An Environmental Product Declaration

According to ISO 14025:2006 and ISO 21930:2017

A company-specific cradle-to-gate EPD for
American Ground Screw, Inc. (AGS) Ground Screws

ASTM International Certified Environmental Product Declaration

This document is a Type III environmental product declaration (EPD) for four (4) AGS's ground screws, as manufactured at its facility in China and delivered to AGS's North American distribution facility in Des Moines, IA.

This declaration has been prepared in accordance with ISO 14025 (1), ISO 21930 (2), ISO 14040/44 (3), (4), and ASTM's General Program Instructions for Type III EPD (5).

The intent of this document is to further the development of environmentally compatible and more sustainable construction methods by providing comprehensive environmental information related to potential impacts of AGS's ground screws in accordance with international standards.

Environmental Product Declaration Summary

General Summary	
EPD Owner	**American Ground Screw, Inc.** 512 Tuttle St. Des Moines, IA 50309 Link (URL): https://www.americangroundscrew.com/ American Ground Screw's (AGS's) factory has been at the forefront of ground screw manufacturing since 2006. AGS' ground screws are manufactured in China and distributed in Europe and North America. North American distribution is completed from a distribution terminal in Des Moines, IA. *The owner of the declaration is liable for the underlying information and evidence.*
Production Locations	Huanghua City Junfeng Hardware Co., Ltd. Qi Jiawu Village, Cangzhou Huanghua City, Hebei Province, China
Product Group and Names	Ground screws (Model 3): IM3316, IM3320, IM34516 and IM34520
Product Group Definition	A ground screw serves as a permanent foundation solution. The declared ground screws are designed to have a pipe inserted into the ground screw and secured with three bolts.
Product Category Rules (PCR)	ISO 21930:2017 serves as the core PCR (2).
Certification Period	12/05/2023 – 5-year validity
Declared Unit	One (1) piece of ground screw
ASTM Declaration Numbers	EPD 456

EPD and Project Report Information	
Program Operator	ASTM International
Declaration Holder	American Ground Screw, Inc.

Declaration Type

A “Cradle-to-gate” production stage EPD for AGS’s ground screw products. Production stage activities include the raw material supply, transport, and manufacturing (modules A1 to A3). The declaration is intended for Business-to-Business (B-to-B) communication.

Applicable Countries

United States and Canada

Product Applicability

AGS’s ground screws provide a permanent foundation solution. Declared ground screws can be used for solar ground mounting systems, fences, decks, temporary structures, and tie backs.

https://www.americangroundscrew.com/product/ground-screw-model-3/

Content of the Declaration

This declaration follows Section 9; Content of an EPD, ISO 21930 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services (2).

This EPD was independently verified by ASTM in accordance with ISO 14025 and ISO 21930:

Internal	External
	X

Tim Brooke, ASTM International

The Project Report *Note that this Project Report is not part of public communication (ISO 21930, 10.1).*	A Cradle-to-Gate Life Cycle Assessment of AGS Ground Screw Products, April 2023 (6).
Prepared by	Lindita Bushi, Ph.D., Jamie Meil, and Grant Finlayson Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org www.athenasmi.org
This EPD project report was independently verified to be in accordance with ISO 14025, ISO 14040/44, and ISO 21930 by:	Thomas P. Gloria, Ph.D. Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA

