

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)

**NEWS OF THE NATIONAL ACADEMY
OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF
GEOLOGY AND TECHNICAL SCIENCES**

№6

2025

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)



N E W S
OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN,
SERIES OF GEOLOGY AND TECHNICAL
SCIENCES

6 (474)
NOVEMBER – DECEMBER 2025

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, 2025

«Central Asian Academic Research Center» LLP is pleased to announce that “News of NAS RK. Series of Geology and Technical sciences” scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of Geology and Technical Sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

«Орталық Азия академиялық ғылыми орталығы» ЖШС «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

ТОО «Центрально-азиатский академический научный центр» сообщает, что научный журнал “Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

EDITOR-IN-CHIEF

ZHURINOV Murat Zhurinovich, Doctor of Chemical Sciences, Professor, Academician of NAS RK, President of National Academy of Sciences of the Republic of Kazakhstan, RPA, General Director of JSC "D.V. Sokolsky Institute of Fuel, Catalysis and Electrochemistry" (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

DEPUTY EDITOR-IN-CHIEF

ABSADYKOV Bakhyt Narikbayevich, Doctor of Technical Sciences, Professor, Academician of NAS RK, Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>, <https://www.webofscience.com/wos/author/record/2411827>

EDITORIAL BOARD:

ABSAMETOV Malis Kudysovich, (Deputy Editor-in-Chief), Doctor of Geological and Mineralogical Sciences, Professor, Academician of NAS RK, Director of the Akhmedsafin Institute of Hydrogeology and Geocology (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>, <https://www.webofscience.com/wos/author/record/1937883>

ZHOLTAEV Geroy Zholtaevich, Doctor of Geological and Mineralogical Sciences, Professor, Honorary Academician of NAS RK (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>, <https://www.webofscience.com/wos/author/record/1939201>

SNOW Daniel, PhD, Associate Professor, Director, Aquatic Sciences Laboratory, University of Nebraska (Nebraska, USA), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>, <https://www.webofscience.com/wos/author/record/1429613>

SELTMAN Reimar, PhD, Head of Petrology and Mineral Deposits Research in the Earth Sciences Department, Natural History Museum (London, England), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>, <https://www.webofscience.com/wos/author/record/1048681>

PANFILOV Mikhail Borisovich, Doctor of Technical Sciences, Professor at the University of Nancy (Nancy, France), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>, <https://www.webofscience.com/wos/author/record/1230499>

SHEN Ping, PhD, Deputy Director of the Mining Geology Committee of the Chinese Geological Society, Member of the American Association of Economic Geologists (Beijing, China), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>, <https://www.webofscience.com/wos/author/record/1753209>

FISCHER Axel, PhD, Associate Professor, Technical University of Dresden (Dresden, Berlin), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>, <https://www.webofscience.com/wos/author/record/2085986>

AGABEKOV Vladimir Enokovich, Doctor of Chemical Sciences, Academician of NAS of Belarus, Honorary Director of the Institute of Chemistry of New Materials (Minsk, Belarus), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

CATALIN Stefan, PhD, Associate Professor, Technical University of Dresden, Germany, <https://www.scopus.com/authid/detail.uri?authorId=35203904500>, <https://www.webofscience.com/wos/author/record/1309251>

JAY Sagin, PhD, Associate Professor, Nazarbayev University (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>, <https://www.webofscience.com/wos/author/record/907886>

FRATTINI Paolo, PhD, Associate Professor, University of Milano - Bicocca (Milan, Italy), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

NURPEISOVA Marzhan Baysanovna – Doctor of Technical Sciences, Professor of Satbayev University, (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>, <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

RATOV Boranbay Tovbasarovich, Doctor of Technical Sciences, Professor, Head of the Department of Geophysics and Seismology, Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>, <https://www.webofscience.com/wos/author/record/1993614>

RONNY Berndtsson, Professor at the Center of Promising Middle Eastern Research, Lund University (Sweden), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>, <https://www.webofscience.com/wos/author/record/1324908>

MIRLAS Vladimir, Faculty chemical engineering and Oriental research center, Ariel University, (Israel), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>, <https://www.webofscience.com/wos/author/record/53680261>

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Owner: «Central Asian Academic Research Center» LLP (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Communications of the Republic of Kazakhstan № KZ50VPY00121155, issued on 05.06.2025

Thematic scope: *geology, hydrogeology, geography, mining and chemical technologies of oil, gas and metals*

Periodicity: 6 times a year.

<http://www.geolog-technical.kz/index.php/en/>

© «Central Asian Academic Research Center» LLP, 2025

БАС РЕДАКТОР

ЖҰРЫНОВ Мұрат Жұрыңұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, РКБ «Қазақстан Республикасы Ұлттық Ғылым академиясының» президенті, АҚ «Д.В. Сокольский атындағы отын, катализ және электрохимия институтының» бас директоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

БАС РЕДАКТОРДЫҢ ОРЫНБАСАРЫ:

АБСАДЫКОВ Бақыт Нәрікбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қ.И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>, <https://www.webofscience.com/wos/author/record/2411827>

РЕДАКЦИЯ АЛҚАСЫ:

ӘБСӘМЕТОВ Мәліс Құдысұлы (бас редактордың орынбасары), геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, У.М. Ахмедсафин атындағы Гидрогеология және геоэкология институтының директоры, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>, <https://www.webofscience.com/wos/author/record/1937883>

ЖОЛТАЕВ Герой Жолтайұлы, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА құрметті академигі, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>, <https://www.webofscience.com/wos/author/record/1939201>

СНОУ Дэниел, PhD, қауымдастырылған профессор, Небраска университетінің Су ғылымдары зертханасының директоры, (Небраска штаты, АҚШ), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>, <https://www.webofscience.com/wos/author/record/1429613>

ЗЕЛБТМАНН Раймар, PhD, Жер туралы ғылымдар бөлімінің петрология және пайдалы қазбалар кен орындары саласындағы зерттеулерінің жетекшісі, Табиғи тарих мұражайы, (Лондон, Ұлыбритания), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>, <https://www.webofscience.com/wos/author/record/1048681>

ПАНФИЛОВ Михаил Борисович, техника ғылымдарының докторы, Нанси университетінің профессоры, (Нанси, Франция), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>, <https://www.webofscience.com/wos/author/record/1230499>

ШЕН Пин, PhD, Қытай геологиялық қоғамының Тау-кен геологиясы комитеті директорының орынбасары, Американдық экономикалық геологтар қауымдастығының мүшесі, (Бейжін, Қытай), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>, <https://www.webofscience.com/wos/author/record/1753209>

ФИШЕР Аксель, қауымдастырылған профессор, PhD, Дрезден техникалық университеті, (Дрезден, Берлин), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>, <https://www.webofscience.com/wos/author/record/2085986>

АГАБЕКОВ Владимир Енокович, химия ғылымдарының докторы, Беларусь ҰҒА академигі, Жана материалдар химиясы институтының құрметті директоры, (Минск, Беларусь), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

КАТАЛИН Стефан, PhD, қауымдастырылған профессор, Техникалық университеті (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>, <https://www.webofscience.com/wos/author/record/1309251>

САҒЫНТАЕВ Жанай, PhD, қауымдастырылған профессор, Назарбаев университеті (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>, <https://www.webofscience.com/wos/author/record/907886>

ФРАТТИНИ Паоло, PhD, қауымдастырылған профессор, Бикок Милан университеті, (Милан, Италия), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

