regulations

Construction (Design and Management) Regulations 2015

Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See section: 3 *Delivery and site handling* (3.1, 3.3 and 3.4) of this Certificate.

Additional Information

CE marking

The Certificate holder has taken the responsibility of CE marking the products and their applications in accordance with ETA 15/0219. An asterisk (*) appearing in this Certificate indicates that data shown are given in the manufacturer's Declaration of Performance.

Technical Specification

1 Description

General

1.1 Maccaferri Gabions are cages formed from hexagonal double-twisted wire mesh panels made of galvanized (zinc-aluminium alloy) steel wire protected with PVC⁽¹⁾, PA6⁽²⁾ or PoliMac⁽³⁾⁽⁴⁾ polymer coating, fabricated into cage structures to be filled with selected granular material (gabion fill).

(1) PVC coating in accordance with BS EN 10245-2 : 2011.

(2) Maccaferri PA6 is an environmentally safe, extruded polyamide coating applied to galvanized mild steel wire to provide increased resistance against mechanical damage, low friction coefficients, long term strength and elasticity, improved adhesion to wire, low liquid penetration for corrosion process, and improved performance in cold temperature.

(3) Maccaferri PoliMac is an environmentally safe an extruded polymer specifically developed with an additional masterbatch, to provide increased resistance to abrasion and to mechanical damage, an improved performance in cold and hot temperatures, and a better performance to UV radiation. The properties of the Polimac coating are in accordance with BS EN 10245-1 : 2011.

(4) Polimac is a registered trademark.

1.2 The products are available in a wide range of standard sizes, as defined in Table 1. Non-standard sizes can be manufactured for specific design requirements.

Table 1 Standard sizes of Maccaferri Gabions fabricated from mesh with a core diameter of 2.7 mm

Length ⁽¹⁾ (mm)	Width ⁽¹⁾ (mm)	Height ⁽¹⁾ (mm)
1	1	0.5 or 1
1.5	1	0.5 or 1
2	1	0.5 or 1
3	1 or 2 or 3	0.5 or 1
4	1 or 2 or 3	0.5 or 1
5	2 or 3	0.5
6	2 or 3	0.5

(1) Values are given in ETA 15/0219.

Note: Non-standard sizes are available for special order with specific design requirements to be checked with the Certificate holder.

Wire mesh

1.3 The hexagonal double-twisted wire mesh is manufactured from steel wire in compliance with BS EN 10218-1 : 2012 and BS EN 10218-2 : 2012. The steel wire has a minimum tensile strength in the range of 350 to 550 N·mm², with a minimum elongation at rupture of 8%, and is drawn from rods complying with BS EN ISO 16120-1 : 2017 and BS EN ISO 16120-2 : 2017.

1.4 The metallic coating is classified Class A⁽¹⁾ for PVC and PoliMac coated wire with nominal thickness of 0.5 mm, and Class E⁽²⁾ for PA6 coated wire with nominal thickness of 0.4 mm. Wire specifications are given in Table 2.

(1) Class A coating, as defined in BS EN 10244-2 : 2009, Table 2, relates to the highest coating thickness.

(2) Class E coating, as defined in BS EN 10244-2 : 2009, Table 2, for which corrosion resistance must be at least equivalent to that of zinc coating to Class B in BS EN 10244-2 : 2011, Table 1.

