A proposal for the landslide damage questionnaire in suburban areas

Uroš Đurić, Biljana Abolmasov, Miloš S. Marjanović, Sanja Jocković, Miloš D. Marjanović

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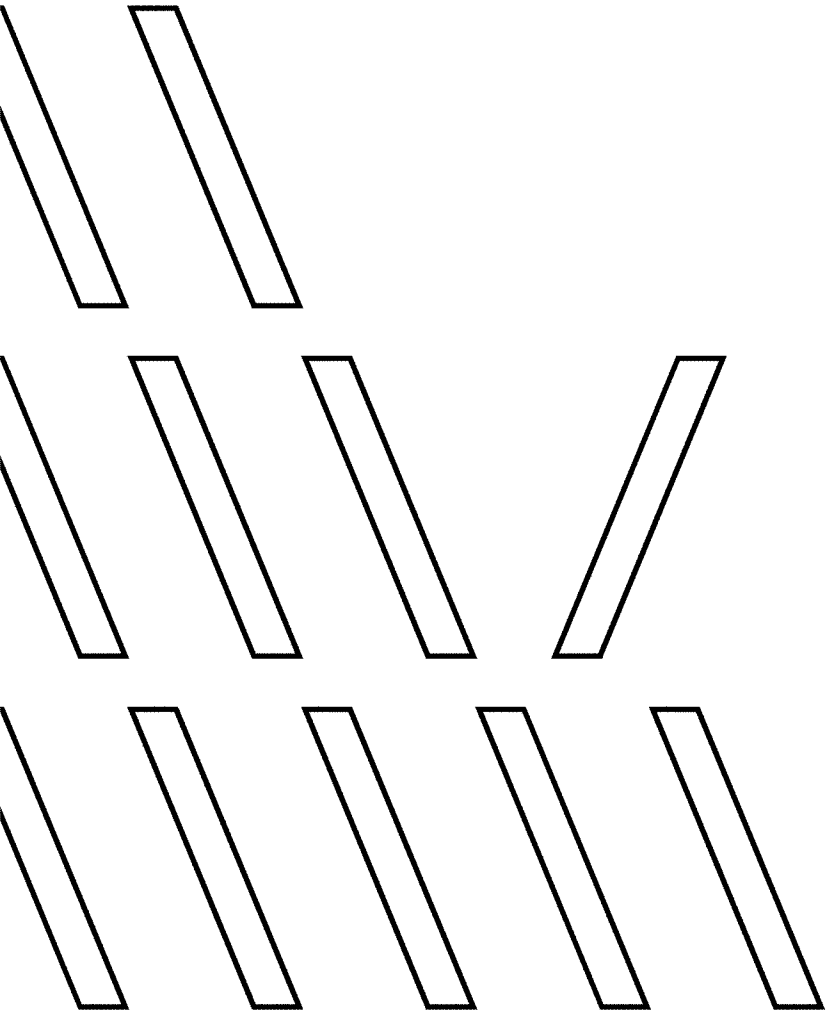
5TH REGIONAL SYMPOSIUM ON LANDSLIDES
IN ADRIATIC-BALKAN REGION

Landslide Modelling & Applications

Proceedings of the 5th ReSyLAB



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Landslide Modelling & Applications

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Landslide Modelling & Applications

Proceedings of the
5th Regional Symposium on Landslides
in the Adriatic-Balkan Region

Croatian Landslide Group
University of Rijeka, Faculty of Civil Engineering
University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering

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Foreword

The Regional Symposium on Landslides in the Adriatic-Balkan Region (ReSyLAB), organized under the auspices of the International Consortium on Landslides (ICL), has reached its fifth edition. This is an important milestone for ICL and for its Adriatic-Balkan Network (ABN).

Ten years ago, the ICL has encouraged the establishment of thematic and regional networks in the framework of its ten-year strategic Plan. The ABN was promptly launched in 2012, gathering together scientists, researchers, engineers, professionals and decision-makers, from the Adriatic and Balkan region and elsewhere, concerned with landslide hazard and risk, their reduction and impact on society.