НҮРПЕЙІСОВА Маржан Байсанқызы – Техника ғылымдарының докторы, Қ.И. Сәтбаев атындағы Қазақ ұлттық зерттеу техникалық университетінің профессоры, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>, <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

РАТОВ Боранбай Товбасарович, техника ғылымдарының докторы, профессор, «Геофизика және сейсмология» кафедрасының меңгерушісі, Қ.И. Сәтбаев атындағы Қазақ ұлттық зерттеу техникалық университеті, (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>, <https://www.webofscience.com/wos/author/record/1993614>

РОННИ Бердтссон, Лунд университетінің Таяу Шығысты перспективалы зерттеу орталығының профессоры, Лунд университетінің толық курсты профессоры, (Швеция), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>, <https://www.webofscience.com/wos/author/record/1324908>

МИРЛАС Владимир, Ариэль университетінің Химиялық инженерия факультеті және Шығыс ғылыми-зерттеу орталығы, (Израиль), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>, <https://www.webofscience.com/wos/author/record/53680261>

«ҚР ҰҒА» РКБ Хабарлары. Геология және техникалық ғылымдар сериясы».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Меншіктеуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).

Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде

05.06.2025 ж. берілген № KZ50VPY00121155 мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *Геология, гидрогеология, география, тау-кен ісі, мұнай, газ және металдардың химиялық технологиялары*

Мерзімділігі: жылына 6 рет.

<http://www.geolog-technical.kz/index.php/en/>

© «Орталық Азия академиялық ғылыми орталығы» ЖШС, 2025

ГЛАВНЫЙ РЕДАКТОР

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик НАН РК, президент РОО Национальной академии наук Республики Казахстан, генеральный директор АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского» (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

ЗАМЕСТИТЕЛЬ ГЛАВНОГО РЕДАКТОРА

АБСАДЫКОВ Бахыт Нарикбаевич, доктор технических наук, профессор, академик НАН РК, Казахский национальный исследовательский технический университет им. К.И. Сатпаева (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>, <https://www.webofscience.com/wos/author/record/2411827>

РЕДАКЦИОННАЯ КОЛЛЕГИЯ:

АБСАМЕТОВ Малис Кудысович, (заместитель главного редактора), доктор геолого-минералогических наук, профессор, академик НАН РК, директор Института гидрогеологии и геоэкологии им. У.М. Ахмедсафина (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>, <https://www.webofscience.com/wos/author/record/1937883>

ЖОЛТАЕВ Герой Жолтаевич, доктор геологоминералогических наук, профессор, почетный академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>, <https://www.webofscience.com/wos/author/record/1939201>

СНОУ Дэниел, PhD, ассоциированный профессор, директор Лаборатории водных наук Университета Небраски (штат Небраска, США), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>, <https://www.webofscience.com/wos/author/record/1429613>

ЗЕЛЪТМАНН Раймар, PhD, руководитель исследований в области петрологии и месторождений полезных ископаемых в Отделе наук о Земле Музея естественной истории (Лондон, Англия), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>, <https://www.webofscience.com/wos/author/record/1048681>

ПАНФИЛОВ Михаил Борисович, доктор технических наук, профессор Университета Нанси (Нанси, Франция), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>, <https://www.webofscience.com/wos/author/record/1230499>

ШЕН Пин, PhD, заместитель директора Комитета по горной геологии Китайского геологического общества, член Американской ассоциации экономических геологов (Пекин, Китай), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>, <https://www.webofscience.com/wos/author/record/1753209>

ФИШЕР Аксель, ассоциированный профессор, PhD, технический университет Дрезден (Дрезден, Берлин), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>, <https://www.webofscience.com/wos/author/record/2085986>

АГАБЕКОВ Владимир Енокович, доктор химических наук, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

КАТАЛИН Стефан, PhD, ассоциированный профессор, Технический университет (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>, <https://www.webofscience.com/wos/author/record/1309251>

САГИНТАЕВ Жанай, PhD, ассоциированный профессор, Назарбаев университет (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>, <https://www.webofscience.com/wos/author/record/907886>

ФРАТТИНИ Паоло, PhD, ассоциированный профессор, Миланский университет Бикокк (Милан, Италия), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

НУРПЕИСОВА Маржан Байсановна – доктор технических наук, профессор Казахского Национального исследовательского технического университета им. К.И. Сатпаева, (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>, <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

РАТОВ Боранбай Товбасарович, доктор технических наук, профессор, заведующий кафедрой «Геофизика и сейсмология», Казахский Национальный исследовательский технический университет им. К.И. Сатпаева, (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>, <https://www.webofscience.com/wos/author/record/1993614>

РОННИ Берндтссон, Профессор Центра перспективных ближневосточных исследований Лундского университета, профессор (полный курс) Лундского университета, (Швеция), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>, <https://www.webofscience.com/wos/author/record/1324908>

МИРЛАС Владимир, Факультет химической инженерии и Восточный научно-исследовательский центр, Университет Ариэль, (Израиль), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>, <https://www.webofscience.com/wos/author/record/53680261>

«Известия РОО «НАН РК». Серия геологии и технических наук».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Собственник: ТОО «Центрально-азиатский академический научный центр» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан № KZ50VPY00121155, выданное 05.06.2025 г.

Тематическая направленность: *геология, гидрогеология, география, горное дело и химические технологии нефти, газа и металлов*

Периодичность: 6 раз в год.

<http://www.geolog-technical.kz/index.php/en/>

© ТОО «Центрально-азиатский академический научный центр», 2025

CONTENTS

A.U. Abdullaev, I.N. Litovchenko, V.S. Lyutikova Swarm recognition algorithm as a promising artificial intelligence method in seismological research.....	8
E.T. Alsheriyeu, K.S. Dossaliyev, A.S. Naukenova, A.M. Yegenova, L. Abdrasilov Mathematical modeling and computer calculation of the prediction of possible consequences of earthquakes.....	22
N. Amirgaliev, L. Ismukhanova, A. Madibekov, B. Sultanbekova, A. Sultanayeva Monitoring the level of polychlorated bipheniles pollution in the Ile River falls.....	32
A.B. Baibatsha, A. Nukhuly, A.Ye. Agmanova, E.S. Bashilova, B.B. Amralinova The legacy of Academician K.I. Satpayev in the study of uranium deposits of Kazakhstan.....	47
R. Bashirov, V. Abbasov, S. Zakenov, G. Bashirova, L. Nurshakhanova Effect of parameters on chip shrinkage in ultrasonic turning of oilfield parts.....	63
M.Zh. Bulenbayev, B.T. Altaibayev, D.R. Magomedov, A.K. Omirgali, A.N. Bakrayeva Investigation of the possibility of separate bio-leaching of uranium and vanadium from black shale raw materials.....	76
U.M. Jabiyeva, K.V. Jafarova, G.I. Malikov, S.Z. Abdullayeva Modeling the path to greener plastics through sustainable innovations in Low-Density Polyethylene.....	92
R.K. Zhanakova, N. Atalykova, G. Jangulova, E. Kakimzhanov, O. Kurmanbaev The near-pit wall rock mass state stability monitoring method.....	102
B.M. Zhurynov, A.F. Tsekhovoy Project-based approach to quantitative assessment of the EPN effectiveness on the example of Kazakhstan industrial holdings.....	118