Table 2 Standard mesh wire specification

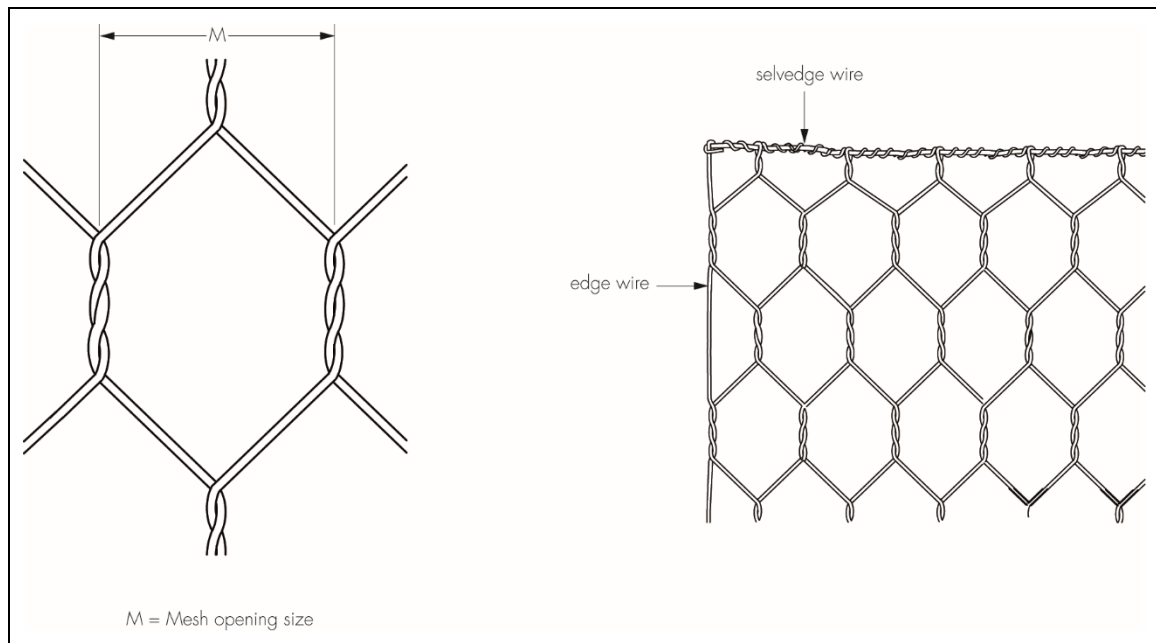
Galvanized wire without polymer coating ⁽¹⁾		Galvanized wire with PVC, PA6 or PoliMac coating ⁽²⁾	Minimum Zn or Zn-Al coating Class A	Minimum Zn-Al coating for PA6 coated wire Class E
Nominal diameter (mm)	Tolerance (mm)	Nominal diameter (external) (mm)	(g·m ²)	(g·m ²)
2.0	± 0.05	3.0	215	60
2.2*	± 0.06*	3.2*	230*	60
2.4*	± 0.06*	3.4	230*	60
2.7*	± 0.06*	3.7*	245*	60
3.0*	± 0.07*	4.0	255*	60
3.4*	± 0.07*	4.4*	265*	60
3.9*	± 0.07*	4.9	275*	60

(1) Manufacturing reference: 8 x 10 mesh type.

(2) Values are given in ETA 15/0219.

1.5 The wire is woven into a hexagonal pattern mesh (see Figure 1) with double-twist joints. Larger diameter wire is introduced along the edges to create the selvedge at cut ends.

Figure 1 Details of hexagonal mesh



1.6 A gabion unit is fabricated from a base panel, two end panels and diaphragm panels (as appropriate, see Figure 2). To form these panels, the mesh is cut, during manufacture, to the required dimensions and selvedge wire positioned and mechanically fixed to the base panel. The gabion end panels are fixed to the base panel. Diaphragm panels, where provided, are connected to the base panel. The fabricated unit is conveniently folded, then packed into bundles for delivery.

1.7 Items used with the products, but outside the scope of this Certificate, include:

- gabion filling material
- backfill material.

1.8 An ancillary item for use with the products is lacing wire.

1.9 The Maccaferri Pneumatic Fixing Tool is a mechanical device for crimping stainless steel or galvanized steel Flex-C rings to the polymer-coated mesh or the galvanized steel mesh, respectively. Stainless steel rings are manufactured from 3 mm diameter stainless steel wire with a minimum tensile strength of 1550 MPa. Galvanized steel rings are manufactured from 3 mm diameter stainless steel wire with a minimum tensile strength of 1720 MPa, and coated with 255 g·m⁻² of Zn or Zn/5%Al. The pull-apart strength of the lacing rings is minimum of 2.0 kN.

2 Manufacture

2.1 The products are manufactured from galvanized steel wire, with or without polymer-coating, which is either manufactured by the Certificate holder or bought in to the Certificate holder's specification. Certificates of conformity and/or mill certificates are supplied with each batch of bought-in wire.