Today we can say that this has proved to be a successful strategy and the ABN is perhaps the best example of successful regional network. Since its foundation in the year 2012, the ABN has regularly organized its regional symposium every two years, dedicated to specific issues, in various countries of the Adriatic-Balkan area: Croatia, Serbia, Slovenia, Bosnia and Herzegovina and Croatia again.

Participation has gradually expanded to other countries, throughout Europe and elsewhere. This year the Symposium sees the participation of scientists from ten countries, providing an effective platform to achieve fruitful cooperation among landslide researchers.

The ReSyLAB represents a successful contribution to the Kyoto Landslide Commitment (KLC2020) launched by ICL in the year 2020 for the global promotion of understanding and reducing landslide disaster risk. The main purpose of the KLC2020 is to build a common platform for sharing ideas, good practices and policies with key actors and stakeholders concerned with landslide risk at the global level. One of the main priority actions of KLC2020 is to facilitate and assess progresses through the organization of meetings at the regional and national level, to take place in respective countries, in order to show deliveries and performances made towards the achievement of objectives for landslide risk reduction on a global scale.

The general theme of the 5th ReSyLAB is "Landslide Modelling & Applications", which clearly shows the close interplay between scientific research and its application in the engineering practice and for supporting risk reduction policies.

For these reasons, I am convinced that the example of the ABN and the ReSyLAB should be valued and exported in other geographical contexts.

Nicola Casagli
President of the International Consortium on Landslides
Florence, Italy

Foreword

The International Consortium on Landslides (ICL) was established in January 2002 in Kyoto, Japan, to promote landslide research for the benefit of society and the environment, and capacity building, including education, notably in developing countries.

In January 2005, the second UN World Conference for Disaster Reduction was organized in Kobe, Japan. ICL, UNESCO, WMO, UNU, IAHS etc. jointly organized a thematic session on Landslides (IPL) and Floods (IFI). The Letter of Intent on Earth System Risk Analysis and Sustainable Disaster Management was agreed in the session and signed by global partners (ICL, UNESCO, WMO, FAO, UNU, UN-ISDR, ICSU, WFEO within 2005. Participants included Professors Ognjen Bonacci from Croatia, Kyoji Sassa, Hideaki Marui, and Kaoru Takara from Japan.

In January 2006, ICL and its global partners (UNESCO, WMO, FAO, UNU, UN-ISDR, ICSU, WFEO etc.) organized the Round Table Discussion for the IPL and adopted the 2006 Tokyo Action Plan strengthening research and learning on landslides and related earth system disasters for global risk preparedness. In 2007, Science and Technology Research Partnership for Sustainable Development (SATREPS) program to promote international joint research for global issues based on the needs of developing countries was founded by the Government of Japan. This programme was very timely to promote the 2006 Tokyo Action Plan. The Croatia-Japan Joint SATREPS Project "Risk identification and land-use planning for disaster mitigation of landslide and floods in Croatia" was proposed in 2007 and accepted as one of the initial SATREPS projects in 2008.

In order to support this SATREPS project, the Ministry of Foreign Affairs of Japan organized a workshop in Tokyo aiming at regional cooperation in South-Eastern Europe on disaster management by inviting Professors Željko Arbanas, Matjaž Mikoš, Snježana Mihalić, Biljana Abolmasov, Sabid Zekan and others from Adriatic-Balkan Region on 14-17 December 2010. This workshop contributed to the establishment of the Adriatic-Balkan Network of International Consortium on Landslides (ICL ABN) in January 2012 and also its biannual regional symposium; the 1st ReSyLAB in March 2013 in Zagreb (Croatia), the 2nd in May 2015 in Belgrade (Serbia), the 3rd in October 2017 in Ljubljana (Slovenia) and the 4th in October 2019 in Sarajevo (Bosnia and Herzegovina), and 5th in March 2022 in Rijeka (Croatia). The ICL has launched the Open Access Book Series "Progress in Landslide Research and Technology" for Kyoto Landslide Commitment 2020 which is published twice a year. I wish to invite all participants of this symposium to contribute articles to this new open access book series. The target readers of the book series are practitioners and other stakeholders who apply in practice the most advanced knowledge of science and technology for landslide disaster risk reduction. Articles must be written in a simplified way easily understandable by practitioners and stakeholders.