G.B. Ilmalieva, D.M. Tursunbekov, E.B. Kenzhaliyev, O.V. Atanova, K.M. Smailov Evaluation of the efficiency of using fly ash in polymer composite materials.....	135
M. Leman, A. Tairov, I. Malkovskiy, L. Toleubaeva, A. Aldiyarova Dynamic-stochastic model of sustainable water resources management in Kazakhstan.....	151
A.V. Mazdubay, D.R. Absolyamova, A.Zh. Taskarina, A.D. Suleimenov, D.D. Alipbayev Tribotechnical analysis of energy-efficient mixers for mineral suspensions.....	168
Sh.M. Medetov Safe transportation of a drilling rig during rockfalls.....	180
B.T. Ratov, A.E. Kuttybayev, M.T. Tabylganov, V.L. Khomenko, A.S. Kainazarov An effective device for the development of shallow aquifers.....	195
S.S. Sayyidkosimov, A.T. Nizamova, A.N. Kazakov1, M.R. Hakberdiev, I.Y. Sohibov Methodology for forecasting dynamic rock pressure manifestations in underground gold mining.....	209
D.Kh. Sunakbaeva, D.Kh. Yuldashbek, K. Aitekova, Y.T. Ergashev Biologically active substances for reducing heavy metal migration in contaminated soils.....	230
V.M. Timokhin, V.V. Kondratiev, V.Yu. Konyukhov, I.S. Remezov, N.N. Bryukhanova Diagnostics of the structure of crystalline materials of rock formations by the method of thermally stimulated depolarization.....	246
J.B. Toshov, K.T. Sherov, U.R. Bainazov, B.N. Absadykov, M.R. Sikhimbayev Study and determination of the stress-strain state of conveyor belts.....	265
J.F. Shiriyev, G.R. Muradov, K.S. Mammadov, S.A. Musayeva, M.A. Azimov Prospectivity assessment of deep sediments in pirsaat, Lower Kura Depression.....	280
N.S. Faiz, Sh.K. Shapalov, K.Zh. Smagulov, N.P. Tokenov, B.K. Nauryz Creation of geoinformation maps for assessment of wind energy potential of local areas of Turkestan region.....	294

NEWS OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 6. Number 474 (2025), 265–279

<https://doi.org/10.32014/2025.2518-170X.584>

UDC 622. 2

© J.B. Toshov¹, K.T. Sherov², U.R. Bainazov³, B.N. Absadykov^{4*},
M.R. Sikhimbayev⁵, 2025.

¹Tashkent State Technical University named after Islam Karimov,
Tashkent, Uzbekistan;

²S. Seifullin Kazakh Agrotechnical Research University, Astana, Kazakhstan;

³Almalyk branch of the Tashkent State Technical University named after Islam
Karimov, Tashkent, Uzbekistan;

⁴Satbayev University, Almaty, Kazakhstan;

⁵Karaganda University of Kazpotreboysuz, Karaganda, Kazakhstan.

*E-mail: b.absadykov@satbayev.university

STUDY AND DETERMINATION OF THE STRESS-STRAIN STATE OF CONVEYOR BELTS

Toshov Javokhir — DSc, Professor, Head of Department, Tashkent State Technical University
named after Islam Karimov, Tashkent, Uzbekistan,

E-mail: j.toshov@tdtu.uz, <https://orcid.org/0000-0003-4278-1557>;

Sherov Karibek — Doctor of Engineering Sciences, Professor, S. Seifullin Kazakh Agrotechnical
Research University, Astana, Kazakhstan,

E-mail: shkt1965@mail.ru, <https://orcid.org/0000-0003-0209-180X>;

Bainazov Umid — PhD, Acting Associate Professor, Almalyk branch of the Tashkent State Technical
University named after Islam Karimov, Tashkent, Uzbekistan,

E-mail: ub629418@gmail.com, <https://orcid.org/0000-0002-9941-0821>;

Absadykov Bakhyt — Doctor of Technical Sciences, Professor, Satbayev University, Almaty,
Kazakhstan,

E-mail: b.absadykov@satbayev.university, <https://orcid.org/0000-0001-7829-0958>;

Sikhimbayev Muratbay — Doctor of Economic Sciences, Professor, Karaganda University of
Kazpotreboysuz, Karaganda, Kazakhstan,

E-mail: smurat@yandex.ru, <https://orcid.org/0000-0002-8763-6145>.

Abstract. Relevance. Reducing the cost of mining and transporting rock in
quarries is one of the main factors affecting the cost of finished products. Today,
belt conveyors are the most cost-effective means of transporting rock worldwide.
Therefore, their use provides significant economic advantages—specifically, a
30–40% reduction in transportation costs. Despite these undeniable advantages,
conveyor systems face a critical issue that significantly reduces their overall
efficiency. Objective. Determination of the stress-strain state of conveyor belts
during interaction of rocks by mathematical modeling. Methods. The research is

based on modern computing tools – Ansys Workbench, MathCAD, and Maple – which enable the creation of 3D models, numerical calculations, and regression relationships. Single- and two-factor models were constructed to evaluate the stress-strain state under various operating conditions and identify optimal operating parameters. The stress-strain state of the conveyor belt occurs under the influence of powerful impact loads when rock falls from the transfer hopper. These dynamic forces cause localized damage, transverse cracks, and punctures, leading to premature and frequent belt ruptures. Therefore, the development of scientifically based approaches to optimizing the operating parameters of transfer units is needed. The results was established that optimizing the geometric parameters of a conveyor transport transfer point (a 5.4-meter-high belt conveyor hopper) can ensure minimal loads during contact between the rock mass and the conveyor belt for this design. The stress state of the conveyor belt was determined depending on the belt speed and the transfer point hopper height using single- and two-factor regression models.

Keywords: conveyor, stress-strain state, belt, Ansys Workbench, Maple, MathCAD, bunker

© Ж.Б. Тошов¹, К.Т. Шеров², У.Р. Байназов³, Б.Н. Абсадыков^{4*},
М.Р. Сихимбаев⁵, 2025.

¹И. Каримов атындағы Ташкент мемлекеттік техникалық университеті,
Ташкент, Өзбекстан;

²С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті,
Астана, Қазақстан;

³И. Каримов атындағы Ташкент мемлекеттік техникалық университетінің
Алмалық филиалы, Ташкент, Өзбекстан;

⁴Сәтбаев Университеті, Алматы, Қазақстан;

⁵Қазтұтынуодағы Қарағанды университеті, Қарағанды, Қазақстан.

*E-mail: b.absadykov@satbayev.university

КОНВЕЙЕР ТАСПАЛАРЫНЫҢ КЕРНЕУЛІК-ДЕФОРМАЦИЯЛЫҚ КҮЙІН ЗЕРТТЕУ ЖӘНЕ АНЫҚТАУ

Тошов Жавохир — техника ғылымдарының докторы, профессор, кафедра меңгерушісі,
И. Каримов атындағы Ташкент мемлекеттік техникалық университеті, Ташкент, Өзбекстан,
E-mail: j.toshov@tdtu.uz, <https://orcid.org/0000-0003-4278-1557>;

Шеров Карибек — техника ғылымдарының докторы, профессор, С. Сейфуллин атындағы
Қазақ агротехникалық зерттеу университеті, Астана, Қазақстан,
E-mail: shkt1965@mail.ru, <https://orcid.org/0000-0003-0209-180X>;

Байназов Умид — PhD, доцент м. а., И. Каримов атындағы Ташкент мемлекеттік техникалық
университетінің Алмалық филиалы, Ташкент, Өзбекстан,
E-mail: ub629418@gmail.com, <https://orcid.org/0000-0002-9941-0821>;

Абсадыков Бахыт — техника ғылымдарының докторы, профессор, Сәтбаев Университеті,
Алматы, Қазақстан,

E-mail: b.absadykov@satbayev.university, <https://orcid.org/0000-0001-7829-0958>;

Сихимбаев Муратбай — экономика ғылымдарының докторы, профессор, Қазтұтынуодағы Қарағанды университеті, Қарағанды, Қазақстан,

E-mail: smurat@yandex.ru, <https://orcid.org/0000-0002-8763-6145>.