2.2 Maccaferri Gabion end panels and diaphragms have a selvedge wire along their upper edges. The cut ends are mechanically selvedged with a wire of greater diameter than that used for the mesh (see Table 2 and Figure 1).

2.3 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control being operated by the manufacturer are being maintained.

2.4 The management system of Maccaferri Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by CERTICOM/Slovak Republic (Certificate CM5620718/1). The management system of Maccaferri Ltd has also been certified by SGS UK for geotechnical design and supplying of retaining structures, erosion protection works, highway and bio-engineering systems (Certificate GB01/52789).

3 Delivery and site handling

3.1 The gabions are delivered to site in bundles weighing from 600 to 900 kg, depending on unit size and mesh specification. A label bearing the Certificate holder's name, the batch and product code numbers, and the BBA logo incorporating the number of this Certificate, is attached to each bundle.

3.2 The products may be stored in the open, but away from site traffic to avoid the risk of accidental damage, and should remain packaged until required.

3.3 All bundles must be handled with due care to avoid damage to the polymer coating. Individual units can be manhandled. Individual units vary in weight between approximately 10 and 75 kg, and the appropriate number of people required to lift the units must therefore be assessed to satisfy manual lifting limits.

3.4 Lacing wire is supplied in 25 kg coils.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Maccaferri Gabions.

Design Considerations

4 Use

4.1 Maccaferri Gabions, used with selected fill materials, are satisfactory for use as retaining wall structures, river training and erosion control, in both short- and long-term applications. Where required by the overseeing authority, the gabions must be protected by the use of environmental barriers, as recommended in HE 85/01.

4.2 The design of structures using Maccaferri Gabions should be carried out by a suitably qualified engineer in accordance with BS EN 1997-1 : 2004, BS 8002 : 2015 and BS 6031 : 2009.

4.3 The design of the gabion structures must be based on the principle of mass gravity earth-retaining walls. Additional allowances may be made to account for the effect of the wire mesh.

4.4 The magnitude and distribution of the earth pressures and earth resistance should be calculated in accordance with current design practices and available guidelines.

4.5 As with other earth-retaining structures, it is necessary to ensure by design that a suitable factor of safety is achieved against the following potential modes of failure:

- overall stability
- overturning
- shearing pressure
- sliding
- internal stability.

4.6 The designer should specify the relevant properties of both the gabion stone fill and backfill material (placed behind the cages) as deemed 'acceptable' for the purpose of the design. 'Acceptable' materials must meet the requirements of the MCHW, Volume 1 SHW.

4.7 The density of filled gabions depends on both the granulometric curve of the filling stones and the installation procedures: generally it should be taken as 60 to 70% of the density of the solid material. A higher value may be

appropriate in certain circumstances, but this will be the responsibility of the consulting engineer who must ensure that the design value is achieved on site.

4.8 The stone infill of the gabions is normally sized between 100 and 200 mm and will depend on the mesh size, the lower limiting size being controlled by the dimensions of the mesh. The fill should satisfy the requirements of the MCHW, Volume 1 SHW, Class 6G⁽¹⁾. The fill must be a hard, durable material, eg stone as quarried or naturally occurring rounded stone (in accordance with BS EN 13383-1 : 2002).

(1) The MCHW, Volume 1, Series NG 600 *Earthworks*.

4.9 Gabion walls can be constructed with a minimum radius of curvature of 25 m on plan without modification of the gabion structure.

4.10 Watercourse linings, weirs and/or other hydraulic or erosion protection structures may require special consideration in regard to scour, uplift, wave action, seepage, etc.

4.11 The specification of the mesh for the gabions should be chosen to achieve the required design life (see section 9).

5 Practicability of installation

The products are designed to be installed by a competent general builder, or contractor, experienced with these types of products, and are easily installed under normal site conditions.

6 Structural performance

6.1 When installed in accordance with the Certificate holder's installation guidelines and this Certificate, the gabions have adequate strength to resist all loads associated with handling, positioning and filling.

6.2 Gabion walls are permeable and, in general, will not allow hydrostatic pressure to build up behind the wall. Gabion earth-retaining structures are not normally designed to withstand hydrostatic pressure.