The Adriatic-Balkan Network of International Consortium on Landslides (ICL ABN) is the most successful network of the ICL and its biennial symposium and its publication contributed to boost the regional potentials for reducing landslide disaster risk. I am very grateful for this tremendous effort to organize the fifth regional symposium of the International Consortium on Landslides. I wish the Adriatic-Balkan network a very successful meeting and a very good publication.

Kyoji Sassa
Secretary-General of the International Consortium on Landslides
and the Kyoto Landslide Commitment 2020
Editor-in-Chief of the Open Access Book Series of the ICL
Kyoto, Japan

Preface

The 5th Regional Symposium on Landslides in Adriatic-Balkan Region (ReSyLAB) will be held in the year of two important anniversaries: 20 years of establishing of International Consortium on Landslides (ICL) and 10 years of establishing regional and thematic networks of ICL. The regional Adriatic-Balkan Network (ABN) is one of the most active networks and this 5th ResyLab2015 will contribute to regional cooperation and widening the Network by the new members in the region. Just for reminder, the 1st ReSyLAB was held in Zagreb, Croatia, 2013; 2nd ReSyLAB in Belgrade, Serbia; 3rd ReSyLAB in Ljubljana, Slovenia and 4th ReSyLAB in Sarajevo, Bosnia and Herzegovina. The 5th ReSyLAB will be held three years after the last Symposium, disrupting the biannual schedule due to Covid-19 pandemic and will be held as hybrid event, but we believe that this will not diminish the significance of this Symposium.

This book contains peer-reviewed papers that will be presented at the 5th Regional Symposium on Landslides in the Adriatic-Balkan Region entitled "Landslide Modelling & Applications". The Symposium will be held in Rijeka, Croatia from March 23th to 26th, 2022. A wide range of landslide topics are presented in the Symposium sessions that include landslide monitoring, landslide investigation, landslide mapping, landslide susceptibility zonation, laboratory testing, physical and numerical modelling of landslides and landslide case studies. This collection of papers is beneficial to practitioners, researchers and other professionals dealing with landsides. The proceedings reflect the ongoing response of researchers and practitioners from 10 countries from the region and around the world. Unfortunately, the Covid-19 pandemic situation disables landslide scientists from Japan that were present at all previous ReSyLABs, to join us in Rijeka.

We would like to thank all authors and participants for sharing their ideas and research results in the area of landslide science and practice. We wish to acknowledge the help from all the reviewers in advising and refining the contributions to their final version published in this book.

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A proposal for the landslide damage questionnaire in suburban areas

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Abstract Landslides are one of the most often natural disasters that have an extensive impact on society including loss of life, destruction of infrastructure and properties, damage to land and loss of natural resources. Landslide losses can significantly vary and they depend on a variety of different criteria such as the size and type of landslide, lithological setting of terrain, the terrain slope gradient, the quality of materials used for construction, and the construction typology. Damage from landslides is usually characterized as either direct or indirect and in most questionnaires only the data referring to the direct damage is collected. In this paper, a landslide damage questionnaire that can be used for landslide damage characterization and determination of landslide hazard and risk in urban areas is proposed. The questionnaire contains 11 groups of questions that include all necessary fields for gathering the data which is essential for both landslide hazard and risk estimation. It was used as an inventory landslide damage form in suburban housings which usually occupy larger land plots, while objects built on such plots are mostly houses for an individual living or ancillary type.

Keywords survey, property, landslide, risk, assessment

Introduction

A landslide damage questionnaire is a crucial tool for landslide risk management. Cooper (2008) provided an overview of various distinct methodologies for mapping facilities damaged by landslides and subsidence, as well as a recommendation for a new hybrid version of the methodology. Corominas et al. (2014) suggest general guidelines for designing a landslide damage questionnaire based on the size area of the research. In contrast, Palmisano et al. (2016) provide a more extensive description of the methodology for landslide damage assessment using the survey approach (2016). Finally, in Uzielli et al. (2008) and Peduto et al. (2017) successful examples of landslide damage assessment are provided.

There is no official form (census sheet or questionnaire) for the Republic of Serbia that can be used to quickly and precisely identify landslide-damaged objects (with damage classification and assessment). This issue is relevant in Serbia and in international practice, in contrast to the earthquake damage assessment (EMS98), which is very well established and recognized internationally (Cooper, 2008).