Аннотация. *Өзектілігі.* Карьерлерде тау жыныстарын өндіру және тасымалдау құнын төмендету дайын өнімнің құнына әсер ететін негізгі факторлардың бірі болып табылады. Бүгінгі таңда таспалы конвейерлер бүкіл әлемде тау жыныстарын тасымалдаудың ең тиімді құралы болып табылады. Сондықтан оларды пайдалану айтарлықтай экономикалық артықшылықтар береді, атап айтқанда, тасымалдау шығындарын 30-40%-ға төмендетеді. Осы даусыз артықшылықтарға қарамастан, конвейерлік жүйелер олардың жалпы тиімділігін айтарлықтай төмендететін маңызды мәселеге тап болады. *Мақсаты.* Математикалық модельдеуді қолдана отырып, тау жыныстарының өзара әрекеттесуі кезінде конвейерлік таспалардың кернеу-деформация күйін анықтау. *Әдістер.* Зерттеу заманауи есептеу құралдарына - Ansys Workbench, MathCAD және Maple - негізделген, бұл 3D модельдерді жасауға, сандық есептеулерді жүргізуге және регрессиялық қатынастарды құруға мүмкіндік береді. Өртүрлі жұмыс жағдайларында конвейерлік таспаның кернеу-деформация күйін бағалау және оңтайлы жұмыс параметрлерін анықтау үшін бір және екі факторлы модельдер жасалған. Конвейерлік таспаның кернеу-деформация күйі тасымалдау бункерінен тау жыныстарының құлауы кезінде күшті соққы жүктемелерінің әсерінен пайда болады. Бұл динамикалық әсерлер жергілікті зақымдануды, көлденең жарықтарды және тесілулерді тудырады, бұл таспаның мезгілсіз және жиі үзілуіне әкеледі. Сондықтан, тасымалдау қондырғыларының жұмыс параметрлерін оңтайландырудың ғылыми негізделген тәсілдерін әзірлеу қажет. *Нәтижелер мен қорытындылар.* Конвейерлік тасымалдау, тасымалдау нүктесінің (биіктігі 5,4 м таспалы конвейерлік бункер) геометриялық параметрлерін оңтайландыру осы конструкция үшін тау жыныстары массасының конвейерлік таспамен жанасуы кезінде минималды жүктемелерді қамтамасыз ете алатыны анықталды. Конвейерлік таспаның кернеу күйі таспа жылдамдығына және тасымалдау нүктесінің бункерінің биіктігіне байланысты бір және екі факторлы регрессиялық модельдерді қолдана отырып анықталады.

Түйін сөздер: конвейер, кернеулі-деформациялық күйі, таспа, Ansys Workbench, Maple, MathCAD, бункер

© Ж.Б. Тошов¹, К.Т. Шеров², У.Р. Байназов³, Б.Н. Абсадыков^{4*},
М.Р. Сихимбаев⁵, 2025.

¹Ташкентский государственный технический университет имени Ислама Каримова, Ташкент, Узбекистан;

²Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан;

³Алмалыкский филиал Ташкентского государственного технического университета имени Ислама Каримова, Ташкент, Узбекистан;

⁴Сатпаев Университет, Алматы, Казахстан;

⁵Карагандинский университет Казпотребсоюза, Караганда, Казахстан.

*E-mail: b.absadykov@satbayev.university

ИССЛЕДОВАНИЕ И ОПРЕДЕЛЕНИЕ НАПРЯЖЕННО-ДЕФОРМИРОВАННОГО СОСТОЯНИЯ КОНВЕЙЕРНЫХ ЛЕНТ

Тошов Жавохир — доктор технических наук, профессор, заведующий кафедрой, Ташкентский государственный технический университет имени Ислама Каримова, Ташкент, Узбекистан, E-mail: j.toshov@tdtu.uz, <https://orcid.org/0000-0003-4278-1557>;

Шеров Карибек — доктор технических наук, профессор, Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан, E-mail: shkt1965@mail.ru, <https://orcid.org/0000-0003-0209-180X>;

Байназов Умид — PhD, и.о. доцента, Алмалыкский филиал Ташкентского государственного технического университета имени Ислама Каримова, Ташкент, Узбекистан, E-mail: ub629418@gmail.com, <https://orcid.org/0000-0002-9941-0821>;

Абсадыков Бахыт — доктор технических наук, профессор, Сатпаев Университет, Алматы, Казахстан,

E-mail: b.absadykov@satbayev.university, <https://orcid.org/0000-0001-7829-0958>;

Сихимбаев Муратбай — доктор экономических наук, профессор, Карагандинский университет Казпотребсоюза, Караганда, Казахстан,

E-mail: smurat@yandex.ru, <https://orcid.org/0000-0002-8763-6145>.

Аннотация. *Актуальность.* Снижение затрат на добычные работы и транспортировку горной массы на карьерах является ключевым фактором уменьшения себестоимости готовой продукции. В мировой практике ленточные конвейеры рассматриваются как наиболее экономичное средство перемещения горных пород, обеспечивающее снижение затрат на транспортировку на 30–40%. Однако конвейерные системы сталкиваются с проблемой возникновения напряжённо-деформированного состояния (НДС) ленты, вызванного ударными нагрузками, что приводит к преждевременному износу и выходу оборудования из строя. *Цель.* Определение напряженно-деформированного состояния конвейерных лент при взаимодействии с горной массой методом математического моделирования для выбора оптимальных эксплуатационных параметров. *Методы.* Исследования выполнены с использованием вычислительных комплексов Ansys Workbench, MathCAD и Maple, обеспечивающих построение трёхмерных моделей, численный

анализ и разработку однофакторных и двухфакторных регрессионных зависимостей. Определены особенности формирования НДС при ударных нагрузках, возникающих в момент падения горной породы на ленту через перегрузочный бункер. Установлены причины локальных повреждений, поперечных трещин и пробоев, связанных с динамической природой нагрузки. *Результаты и выводы.* Показано, что оптимизация геометрических параметров перегрузочного узла конвейера (для бункера высотой 5,4 м) позволяет существенно снизить пиковые нагрузки и минимизировать НДС ленты. Получены регрессионные модели, описывающие зависимость напряжённого состояния от скорости движения ленты и высоты падения груза. Результаты моделирования демонстрируют, что корректная настройка параметров системы снижает вероятность разрывов ленты и увеличивает ресурс работы конвейера.