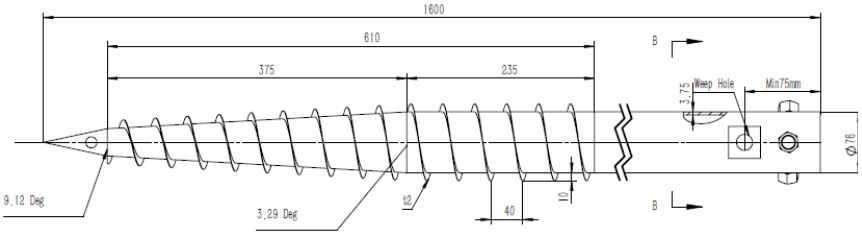
Figure 1 Ground screw illustration

1 PRODUCT IDENTIFICATION

1.1 PRODUCT DEFINITION AND SPECIFICATIONS

A ground screw is designed to be twisted into the soil and thereafter serve as a permanent foundation podium. *The ground screw is composed of a pipe pile with spiral blades welded on the surface of the metal pipe after hot forging* (7). This LCA study focuses on four declared ground screws fabricated at AGS's facility located in China. *All ground screws are made of Q235B steel and, the chemical composition and mechanical properties meet the requirement of Q235B Grade in GB/T 700, corresponding to the Round Structural Tubing of Grade A of American standard ASTM A500, hot dip galvanizing is adopted for surface treatment. The grade of galvanized layer meets the FB grade in GB/T 2518 and corresponds to the grade of Grade 75 in Table 2 of ASTM A123* (7).
Additional product properties and characteristics for each ground screw type can be viewed and downloaded from AGS's website: https://www.americangroundscrew.com/product/ground-screw-model-3/. Figure 1 shows an illustration of a model 3 ground screw product.

Table 1 Ground screw specifications

Product description	IM3316 Ground Screw	IM3320 Ground Screw	IM34516 Ground Screw	IM34520 Ground Screw
Material	Q235B[1)]	Q235B	Q235B	Q235B
Surface finish	HDG[2)]	HDG	HDG	HDG
Diameter x length (mm)	76 × 1600	76 × 2000	114 × 1600	114 × 2000
Pipe wall thickness (mm)	3.75	3.75	3.75	3.75
Screw thread pitch (mm)	40	40	40	40
Screw thread thickness (mm)	2	2	2	2
Screw thread width (mm)	10	10	10	10
Model 3 ground screw drawing illustration				
ICC Approvals	ICC[3)]	ICC	ICC	ICC
Applications	Solar ground mounting systems; Fences; Decks; Temporary structures; Tie Backs			
Installation	These ground screws are designed to have a pipe inserted into the ground screw and secured with three bolts.			

Notes to Table 1:
[1)] Q235 is a low-carbon steel that is used throughout China. As mild steel, Q235 is utilized in production without heat treatment. The Q designates the yield point, and the 235 indicates the yield strength. It has good plasticity and weldability. Q235B is made up of an iron (Fe) base with the addition of carbon, C (0.20%), silicon, Si (0.35%), manganese, Mn (1.40%), phosphor, P (0.045%) and sulphur, S (0.045%).
[2)] HDG stands for hot dipped galvanized.

[3)] ICC stands for International Code Council (ICC) approved. An ICC-ES Evaluation Report is a document that presents the findings, conclusions, and recommendations from a particular evaluation. ICC-ES Reports verify that new and innovative building products comply with code requirements. ICC-ES Reports providing information about what code requirements or acceptance criteria were used to evaluate a product, and how the product should be identified, installed and much more. The American Ground Screw evaluation report (ESR-4226) can be downloaded from the AGS website https://www.americangroundscrew.com/code-compliance/.

2 DECLARED UNIT

The declared product is one (1) piece of the ground screw as manufactured at AGS's facility in China – see Table 2.

Table 2 Declared unit per ground screw

Declared Products	IM3316 Ground Screw	IM3320 Ground Screw	IM34516 Ground Screw	IM34520 Ground Screw
Declared unit	1 piece	1 piece	1 piece	1 piece
Mass (kg/piece)	11.93	14.70	17.81	21.99

3 MATERIAL COMPOSITION and COMPONENT CONTENT

Table 3 Material composition and component content per ground screw (in %)

Materials	IM3316 Ground Screw	IM3320 Ground Screw	IM34516 Ground Screw	IM34520 Ground Screw
Pipe Pile (welded tubes), Q235B	89.6%	91.5%	91.3%	93.0%
Spiral Blade (screw blade), Q235B	8.5%	6.9%	8.3%	6.7%
Nuts, carbon steel	1.9%	1.6%	0.4%	0.4%
Finished product mass	100.0%	100.0%	100.0%	100.0%