6.3 Where cohesive material, such as clay, is retained, water movement may cause it to exude into the gabion structure and block the passage of water. To reduce the risk of a build-up of hydrostatic pressure in these conditions, it may be necessary to provide additional granular layers behind the gabion structure to allow water to drain away.

6.4 Maccaferri Gabion cages have adequate strength to permit pre-filling and placing by crane, carried out in accordance with the Certificate holder's instructions.

7 Resistance to weathering

7.1 Some localised damage may occur to the polymer coating during installation and in exposed areas this may lead to local corrosion of the mesh. Site evidence and test data indicate that such damage will not spread and will not cause sequential corrosion underneath the intact adjacent area of mesh. The design of the wire mesh, and the fact that the strength of the external facing mesh is not used in the design of the structure as a whole, indicate that this local damage will not affect the integrity of the structure.

7.2 A gabion wall is a mass earth-retaining structure and settlement may occur under the action of its self-weight. The movement associated with this will gradually increase the density of the structure and reduce the volume of voids. Additional settlement may occur when gabions are founded on weak soils.

7.3 A gabion wall will permit the growth of vegetation, which will contribute to the integrity of the structure and to maintaining a natural appearance.

8 Maintenance and repair

Routine maintenance is not normally required; however, should the exposed gabion be damaged, additional or replacement panels can readily be fixed to the structure.

9 Durability

9.1 For a particular installation environment, the most appropriate Maccaferri mesh wire coating specification may be selected in accordance with BS EN 10223-3 : 2013, Annex A, to satisfy the required project design life.

9.2 Evidence from tests show that the polymer-coated, Zn-Al alloy galvanized wire, has good resistance to chemical corrosion, bio-degradation, temperature effects and ultraviolet exposure and will not be affected by the chemicals normally encountered in earth-retaining structures.

9.3 The life of a gabion structure is dependent on the quality of the mesh, the durability of the stone fill and, in the longer term, the stability of the consolidated mass of the infill material and the conditions of exposure encountered during the structure's design life.

9.4 In the opinion of the BBA, when used and installed in accordance with this Certificate, the polymer coated gabions may be considered to have a design life in excess of 120 years.

9.5 The Certificate holder can advise on the life expectancy of products used in river erosion and coastal protection schemes and the design of such installation if required to optimise the performance of the system.

10 Reuse and recyclability

The products are made from polymer-coated (PVC, PA6 or PoliMac), galvanized (zinc-aluminium alloy) steel wire, which can be recycled.

Installation

11 General

11.1 Installation of Maccaferri Gabions must be in accordance with this Certificate and the Certificate holder's installation instructions.

11.2 Prior to and during installation, particular care must be taken to ensure that:

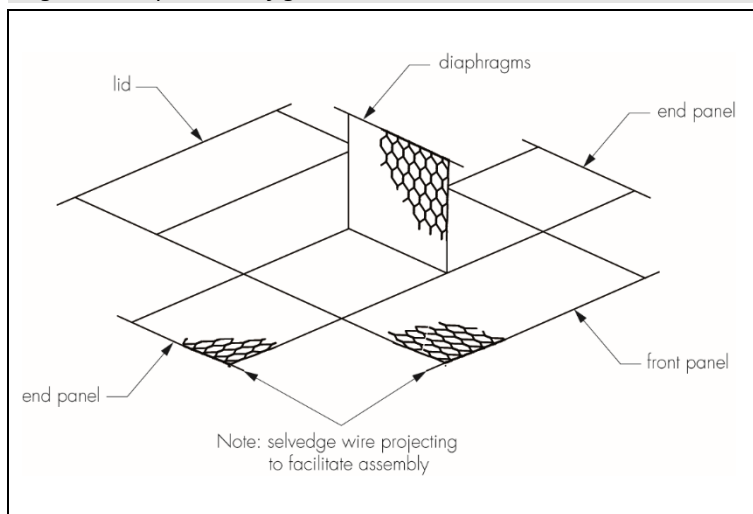
- site preparation and gabion foundation are in accordance with the contract drawings
- gabion construction is as detailed in section 12
- fill properties (gabion stone and backfill) satisfy the design specification
- drainage is adequate at all stages of construction, as required by the contract documents
- the system is protected against damage from site traffic and installation equipment
- the stability of existing structures is not affected.