Ключевые слова: конвейер, напряженно-деформированное состояние, лента, Ansys Workbench, Maple, MathCAD, бункер

Introduction. Conveyor transport is an integral part of the technological process at modern mining enterprises. In open-pit coal mining, belt conveyors demonstrate significant advantages over road and rail transport: they reduce transportation costs by 30-40%, increase labor productivity by 1.4-2.0 times, ensure continuous production, and enable comprehensive automation (Anistratov, 1995:350, Poderni, 2003:606). Belt conveyors with throughputs of up to 25,000 m³/h, travel speeds of up to 10 m/s, and installed drive power of up to 10 MW are used worldwide. Modern systems allow for the transport of rock mass over distances of over 5 km along routes with complex geometries, including sections with slopes of up to 16-18° (Rabatuly et al., 2025:11). However, despite the obvious advantages, conveyor transport has a number of significant disadvantages associated with the short service life of the belt and roller supports, high energy consumption, and material spillage and dusting. The conveyor belt, which is both a load-bearing and traction element, has a limited service life (3-5 years) and accounts for 50-60% of the total cost of the conveyor. Moreover, belt damage leads to downtime, the losses from which many times exceed its cost. Particularly critical are transfer points, where the rock mass is transferred from one conveyor to another. It is in these areas that the greatest belt wear is observed due to the intense stress-strain state (SSS), which occurs under the action of impact loads during rock fall. This leads to localized damage, the formation of transverse cracks, punctures, and ruptures of the conveyor belt (Toshov, 2024a:11, Donenbaev et al., 2023:9).

Research materials and methods. The issues of improving conveyor transport have been the subject of the works of many researchers. Significant contributions to the development of the theory and practice of belt conveyors were made by Anistratov Yu.I., Galkin V.I., Dmitriev V.G., Poderni R.Yu., Rzhnevsky V.V., Sheshko E.E., as well as foreign scientists Gabriel Fedorko, Lech Gładysiewicz, Robert

Krol and others (Dmitriev et al., 2011:11, Reshetnyak, 1998:423, Fedotenko et al., 2020:6, Lagerev et al., 2017:384, Dolgikh, 2018:7, Korneev et al., 2014:4). The works of these authors considered the issues of calculating the main parameters of conveyors, selecting the type of belt, determining the traction forces and power of drives. However, the issues of optimizing the design of transfer points taking into account the dynamic interaction of falling rock with the belt remain insufficiently studied. To solve the assigned problems, a finite element method was used using the ANSYS Workbench 2021 software package, Explicit Dynamics module. This software enables nonlinear dynamic analysis taking into account large deformations, contact interactions, and complex material models (Fimlinger, 2021:98, Ogden, 1972:20).



Figure 1. Belt conveyor transfer point in open-pit mining

Belt reliability and stability play a key role in transporting rock by conveyors. To ensure the smooth and safe operation of the conveyor, it is essential to consider the belt's stress-strain state (SSS), which serves as an important indicator of its technical condition, service life, and reliability. SSS analysis allows one to identify belt sections experiencing the greatest internal stresses and deformations under the impact of the transported rock mass. This is especially important when the belt is subject to external factors, such as high speed, impact loads from rock falling from the hopper, and the geometric features of the transfer section. For example, significant loading heights increase the impulse load, which can cause fatigue damage and accelerated belt failure. To conduct engineering analysis and obtain accurate quantitative characteristics of the stress-strain state, it is recommended to use modern software and computing tools such as MathCAD and Maple 18. These systems offer extensive mathematical modeling capabilities and allow:

- Develop adequate models of belt behavior under load, taking into account its physical and mechanical properties;
- Perform numerical solutions to continuum mechanics equations;
- Perform parametric studies, varying design and operational parameters;
- Visualize the results in the form of graphs and stress distributions, simplifying data interpretation.

The use of such software packages makes it possible to optimize the design of handling units, select rational conveyor operating parameters, and, as a result, improve the overall reliability and efficiency of the transport system at a mining facility. This is especially relevant when developing new sites or upgrading existing facilities, where complex mining, geological, and technological conditions must be taken into account. Using Ansys Workbench software, 3D models of a loading and unloading bin located between two sections of conveyor lines were developed using precise geometric parameters. Analysis of the resulting 3D models revealed a number of factors that contribute to damage and rupture of the main conveyor belt. Specifically, graphical and numerical calculations revealed that the bin's design features, rock fall height, trajectory deviation angle, and uneven material distribution on the receiving end of the belt are key factors influencing the occurrence of critical loads.

Stage 1. Creating a Geometric Model

1. A 3D model of the transfer point was created, including:
2. A hopper made of 30 mm thick steel sheet (height varied: 3.5 m, 5.4 m, 7.8 m);
3. A section of conveyor belt 8.4886 m long;
4. A system of roller supports with installation pitches of 0.25 m, 0.5 m, and 1.0 m;
5. A rock mass weighing 143.17 kg.

Step 2. Determining the properties of materials

To accurately describe the behavior of the rubber-cord belt, the Ogden hyperelastic model was used, which adequately describes the nonlinear behavior of rubber-like materials under large deformations. The strain energy density in the Ogden model is determined by the expression:

$$W = \sum_{i=1}^N \frac{\mu_i}{\alpha_i} (\lambda_1^{\alpha_i} + \lambda_2^{\alpha_i} + \lambda_3^{\alpha_i} - 3) + \sum_{i=1}^N \frac{1}{D_i} (J - 1)^{2i} \quad (1)$$

where μ_i , α_i , D_i – material constants; λ_1 , λ_2 , λ_3 – main extensions; J – volume ratio.

The following parameters were used for the STAHLCORD® ST 1600 conveyor belt:

1. Young's modulus of steel cables: $E = 200 \text{ GPa}$;
2. Poisson's ratio of rubber: $\nu = 0.49$;
3. Density: $\rho = 1200 \text{ kg/m}^3$;
4. Number of cables in the belt: 114 pcs.;
5. Cable diameter: 11.2 mm;
6. Cable pitch: 17.2 mm.

The rock was modeled as a perfectly solid body with a density of 2000 kg/m^3 , which corresponds to the overburden of a coal mine. The bin is made of structural steel with a Young's modulus of $E = 200 \text{ GPa}$ and a Poisson's ratio of $\nu = 0.3$.

Step 3. Setting boundary conditions and loads

The process of rock falling from the hopper of a face conveyor (speed 5 m/s) onto the belt of a main conveyor (speed 5.6 m/s) was simulated. The edges of the belt were secured longitudinally to simulate an endless belt. The roller supports and hopper were fixed. The coefficient of friction between the rock and the belt was assumed to be 0.2.

Step 4. Building a finite element mesh

To discretize the model, 8-mm-sized hexahedral volume elements were used. In areas of rock-belt contact, local mesh refinement to 4 mm was applied to improve calculation accuracy. The total number of nodes was 4,300, and the number of elements was 2,040 (Kassenov, et al., 2022:6, Toshov, et al., 2023b:13, Sagitov, et al., 2023:12). In the graph (Figure 2), the maximum stress value is shown in green, the average stress value is shown in blue, and the minimum stress value is shown in red. According to this graph, the maximum stress of 6.881 MPa is reached at 4 seconds, which is caused by improper use of the conveyor belt, which reduces its reliability.

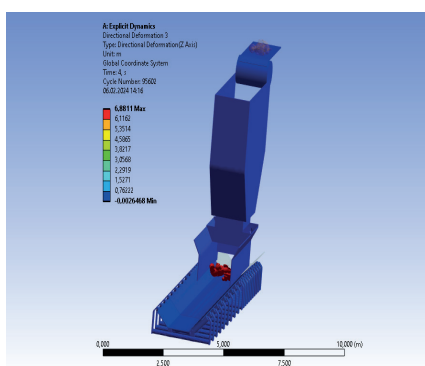


Figure 2. General view of the transfer point model, stress-strain state of the conveyor belt

The graph shows the dependence of the movement of rock along a conveyor (Figure 3) from a 7.8 m high bin on time. Numerical values of rock stress are given in Table 1.