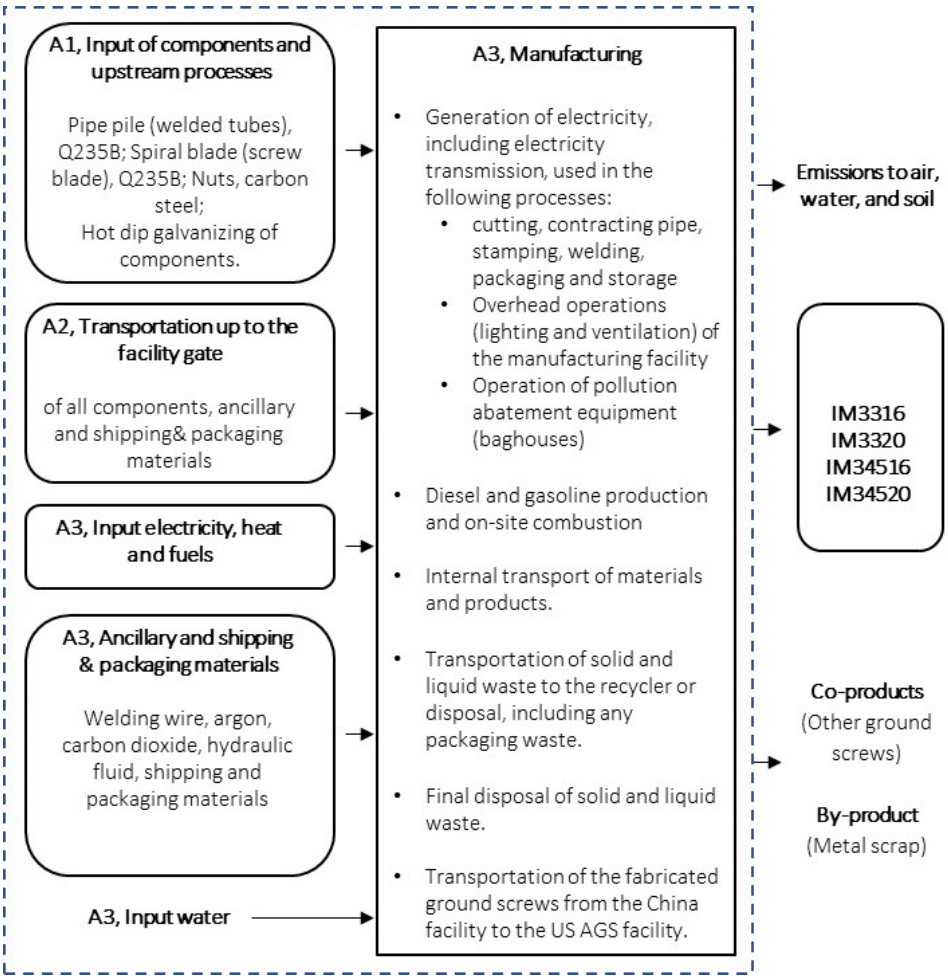
4 LIFE CYCLE STAGES

Figure 2 shows the life cycle stages and information modules that are included within the cradle-to-gate LCA system boundary of this EPD. The boundary is "cradle-to-gate," which includes the *Production stage* (A1 to A3 modules). *Construction, Use, and End-of-Life stages* - are excluded from the system boundary. The *Production stage* system boundary is shown in Figure 3. Per ISO 21930, 7.1.7.2.1 (2), *the system boundary with nature (natural environment) includes those technical processes that provide the material and energy inputs into the system and the subsequent manufacturing and transport processes up to the to the factory gate, as well as the processing of any waste arising from those processes.* For this EPD, transport from China to the distribution center in the US is included in Module A3.

Figure 2 Life Cycle Stages and Modules

Production stage			Construction stage		Use stage							End-of-life stage			
Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X			MND												
X- module is included in system boundary; MND- module is not declared (excluded from system boundary)															

Figure 3 Production stage (module A1 to A3) system boundary of AGS Ground Screws



5 LIFE CYCLE INVENTORY

5.1 DATA COLLECTION, SOURCES, AND CALCULATIONS

Primary gate-to-gate LCI manufacturing and input transportation data were collected for ground screw components for the reference year 2021.

Data calculation procedures follow ISO 14044 (4), and ISO 21930 (2). The LCA model was developed using SimaPro v.9.4 2023 (8). SimaPro LCA software contains recognized databases (e.g., ecoinvent v3.8, 2021 database, Allocation, Cut-off by classification, Industry data 2.0, 2019, and U.S. LCI Database, 2015) that provide LCI datasets for upstream, core, and downstream material and processes. SimaPro 9.4 2023 also contains the U.S. EPA TRACI v2.1 2012 LCIA methodology, CML-baseline version 4.7 2016 LCIA methodology, and the Cumulative Energy Demand, LHV (NCV) version 1.0 November 2018 which are used for this LCA study. Per ISO 21930, 7.2.2 (2), when transforming the inputs and outputs of combustible material into inputs and outputs of energy, the net calorific value (lower heating value) of fuels is applied according to scientifically based and accepted values specific to the combustible material.