For example, after the extreme precipitation, which was followed by catastrophic floods that occurred in Serbia in May 2014, the Unique Methodology for the Assessment of Losses from Natural Disasters (Official Gazette of SFRY no. 27 of 10 April 1987) was used by the official expert teams for the flood damage assessment. According to this methodology, all buildings and facilities, regardless of their purpose, are classified into five categories of damage, which are the consequences of earthquakes. Therefore, amendments to the same methodology were made for the 2014 flood damage assessment, while landslide damage was not defined, although a large number of objects and facilities were affected by the landslide processes that occurred during and after the flood events (Marjanović et al. 2017).

Materials and Methods

Case study

Umka landslide area is selected for testing the landslide damage questionnaire, as a typical example of landslide in suburban areas. Umka landslide is the most systematically investigated and largest populated landslide in Serbia. Umka landslide mechanism was defined by Abolmasov et al. (2012), Abolmasov et al. (2015), while most details about the Umka landslide were described in Đurić et al. (2018) and Đurić (2020).

Although the landslide is well-known and occasionally mentioned in public and mass media, certain population migration in that area is still evident. Besides constant landslide movement, some new objects with permanent residents are still being built, even within the most active and most affected part of the landslide. This is probably caused by significantly lower market prices of households and plots in this area. The last inventorying and damage classification on objects was performed during 1990, when a map and a brief report of the damaged objects (with the type of foundation, walls, and category of an object) was created (Vujanić et al. 1992, 1995). During that investigation, the local water system was mapped and the population was evaluated using the most recent census

data. Even though the last inventorying was performed 30 years ago, the vulnerability of the population is present, as a consequence of unplanned and illegal construction works during and after 2005, when all construction works have been officially forbidden (for the most active parts of the landslide). Furthermore, previous inventorying didn't include the information about households, working population and life habits which are necessary data for the risk estimation. Given the foregoing, there was a need for a proposal of the new questionnaire and survey methods that should result with the updated inventory of all objects within the landslide area.

Questionnaire

According to Palmisano et al. (2016), the main objectives and guidelines for landslide damage assessment are to quickly acquire the relevant information that can be used for landslide hazard assessment, especially if they are collected in combination with the geotechnical monitoring data and according to geodynamical and morphological settings of the terrain; to form the database that will be used for the landslide risk assessment. The guidelines mentioned above were essential for forming the questionnaire proposal and included a survey research method and data about constructions and their damage assessments collected directly on the field.

The proposal of a new questionnaire was based on the fact that most objects will be inspected visually by noticing the damage that has occurred on small individual houses, cottages, ancillary objects etc. The data collected for the Umka landslide had to be sufficient for the level of advanced landslide risk assessment proposed by Fell et al. (2008), and for both direct and indirect losses The Highway Institute - Belgrade's questionnaire from 1990 (Vujanić et al. 1992, 1995) served as a basis for the development of the questionnaire proposal that consists of 11 main question groups. Tables 1 & 2 show an example of a blank questionnaire proposal, while brief description of each question group is described in the following lines.
The groups of questions were as follows:

1. General information about the object / facility
2. Information about the construction
3. Damage to the construction
4. Information about the foundation
5. Information about household members
6. Damage assessment (brief estimation)
7. Emergency and temporary interventions
8. Possibility of damage repair
9. Information about water supply, sewage, surface and groundwater at location
10. Object or facility damage sketch
11. Other observations

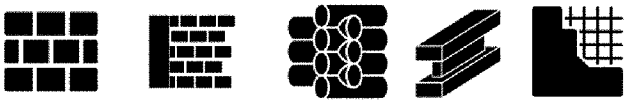
General information about the object / facility

This group of questions contains the basic information about the surveyed object like owner or tenant, address of the object, cadastral parcel, year of the construction, estimated lifespan, object coordinates, etc. If the object was extended or modified, here it should be noted. According to our practice, owners usually report a smaller useful surface than it is in reality if the object is illegally constructed or extended. Considering that fact, the approximate useful surface should be estimated by the surveyor. For estimating the value of the property, the last known tax record for the property can be noted here (if it is shared with the surveyor by the owner). It is very important for the surveyor to adequately categorize the object by its main purpose which can be of various typological types (Fig. 1). Information about storeys and number of vehicles that are used by the household should be noticed as well. The questionnaire design proposal for this group of question is shown in section 1 of Table 1.