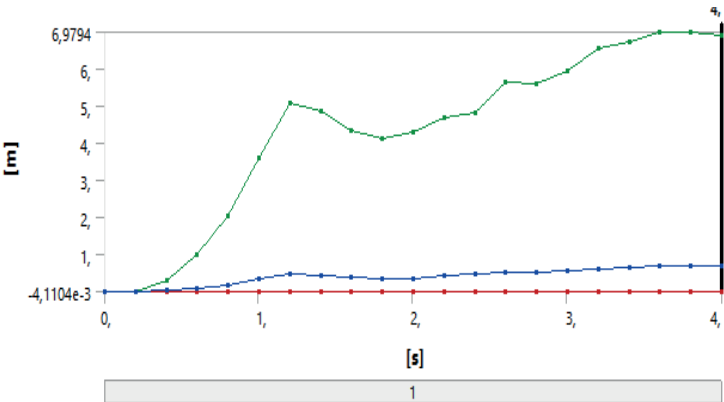


Figure 3. Graph of voltage versus time during loading of a hopper with rock

Table 1. Numerical values of rock stress (7.8 m)

Time (s)	Minimum (MPa)	Maximum (MPa)	Average (MPa)
1,1755e-038			
0,2	8,2027e-005	2,1574e-003	-7,4216e-005
0,4	8,3377e-005	0,28732	2,179e-002
0,6	0	0,97651	8,3257e-002
0,8		2,043	0,18428
1	8,7678e-005	3,6078	0,32728
1,2	8,6954e-005	5,087	0,47641
1,4	0	4,8652	0,43775
1,6	7,0919e-005	4,3137	0,38328
1,8	1,078e-004	4,1191	0,35089
2	0	4,2917	0,36165
2,2		4,6891	0,41616
2,4	1,0919e-005	4,8137	0,46946
2,6	6,6299e-004	5,6519	0,52721
2,8	6,2206e-004	5,5866	0,5351
3	2,3985e-004	5,9213	0,56474
3,2	8,0004e-004	6,5554	0,61902
3,4	3,7188e-004	6,7116	0,65906
3,6	8,0968e-004	6,9736	0,67127
3,8	3,1114e-004	6,9794	0,68129
4	2,6468e-003	6,8811	0,67522

We conducted a detailed study and analysis of the operational challenges of conveyor transport during stripping operations in quarries. This analysis revealed that the main problems in transporting overburden stem from various causes of belt breaks. Therefore, a scientific study was conducted, which identified one of the

main problems: frequent belt conveyor breaks during operation, caused by both the structural and technical features of the belt itself, as well as the impact force of the mined rock from the conveyor's loading and unloading hopper. Detailed modeling has shown that with an increase in the hopper height by 20–30%, the stress concentration in the receiving zone of the conveyor belt increases by more than 40%. An unfavorable combination of drop height and hopper shape leads to localized impact loads, which causes accelerated wear, the appearance of microcracks, and subsequent belt ruptures (Mityushov et al., 2005:176). the study also examined in detail the specifics of conveyor operation during stripping operations at open-pit coal mines. Analysis of practical data and modeling revealed that belt damage on main conveyors is caused not only by the design and technical characteristics of the belt itself (strength, thickness, reinforcing materials), but also by the impact loads generated when rock mass falls from the hopper. The scientific study confirmed that the combination of these factors-belt design features and dynamic loads-is the key cause of frequent accidents and ruptures of main conveyor belts during operation.

Results. Thus, modeling and analysis confirmed the need for an integrated approach to the design and operation of conveyor transfer units, which will significantly increase the service life of the equipment and reduce repair costs. The results of the studies of the belt stress-strain state depending on various transfer point bin heights are shown in the table 2.

Table 2.

Conveyor line speed	Bunker height		
	3,5 м	5,4 м	7,8 м
6-6,6 м/с	5,461 МПа	4,421 МПа	7,387 МПа
3,15-4 м/с	5,161 МПа	4,339 МПа	6,881 МПа
5-5,6 м/с	0,483 МПа	0,433 МПа	1,203 МПа

The results of these studies are reflected in the graphs of the stress-strain state of the belt depending on the fall of rock from various heights of the bunker per unit of time (Figure 4).

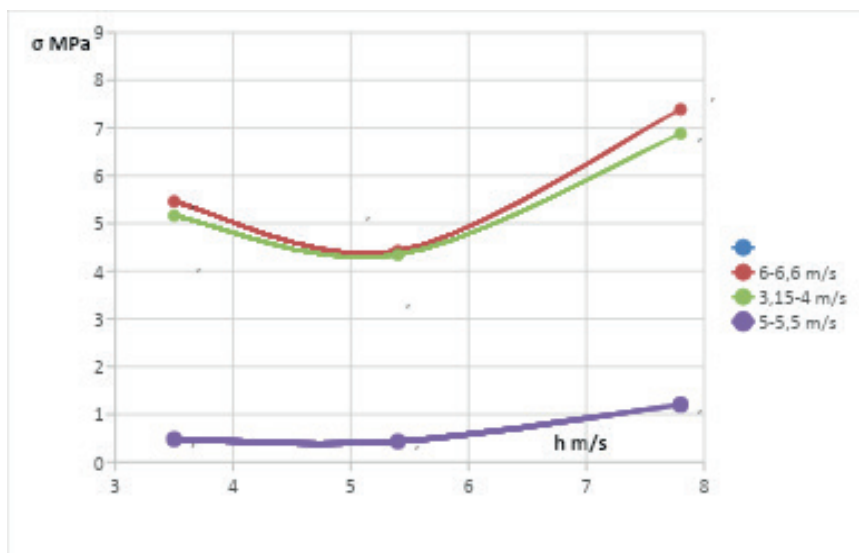


Figure 4. Graph of the dependence of the stress-strain state of the tape on the height of the rock mass fall

As a result of such determination of the optimal height of the bunker for this technological process, the following formulas were obtained:

$$\sigma = \{0,415h^2 - 4,238h + 15,215 \text{ if speed } v = 6 - 6,6 \frac{m}{s} 0,347h^2 - 3,52h + 13,232 \text{ if speed } v = 3,15 - 4 \frac{m}{s} 0,081h^2 - 0,745h + 2,101 \text{ if speed } v = 5 - 5,5 \frac{m}{s}\} \quad (2)$$

Formulas for quadratic sigma-h relations obtained by processing with linfit in MathCAD.

To obtain analytical relationships suitable for engineering calculations, statistical processing of the modeling results was performed using regression analysis. We constructed a single-factor regression model. Thus, the problem is reduced to solving the following system of equations:

$$\begin{bmatrix} 1 & v_0 & v_0^2 \\ 1 & v_1 & v_1^2 \\ 1 & v_2 & v_2^2 \end{bmatrix} \cdot \begin{bmatrix} a_0 \\ a_1 \\ a_2 \end{bmatrix} = \begin{bmatrix} \sigma_0 \\ \sigma_1 \\ \sigma_2 \end{bmatrix}. \quad (3)$$

According to the obtained results (Table 2), the coupling function that allows solving equation (4) and determining the values of the belt tension depending on the change in the linear speed of the conveyor for different bin heights has the following form:

$$\sigma = 2,94004662v^2 - 31,04910956v + 82,31669232 \quad \text{at } h = 3,5\text{ M} \quad 1,277082112v^2 - 11,82723901v + 26,85108066 \quad \text{at } h = 5,4\text{ M} \quad 3,575710954v^2 - 37,70792074v + 100,5013077 \quad \text{at } h = 7,8\text{ M} \quad (4)$$

Using the Maple 18 program, a graph (Figure 5) was constructed of the belt tension depending on the change in the linear speed of the conveyor for different bin heights.