12 Procedure

In-situ filled gabions units

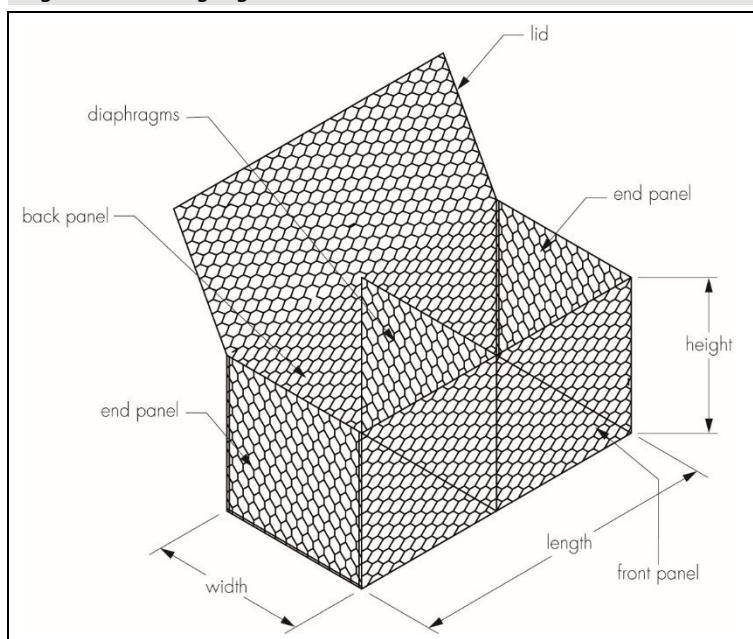
12.1 The flat-packed gabion cages are opened and folded on a hard surface, pressing out any unwanted creases (see Figure 2).

Figure 2 Preparation of gabion boxes



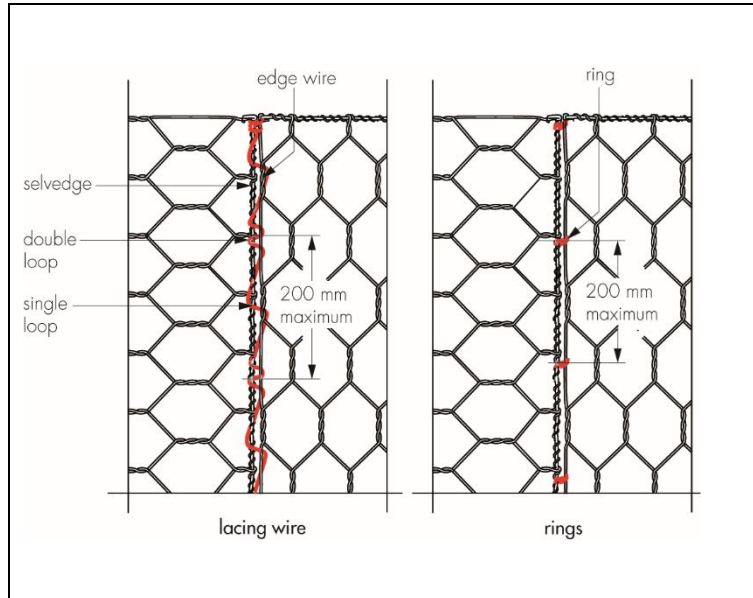
12.2 The front and rear sides, ends and diaphragm are lifted into position to form a box shape (see Figure 3).

Figure 3 Forming a gabion box



12.3 Top corners are secured with the projecting lengths of thick selvedge wire. Vertical edges are then joined together, starting from the top, using either the appropriate lacing wire, in a continuous operation with alternate single and double twists, or with rings applied using the Maccaferri Pneumatic Fixing Tool (see Figure 4).