5.2 DATA QUALITY REQUIREMENTS AND ASSESSMENTS

A detailed description of collected data and the data quality assessment regarding the ISO 14044 (4) and ISO 21930 (2) is provided in the LCA project report. Data quality is assessed based on its representativeness (technology coverage, geographic coverage, time coverage), completeness, consistency, reproducibility, transparency, and uncertainty (Table 4).

Table 2. Data Quality Requirements and Assessments

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing technology at AGS's manufacturing facility in China. Whenever available, for all upstream and core material and processes, technological specific or average industry LCI datasets were utilized. *Technological representativeness is characterized as "high".*
Geographic Coverage	The geographic region considered is Global. The geographic coverage of all LCI databases and datasets is provided in the LCA report. Whenever available, for all upstream and core material and processes, geographic specific LCI datasets were utilized). *Geographical representativeness is characterized as "high".*
Time Coverage	Gate-to-gate activity data are representative as of 2021. - Generic data: the most appropriate LCI datasets were used as found in the ecoinvent v.3.8 database, 2021, Industry data 2.0, 2019, and U.S. LCI Database 2015.

Data Quality Requirements	Description
Completeness	All relevant, specific processes, including inputs (raw materials, energy, and additives) and outputs (emissions and production volume) were considered and modeled in the framework of this EPD project. The relevant background materials and processes were taken from the ecoinvent v.3.8 database, 2021, Industry data 2.0, 2019, and U.S. LCI Database 2015, and modeled in SimaPro LCA software v.9.4, 2023 (8). The completeness of the cradle-to-gate process chain in terms of inputs/outputs is rigorously assessed and benchmarked for the product of interest.
Consistency	To ensure consistency, the input/output LCI modeling of the ground screws used the same LCI modeling structure, which consisted of input raw, secondary (if applicable), ancillary and packaging materials, intermediate products, energy flows, water resource inputs, product outputs, co-products, emissions to air, water and soil, and solid and liquid waste disposal. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the facility level to maintain a high level of consistency.
Reproducibility	Internal reproducibility is possible since the data and the models are stored and available in Athena AGS LCI database developed in SimaPro, 2023. A high level of transparency is provided throughout the reviewed LCA report as the LCI profile is presented for each of the declared products. Key primary (manufacturer specific) and secondary (generic) LCI data sources are summarized in the LCA Report.
Transparency	Activity and background LCI datasets are transparently documented in the LCA report, including data sources. Data are rounded to an appropriate number of significant digits (2 to 5).
Uncertainty	A *sensitivity check* was conducted to assess the reliability of the reported LCA results and conclusions by determining how they are affected by value choices in the data or assumptions on calculation of LCIA and energy indicator results. The sensitivity check includes the results of the sensitivity analysis and Monte Carlo uncertainty analysis.

5.3 ALLOCATION RULES

The manufacturing facility produces various ground screws as well as a limited number of non-ground screw products and as such allocation was necessary. “Mass” based, plant specific data for 1-piece of declared ground screw were used to calculate the input raw, shipping and packaging materials consumed. “Mass” was used as the physical parameter for allocating flows between the products of interest and other co-products to calculate the input energy flows (electricity, and fuels), ancillary materials used at the facility, total water consumption, process emissions to air and water and waste flows. No environmental burden or credit is allocated to the by-product (metal scrap) of the declared ground screws. The LCI modeling accounts for the manufacturing yield of all upstream and on-site processes. In addition, allocation related to transport is based on the mass of transported inputs and outputs.

5.4 CUT OFF RULES

The cut-off criteria as per ISO 21930, 7.1.8 (2) were followed. All input/output data collected at the AGS's facility were included in the LCI modelling developed using SimaPro v.9.4 2023 (8). None of the input/output data were excluded based on the cut-off criteria. The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory. None of the input/output was knowingly excluded from the system boundary. This EPD excludes the following processes:

- Capital goods and infrastructure, and
- Personnel related activity (travel, furniture, office operations and supplies).