Fig. 1 Typology of most common types of objects by the purpose: residential house or cottage, garage, commercial, greenhouse and barn

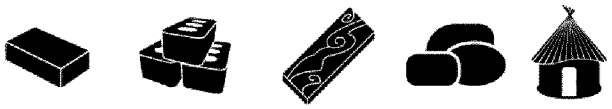
Information about construction

Questions and predefined answers about the object construction (above ground) are shown in section 2 of Table 1. If the object was built using the different types of materials or construction types, the most dominant should be used as primary selection. Besides construction typology, it was important to include questions about roof geometry and dominant wall material. Some examples of typological selections that are proposed within this group of questions are shown in Fig. 2.



Most common typology of object construction: load bearing walls; masonry; timber framing; steel framing; RC

Most common typology of object roof type: flat; inclined; curved; unfinished/plate; without roof



Most common typology of dominant wall material: masonry brick; hollow clay block; wood; masonry stone; cane/mud

Fig. 2 Typology of most common types of object construction, roof type and dominant wall material

Damage to the construction

For the objects damage classification purposes, it is generally recommended to use the EMS-98 earthquake damage classification and descriptions as the basis for the

landslide damage assessment (Grünthal 1998). The scale can be modified for the landslide damage assessment (Palmisano et al. 2016). If historical damage assessment databases or records of finished surveys exist for the research area, it is very important to provide local classification within the questionnaire and to classify all objects by damage again during the new survey (for the comparison). Some examples of typological selections within this group of questions are shown in Table 1 - Section 3a & 3b and Fig. 3.

Fig. 3 Typology of most common object damage classification: negligible; negligible to slight; moderate; prone to collapse; destructed

Information about the foundation

Information about the object foundations can be divided into two sections - the one defining the type of foundation and the other defining the foundation material. In the case of mixed types of foundation or materials, the most dominant should be evidenced. Questions about foundation depths and foot width can be included here, but this is very hard to estimate precisely in most cases. The foundations material is mostly the same or similar to the one for dominant wall material. Some examples of proposed typological selections within this group of questions are shown in Table 1 - Section 4 and Fig. 4.

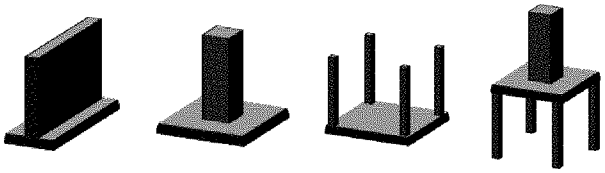


Fig. 4 Typology of the most common types of foundations: strip footing; spread footing; mat (raft); piles

Information about household members

This group of questions represents the most basic population census data. For the possibility of basic landslide risk assessment, it is necessary to collect the data about the number of household members, employment rate, number of minors or incapable of work etc. All collected data should be anonymous. Question examples within this group of questions are shown in Table 1 - Section 5.

Damage assessment (brief estimation)

Within this section, several questions about brief damage assessment are proposed. It is important to distinguish whether the damage assessment is documented by the official authorities' documentation or is it estimated relatively by the surveyor. Estimated direct damage should be the damage to the object caused by the landslide movement. Indirect damage should be expressed as the value amount that the owner or household members should spend annually to fix the damage so the object remains functional. Question examples proposed within this group of questions are shown in Table 1 - Section 6.

Emergency and temporary interventions

The surveyor recommendation and expenses needed for emergency or temporary interventions on the object or its surroundings to reduce the risk to the household members or neighbours should be noted. Question examples proposed within this group of questions are shown in Table 1 - Section 7.

Possibility of damage repair

The surveyor estimation of the possibility to repair the damage, for example, can range from "not needed" to "not possible". Question examples proposed within this group of questions are shown in Table 1 - Section 8.