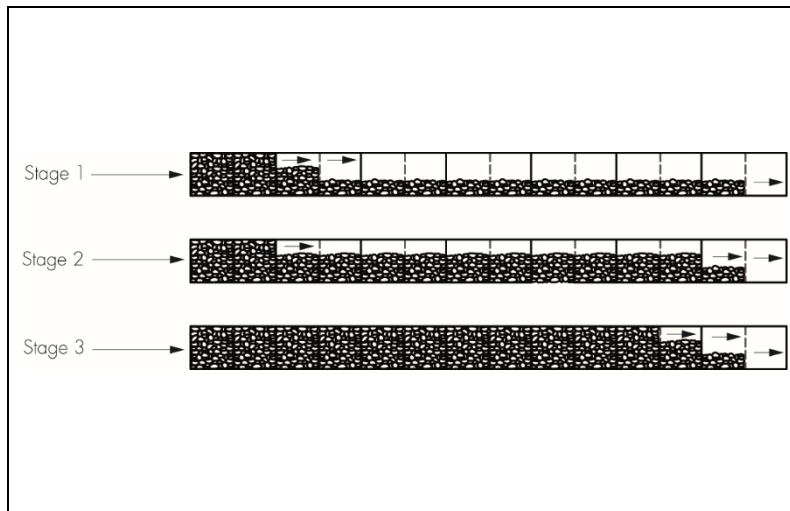
Figure 4 Typical Wiring pattern



12.4 A number of empty gabions are placed in position on a flat surface and secured together as described in section 12.3.

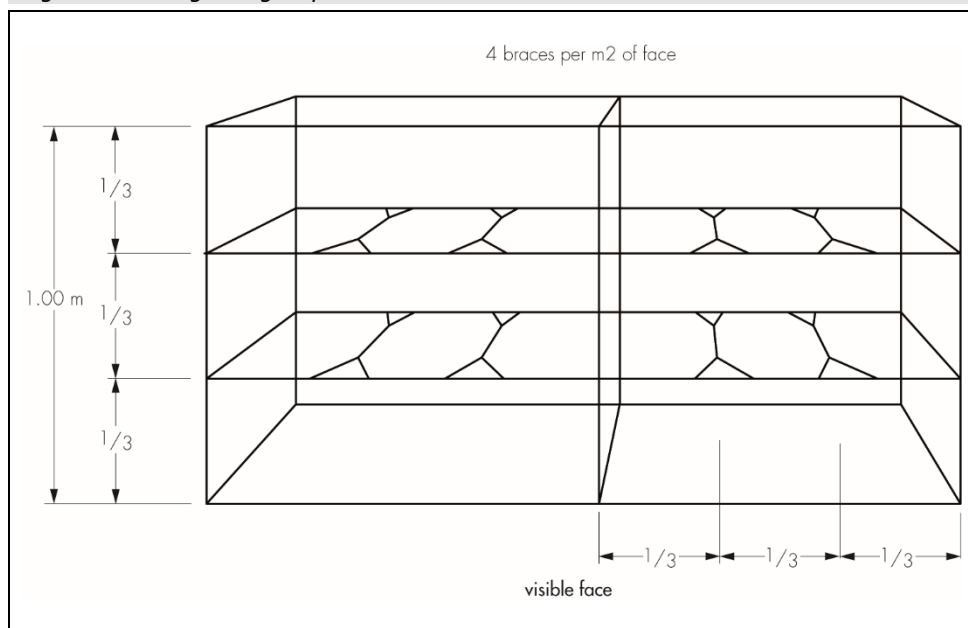
12.5 The gabions are filled progressively, in one third height layers, with suitable stone. To ensure a good finished appearance, all visible faces should be carefully hand-packed. Gabions should be overfilled to allow for natural settlement of the rock fill, see Figure 5.

Figure 5 Filling Sequence



12.6 Gabions forming the exposed face of a structure should be filled to one-third height, braced from front to rear with bracing wires (lacing wire) located as shown in Figure 6, then filled to two-thirds height and again braced (see Figure 6). Four bracing wires should be provided for each square metre of visible face. Filling may then be completed.