6 LIFE CYCLE ASSESSMENT RESULTS

Table 5 presents the "cradle-to-gate" LCA results present the cradle-to-gate LCA results per ISO 21930 for the four ground screws of interest. As per the US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), version 2.1, 2012 **(9)** impact categories are used as they provide a North American context for the mandatory category indicators to be included in this EPD.

These are relative expressions only and do not predict category impact endpoints, the exceeding of thresholds, safety margins or risks (4). Per ISO 21930, 7.1.7.1 (2), "individual indicators for information modules A1, A2 and A3 may be aggregated to a total for each indicator in the production stage."

Table 3. Production stage (A1-A3) EPD results for 1-piece of Ground Screw

Impact category and inventory indicators	Unit	IM3316	IM3320	IM34516	IM34520
Global warming potential, GWP 100[1)]	kg CO_2 eq	**43.5**	**53.1**	**65.9**	**80.1**
Ozone depletion potential, ODP[1)]	kg CFC-11 eq	**1.9E-06**	**2.3E-06**	**2.9E-06**	**3.5E-06**
Smog formation potential, SFP[1)]	kg O_3 eq	**3.16**	**3.87**	**4.81**	**5.87**
Acidification potential, AP[1)]	kg SO_2 eq	**0.166**	**0.203**	**0.253**	**0.308**
Eutrophication potential, EP[1)]	kg N eq	**0.027**	**0.033**	**0.046**	**0.053**
Fossil fuel depletion, FFD[1)]	MJ surplus	**27.9**	**34.0**	**43.3**	**52.2**
Abiotic depletion potential, fossil ADPf[2)]	MJ LHV	**477.8**	**583.3**	**724.7**	**881.7**
Renewable primary resources used as an energy carrier (fuel), RPR_E	MJ LHV	**7.96**	**9.66**	**13.25**	**15.54**
Renewable primary resources with energy content used as material, RPR_M[3)]	MJ LHV	**0**	**0**	**0**	**0**
Non-renewable primary resources used as an energy carrier (fuel), $NRPR_E$	MJ LHV	**485.9**	**593.3**	**738.9**	**898.4**
Non-renewable primary resources with energy content used as material, $NRPR_M$[4)]	MJ LHV	**0**	**0**	**0**	**0**
Secondary materials, SM[5)]	kg	**1.03**	**1.26**	**1.53**	**1.87**
Renewable secondary fuels, RSF[6)]	MJ LHV	**0**	**0**	**0**	**0**
Non-renewable secondary fuels, NRSF[7)]	MJ LHV	**0**	**0**	**0**	**0**
Recovered energy, RE[8)]	MJ LHV	**0**	**0**	**0**	**0**
Consumption of freshwater, FW[9)]	m^3	**1.6E-02**	**1.7E-02**	**4.2E-02**	**4.0E-02**
Hazardous waste disposed, HWD[10)]	kg	**4.3E-04**	**5.3E-04**	**6.4E-04**	**7.9E-04**
Non-hazardous waste disposed, NHWD[11)]	kg	**3.2E-02**	**4.0E-02**	**4.8E-02**	**5.9E-02**
High-level radioactive waste, conditioned, to final repository, HLRW[12)]	m^3	**5.3E-09**	**6.6E-09**	**1.0E-08**	**1.2E-08**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW[13)]	m^3	**6.0E-07**	**7.3E-07**	**9.1E-07**	**1.1E-06**
Components for re-use, CRU[14)]	kg	**0**	**0**	**0**	**0**
Materials for recycling, MR[15)]	kg	**0.340**	**0.358**	**0.452**	**0.475**
Materials for energy recovery, MER[16)]	kg	**0**	**0**	**0**	**0**
Recovered energy exported from the product system, EE[17)]	MJ LHV	**0**	**0**	**0**	**0**

Notes:

[1)] Calculated as per U.S EPA TRACI 2.1, v1.06, SimaPro v 9.4 GWP-100, excludes biogenic CO_2 removals and emissions associated with any biobased products, including bio-based packaging. There is no biogenic content in the declared products. CO_2 emissions from calcination and carbonation are not applicable to the declared products; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5), TRACI 2.1, v1.05 (9). FFD is required in LEED v4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations (10).