Information about water supply, sewage, surface and groundwater at location

This question group should collect information about the object water supply or sewage disposal systems at the location and information about the surface waters and well conditions. Since the ground and surface waters are usually one of the dominant triggering factors for the landslide (re)activation, the surveyor should mandatorily fill this group of questions. Question examples proposed within this group of questions are shown in Table 2 - Section 9.

Object or facility damage sketch

The schemes for sketching the sides of the objects and damage that is observed on the field and some typological questions about objects and surrounding terrain conditions are shown in Table 2 - Section 10. It is recommended that "A" side of the object (Fig. 5) should be the side that mostly "looks" toward the possible vector of landslide movement and all other sides should be labelled in a clockwise direction, starting from the "A" side. If the object is of irregular shape (has more than four side walls), those sides should be sketched from the surveyor point of view and considered as one single side with indicating the wall break lines (Fig. 5, right). Within this section, data about the total object damage should be noted, same as subsidence and surrounding terrain deformation if occurs. An example of labelling convention and sketched side from point of surveyor view of an object is shown in Fig. 5.

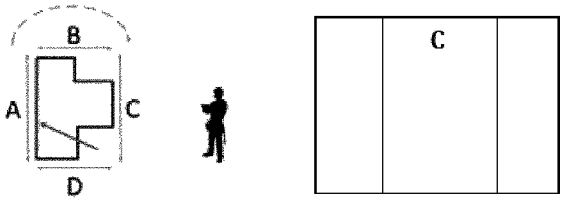


Table 1. Front page of the proposed landslide damage questionnaire

UNIQUE OBJECT ID:

Address

Cadastral parcel
Year of construct.
Building permit No ☐ ☐
X coordinate ace
Y coordinate Storeys
Extension Yes ☐

Demolished ☐
Prone to collapse ☐
Moderate ☐
Negligible to slight ☐
Negligible ☐

Assessment meth. | Relative ☐ Document. ☐
Estimated direct damage (€)
Estimated indirect damage (€/yr.)

Surname & Name
Telephone number
e-mail address

Minor civil works ☐
Ordinary maintenance ☐
Repair is not needed ☐

Survey copy Yes ☐ No ☐
measurements (€)

Data Processing Agreement (signature):

Table 2. Back page of the proposed landslide damage questionnaire

m

Surface waters not regulated ☐

☐ Other observations:

A **B**

C **D**

A B C idence No ☐ m

No ☐

Photo (image) file names or numbers:

Observation date: **Surveyor:**

Other observations

This section represents the blank textual field where surveyor should enter all other observations considered as important for the specific object. Some of the previous selections or entries can be explained here in detail.

Discussion and Conclusion

The main advantage of field surveying is the fact that all details about the object condition and damage can be noted and evidenced. This is not always possible with the other survey methods such as remote sensing for example. Another advantage is that the surveyor can discuss with the object owner and ask him about some details that cannot be assessed only from the side looking at the object. For example, an owner can let the surveyor in the basement to inspect the condition of beams, footings etc. Also, the owner can probably provide the surveyor the project documentation (if exists) where other important information regarding the material type, foundations depths and geometry can be checked and entered into a questionnaire.

The survey should be performed only by qualified staff and our general recommendation is that it should be done by engineers with a geotechnical background (civil + geological). Not all fields need to be filled by the surveyor, but some of them that are essential for the landslide hazard and risk estimation should be mandatory, such as information about the construction, damage estimation, and purpose of the object, household members, water & sewage and deformation sketch.

We have proposed a landslide damage questionnaire that is calibrated for the large and slow-moving landslides that are affecting the suburban areas. On such landslides, there is great dispersion of damage intensity across the landslide body (from negligible to destruct), while objects are mostly for individual living, smaller cottages or ancillary type and they are still occupied despite the fact the landslide activity. The questionnaire presented in this paper is adjusted for the most common typology choices that are expected for the mechanism and dynamics of the slow moving landslide as a presented case study. For other types of landslides (with different velocity, magnitude, mechanism and dynamics) and type of objects, modifications of the questionnaire is highly encouraged. During the preparation of the questionnaire, it was important to format it in such manner it can be filled quickly and easily, but still comprehensive. Our experience from the Umka landslide damage assessment showed us that time for filling the questionnaire vary from 1 - 2 hours per object.

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