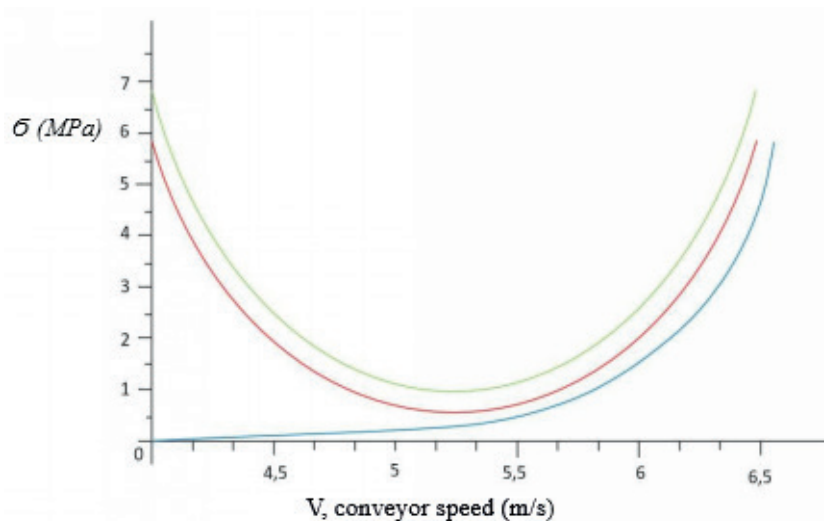


Figure 5. Graph of the stress-strain state of the belt depending on the change in the linear speed of the conveyor for different bin heights

Now let's construct a two-factor regression model, that is, determine a single-valued correlation function describing changes in conveyor belt stress depending on bin height and belt speed. To do this, we construct a two-factor function in nonlinear form. In this case, we use the least-squares method to make the model usable. In general, force is defined as follows:

$$\sigma = a + bh + cv + dh^2 + ev^2 + fhv + kh^2v + lhv^2 + mv^3 \quad (5)$$

Here $a, b, c, d, e, f, k, l, m$ are the coefficients that need to be determined, calculated and determined using the Maple 18 software package based on the data given in Table 2.

The problem is reduced to solving this system of equations:

$$\begin{bmatrix} 1 & h_0 & v_0 & h_0^2 & v_0^2 & h_0v_0 & h_0^2v_0 & h_0v_0^2 & v_0^3 \\ 1 & h_1 & v_1 & h_1^2 & v_1^2 & h_1v_1 & h_1^2v_1 & h_1v_1^2 & v_1^3 \\ \boxtimes & \boxtimes & \boxtimes & \boxtimes & \boxtimes & \boxtimes & \boxtimes & \boxtimes & \boxtimes \\ 1 & h_8 & v_8 & h_8^2 & v_8^2 & h_8v_8 & h_8^2v_8 & h_8v_8^2 & v_8^3 \end{bmatrix} \cdot \begin{bmatrix} a_0 \\ a_1 \\ \boxtimes \\ a_9 \end{bmatrix} = \begin{bmatrix} \sigma_0 \\ \sigma_1 \\ \boxtimes \\ \sigma_9 \end{bmatrix}. \quad (6)$$

Now we define the following two-factor correlation function:

$$\sigma = 0,013h^2v + 0,173hv^2 + 592,547v^3 + 0,207h^2 - 1,974hv - 9538v^2 + 2,570h + 50167,8 - 85975,509 \quad (7)$$

Using this objective function (4), the belt stress is determined using a single value for various changes in bin height (h) and conveyor speed (v). The accuracy level of the Fisher criterion is $P = 0.93\text{--}0.96\%$ for the function (Figure 5).

A graph of the change in the stress-strain state of the belt depending on the speed and height of the conveyor bin was obtained (Figure 6).

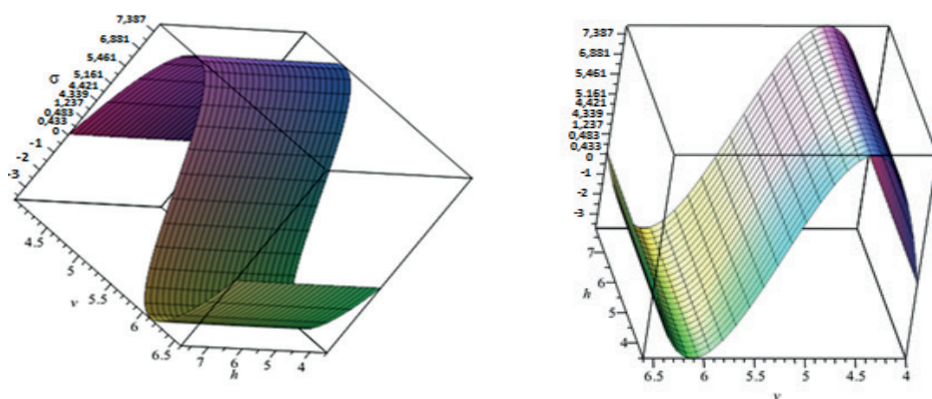


Figure 6. Graph of changes in the stress-strain state of the belt depending on the speed and height of the conveyor hopper

The obtained results are consistent with the research of other authors in the field of conveyor transport optimization. In particular, the work of Lech Gładysiewicz and Robert Krol (Lech, et al., 2021:6) showed that optimizing the design of transfer points can reduce dynamic loads on the belt by 25-40%, which is close to our results (a reduction of 64% when moving from a height of 7.8 m to 5.4 m).

Research by Gabriel Fedorko et al. (Gabrie et al., 2018:12) confirmed the effectiveness of the finite element method for analyzing the stress-strain state of conveyor belts. However, their work focused on analyzing cable frame defects during operation, while our study focuses on optimizing the design to prevent damage. The Ogden model used to describe the behavior of the rubber elements of the belt showed good agreement with the experimental data, which is consistent with the conclusions of (Miriam et al., 2019:11). The model coefficients determined for a specific type of belt made it possible to describe its behavior under large deformations with high accuracy. Theoretical and numerical studies demonstrated that accounting for the stress-strain state (SSS) of a belt, depending on changes in operational factors such as conveying speed and transfer height, provides important

engineering data for subsequent design and technological improvements to belt conveyors. The calculation results not only identified potentially hazardous areas with increased stress concentrations but also suggested approaches to optimizing equipment operation to minimize wear and tear and increase its service life. The use of MathCAD and Maple 18 computational programs demonstrated extensive capabilities in modeling complex processes arising during the interaction of rock with a moving belt. The flexibility of setting calculation parameters, the high accuracy of numerical solutions, and the visualization of results ensured a high-quality analysis of the structure's behavior in various operating modes. Thus, the conducted research forms the basis for further engineering research aimed at improving the reliability and efficiency of conveyor transport systems, which is essential for mining companies facing increasing demands on productivity and process stability.

Conclusion. It was established that the primary causes of conveyor belt damage are associated with high conveyor speeds and large rock drop heights from the hopper.