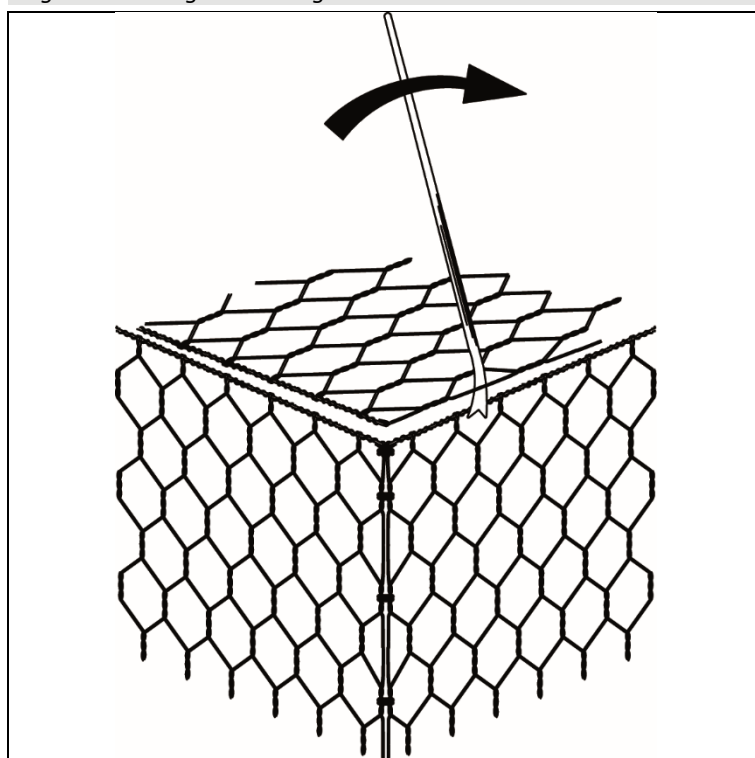
Figure 6 Bracing Filling Sequence



12.7 When considered necessary for aesthetic or other considerations, the gabion may be filled whilst under tension. Gabions are tensioned by applying a load, distributed over the full end panel of a row of gabions, to the first cell which has been anchored in position. An external frame may also be used.

12.8 On completion of the gabion cage filling, the mesh lid is folded down, stretched into position and laced to the top of the front and side panels/adjacent gabion, and the top of any diaphragms.

Figure 7 Closing the lid on gabions



12.9 The remaining row of gabions is then filled sequentially in the same manner.

12.10 It is essential that each gabion is properly secured to adjacent gabions above, below and on each side, using the lacing wire as described in section 12.3.

Pre-filled gabions units

12.11 The Certificate holder should be contacted for specific advice on the pre-filling procedure.

12.12 Prefilled Gabion units [traded under the name Readymac⁽¹⁾ or Cubiroc⁽¹⁾] are constructed as described in sections 12.1 to 12.9, but with double loop lacing throughout. It is advantageous to construct a slightly oversized frame within which the empty unit can be held, stretched taut during filling. For example, Cubiroc units are filled using a special frame combined with a shaking table to ensure that the stone are compacted by vibration.

(1) Readymac and Cubiroc are registered trademarks.

12.13 During the filling operations, reinforcing steel bars or lifting straps are included to maintain the shape of the gabion during lifting.

12.14 Purpose-made lifting frames and slings must be used for lifting the filled units, which weigh up to 1.8 tonnes per cubic metre.

Technical Investigations

13 Investigations

13.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

13.2 An assessment of data was made to determine:

- dimensional accuracy*
- tensile strength*
- quantity of galvanized coating*
- the effect of tolerances
- strength of wire, mesh and filled gabions
- quality of materials
- quality of plastic coating
- ease of assembly
- compliance with the MCHW, Volume 1, Clause 262
- specification (see sections 1.1 and 5.1)
- design procedures
- strength of the lifting frame
- durability effect of site damage
- equivalent performance of zinc-aluminium alloy steel and galvanized coated wire.

13.3 Site visits were carried out to assess the practicability, ease of handling and installation under various site conditions.

Bibliography

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BS EN 10223-3 : 2013 *Steel wire and wire products for fencing and netting — Hexagonal steel wire mesh products for civil engineering purposes*

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ETA 15/0219 *European Technical Assessment- Hexagona Woven Mesh Gabion Boxes and Mattresses, version 01 of 07/04/201*

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14 Conditions

14.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
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14.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

14.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

14.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

14.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

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