[2)] Calculated as per CML-IA Baseline v3.05, SimaPro v 9.4. ADP_f is also required in LEED v4.1 MR2 Credit: Building Product Disclosure and Optimization – Environmental Product Declarations (10).

[3)] Calculated as per ACLCA ISO 21930 Guidance (11), respective sections 6.2 to 10.8.

[4] It should be noted that the foreground system (ground screw manufacturing process) does not generate any HLRW or ILLRW. High, intermediate, or low-level radioactive waste is generated by electricity production (spent fuel from reactors, routine facility maintenance and operations)" (ISO 21930:2017, clause 7.2.14). High-level radioactive waste, e.g., when generated by electricity production, consists mostly of spent fuel from reactors." (ISO 21930:2017, clause 7.2.14).

7 INTERPRETATION

Across all the declared ground screws, Module A1 Extraction and upstream material input production contributes the largest share of the LCIA category and energy indicator results – accounting for between 21% (ODP) and 84% (RPRE) of the potential environmental burdens. Module A2 Transportation contribution ranges between 19% (ODP) to 3% (EP) of the overall potential impact of ground screw production stage. Module A3 Manufacturing contributed 12% to 15% to GWP-100 and is the second largest contributor (<20%) to the overall potential environmental impacts of ground screw manufacture.

The top contributors to Production stage GWP-100 effects across all ground screws, in descending order are: A1, steel welded pipe production (61% to 64%); A1, spiral blade production (9% to 11%); A3-2 transport of finished ground screw from China to the AGS facility in the US (11%), A1, hot dip galvanizing (6% to 9%), and A3-1 Manufacturing (fabrication) of the ground screws at the facility in China (4 to 5%)

8 ADDITIONAL ENVIRONMENTAL INFORMATION

- AGS's ground screws are ICCC certified.

9 DECLARATION TYPE

This "cradle-to-gate" EPD applies to American Ground Screws foundation system as available in North America. Production activities covered include the extraction and upstream production, transport to factory, and manufacturing (inclusive of final product transport from China to the US). The declaration is intended for use in Business-to-Business (B-to-B) communication.

The four declared ground screws fall under the description:

- *A product-specific EPD, from one (1) manufacturer's plant*.

10 EPD COMPARABILITY LIMITATION STATEMENT

The following ISO 14025 and ISO 21930 statements indicate the EPD comparability limitations and intent to avoid any market distortions or misinterpretation of EPDs.

- *Environmental declarations from different programmes may not be comparable* (1).
- Only EPDs prepared from cradle-to-grave life cycle results and based on the same function, Reference Service Life, quantified by the same functional unit, and meeting all the conditions for comparability listed in ISO 14025:2006 and ISO 21930:2017 can be used to comparison between products.

11 REFERENCES

1. ISO 14025: 2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

2. ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.

3. ISO 14040/Amd1:2020 Environmental Management – Life Cycle Assessment – Principles and Framework, International Organization for Standardization, 2006.

4. ISO 14044/Amd1:2017/Amd2:2020 Environmental Management – Life Cycle Assessment – Requirements and guidelines, International Organization for Standardization, 2006.

5. ASTM Program Operator for Product Category Rules (PCRs) and Environmental Product Declarations (EPDs), General Program Instructions, v8, 04/29/20.

6. ASMI 2023, A Cradle-to-Gate Life Cycle Assessment of AGS Ground Screw Products, April 2023 (56pp).

7. AGS 2020, Quality Control Manual, Files No.: QCM-2018-12/R1, Original Issue Date: 20181114, Revise Date: 20200206, QCM Holder: AMERICAN GROUND SCREW INC., Manufacturing Plant: Huanghua City Junfeng Hardware Co., Ltd. Product Evaluated: Ground Screw.

8. PRé 2023. SimaPro LCA Software v9.4, 2023., https://simapro.com/.

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10. LEED v4.1, MRc2: Building product disclosure and optimization, Environmental Product Declarations,. https://leeduser.buildinggreen.com/credit/NC-v4.1/MRc2#tab-credit-language .

11. ACLCA 2019, Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017. The American Centre for Life Cycle Assessment. May, 2019.