Modeling in Ansys Workbench identified critical stress concentration zones and provided recommendations for optimizing the design of handling units.

Regression models constructed in MathCAD and Maple confirmed the relationship between hopper height, conveyor speed, and SSS with a high degree of reliability ($P = 0.93\text{--}0.96$).

To reduce belt damage, the following is recommended:

- Optimize hopper height and belt speed;
- Use guide devices to evenly distribute rock;
- Use shock-absorbing inserts in the impact zone;
- Select belt materials with increased wear resistance.

These results can be used in the design and modernization of belt conveyors to improve their reliability and durability in mining environments.

References

- Anistratov Yu. I. (1995) *Technologiya otkrytykh gornykh rabot* [Technological processes of open-pit mining]. Moscow: Nedra, 1995. — 350 p. (In Russian).
- Dmitriev V.G., Sergeeva N.V. (2011) Methodology for traction calculation of a tubular belt conveyor. *GIAB*. Moscow: Moscow State Mining University, 2011. No. 7. — P. 218-228. (In English).
- Dolgikh V.P. Modeling the “Cargo-Conveyor Belt-Idler” System in the Ansys Workbench Software Package. *CORE*. — P. 121-127. (In English).
- Donenbaev B.S., Magavin S.Sh., Sherov K.T., Rakishev A.K., Musaev M.M. (2023) Experimental study and numerical modeling of the development stage of low-carbon steel failures / *Gumilyov Eurasian National University Bulletin. Series: Technical Sciences and Technologies* – Astana: ENU Publishing House, No 3(144)/2023. — P. 134-142. DOI: <https://doi.org/10.32523/2616-7263-2023-144-3-134-142> (In English).
- Fedotenko V.S., Vlasov A.V., Kliver S.Ya., Shadrinov A.G. (2020) Justification of the Conditions and Parameters for the Formation of Mining Engineering Systems during the Construction and Operation of a Cyclic-Flow Geotechnology Complex in Deep Quarries. *Mining Industry*, 2020. — No. 5. — P. 102-107. (In English).
- Fimbinger E. (2021) *A Methodology for Dynamic Belt Simulation*. Doctoral Thesis, Montanuniversität Leoben, 2021. <https://doi.org/10.34901/mul.pub.2021.3> (In English).

Gabriel Fedorko et al. (2018) Analysis of defects in carcass of rubber-textile conveyor belts using metrotomography. *Journal of Industrial Textiles*, 2018. — Vol. 47 (7). <https://doi.org/10.1177/1528083717710712>. (In English).

Korneev S.V., Dolgikh V.P. Coefficients of the Mooney-Rivlin model in the ANSYS software package obtained for the lining rubber of mine conveyor belts. *Collection of scientific papers of DonSTU. IPC "Lado"*, 2014. — No. 42. — P. 44-48. (In English).

Kassenov A.Zh., Abishev K.K., Absadykov B.N., Yessaulkov V.S., Bolatova A.B. (2022) Analysis and justification of the layout of a multipurpose machine for the development of mineral deposits. *News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences*. Volume 1, Number 451 (2022). — P. 63-68 <https://doi.org/10.32014/2022.2518-170X.141> (In English).

Lagerev A.V., Tolkachev E.N., Goncharov K.A. (2017) *Modelirovanie rabochikh protsessov i proektirovanie mnogoprivodnykh lentochnykh konveyerov* [Modeling of work processes and design of multi-drive belt conveyors]. Bryansk, RIO BGU, 2017. — 384 p. DOI: <https://doi.org/10.5281/zenodo.1196612> (In Russian)

Lech Gładysiewicz, Robert Krol. (2021) Experimental verification of load models for upper idlers in belt conveyor. *Measurement*, 2021. — Vol. 168. 108251. (In English).

Mityushov E.A., Konoplev V.A., Ogorodnikova O.M., et al. *Computer Engineering Analysis*. Yekaterinburg: GOU VPO USTU-UI, 2005. 176 p. (In English).

Miriam Andrejiova, Anna Grincova, Daniela Marasova. (2019) Failure analysis of the rubber-textile conveyor belts using classification models. *Engineering Failure Analysis*, 2019. — Vol. 101. — P. 407-417. (In English).

Ogden R.W. Large Deformation Isotropic Elasticity: On the Correlation of Theory and Experiment for Incompressible Rubberlike Solids. *Proceedings of the Royal Society of London. Series A, Mathematical and Physical Sciences*, 1972. — Vol. 326. — No. 1567. — P. 565-584. (In English).

Poderni R.Yu. *Mekhanicheskoe oborudovanie kar'erov* [Mechanical equipment of quarries]. Moscow, Izd-vo MGGU, 2007. — 680 p. (In Russian).

Rabatuly M., Demin V.F., Kenetaeva A.A., Steflyuk Yu.Yu., Toshov J.B. (2025) Evaluation of modern methods and techniques for calculating parameters during coal bed degassing. *Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources*. 2025; 334(3):110-120. DOI: <https://doi.org/10.31643/2025/6445.33> (In English).

Reshetnyak S.P. (1998) *Обоснование и разработка схем циклично-поточной технологии с внутрикарьерными передвижными дробильно-перегрузочными комплексами* [Justification and Development of Cyclic-Flow Technology Schemes with In-Quarry Mobile Crushing and Handling Complexes]: Dis. ... Doctor of Engineering Sciences. Apatity, 1998. — 423 p. (In Russian).

Sagitov A., Sherov K., Nasad T., Abdugaliyeva G., Okimbayeva A. (2023) Calculation of multi-blade rotary-friction tool shaft for strength. *Gumilyov Eurasian National University Bulletin. Series: Technical Sciences and Technologies* – Astana: ENU Publishing House, No 3(144)/2023 – P.8-19. DOI: <https://doi.org/10.32523/2616-7263-2023-144-3-08-19>. (In English).

Toshov J.B., Sherov K.T., Sikhimbayev M.R., Absadykov B.N., Esirkepov A. (2024) Analysis of interaction of rock breaking tool with rock in the drilling process. *News of the National Academy of Sciences of the Republic of Kazakhstan Series of geology and technical sciences*. Volume 1, Number 463 (2024). — P. 271–281. <https://doi.org/10.32014/2024.2518-170X.380> . (In English).

Toshov J.B., Malikov Sh.R., Ergashev O.S., Sherov A.K., Esirkepov A. (2023) Improving the efficiency of the process of drilling wells in complex conditions at geological prospecting sites // *NEWS of the National Academy of Sciences of the Republic of Kazakhstan "Series of geology and technical sciences"*. – Almaty, Volume 3, Number 459 (2023). — P. 282–294 <https://doi.org/10.32014/2023.2518-170X.313>. (In English).

Publication Ethics and Publication Malpractice in the journals of the Central Asian Academic Research Center LLP

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the journals of the Central Asian Academic Research Center LLP implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The Central Asian Academic Research Center LLP follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/ or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the Central Asian Academic Research Center LLP.

The Editorial Board of the Central Asian Academic Research Center LLP will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

**www.nauka-nanrk.kz
<http://www.geolog-technical.kz/index.php/en/>
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)**

Ответственный редактор *А. Ботанқызы*
Редакторы: *Д.С. Аленов, Т. Апендиев*
Верстка на компьютере: *Г.Д. Жадырановой*

Подписано в печать 15.12.2025.
Формат 70х90^{1/16}, 20,5 п.л.
Заказ 6.